Early birds in day care: The Social Gradient in Starting Day Care and Children's Non-cognitive Skills*

Frauke H. Peter[1,†], Pia S. Schober[1] and C. Katharina Spiess[1,2]

[1]*DIW Berlin, Germany*
[2]*Freie Universität Berlin, Germany*

Abstract

In recent years, almost all children below school age in Western industrialized countries have some experience of attending day care institutions. However, the age at which children enter day care and therefore the overall time spent in day care varies substantially. We investigate the potential impact of later day care entry on the social and emotional behaviour of children, one important aspect of non-cognitive skills. Based on the English sample of the Millennium Cohort Study, we analyse how later entries are associated with children's development at the age of five and seven, using propensity score techniques. We find clear evidence of significant associations at the age of seven: Later day care entry appears to increase children's peer-problems and to reduce prosocial behaviour. We find hardly any associations with the emotional development of children. Children with low educated mothers and those from families with a household income below the poverty line are most strongly affected, which provides support for a social gradient in how earlier day care entry impacts non-cognitive skills. (JEL codes: J13, I21)

Keywords: day care entrance, early start, socio-emotional behaviour, propensity score matching.

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† Corresponding author, email: fpeter@diw.de, DIW Berlin, Mohrenstraße 58, 10117 Berlin, Germany.

1 Introduction

With a growing labour force participation of mothers with young children in many industrialized countries and increasing acceptance of day care centres as educational institutions, the percentage of children attending day care has gone up. In 2010, at the EU27-level almost 83 per cent of all children 3 to 5 years of age attended some sort of day care institution (or preschool) before they enter school.[1] By contrast, only every third child below the age of three years attended some kind of day care in 2010 (33%), with huge differences between the countries: These range from 7 to 66 per cent of all under three years olds in day care. The UK ranges with 93 per cent of children from age 3 and 42 per cent of children under three years slightly above the EU average.[2]

Overall day care has become an important phase in children's education biography and questions regarding the effects of day care attendance on children's development have gained increasing attention also in the economic literature (see chapter 2). The results of economic studies have been diverse, among other reasons due to significant cross-national variation in how and to which groups day care services are provided. Furthermore, most of these studies mainly focus on the effects of attending versus not attending day care. Given that in the European context nowadays nearly all children attend day care institutions at some point in their lives, the more relevant and challenging question concerns the optimal starting age[3]. We therefore investigate the question 'is it better to start early or later?' based on a rich data set for England as one European day care context.

The theory on skill formation posits that children develop cognitive and non-cognitive skills by childhood stages (see Cunha and Heckman 2007; Cunha et al. 2006 and 2010). It emphasizes that children's development benefits from high quality care and education contexts. In particular children who were exposed to adverse (family) environments are assumed to benefit most from the experience of extra-familial care. Thus one might argue that an earlier starting age

[1] The term day care is used in various ways in the literature, covering various types of early childhood education and care services or preschool provision. We use this term for all kinds of non-compulsory formal child care arrangements taking place outside the home of a child.

[2] All relevant figures in this chapter on attendance rates in EU countries are taken from the OECD Family Data base (OECD 2014).

[3] For an overview of this discussion, see Baker (2011).

in high-quality day care and longer experience in terms of years of attendance are more beneficial for the development of these children than a later entry and fewer years of experience. This can mainly be explained by the complementarity of skill formation as higher levels of skills at an earlier level beget further development of skills at a later stage (e.g. Cunha et al. 2010). Emphasizing this later mechanism, one might also argue that an earlier entry may be beneficial for children from high quality family environments as their skills developed in the family context would be complemented by positive learning experiences in a day care context. However, it should be noted that for very young children, e.g. under one year of age, or in combination with long hours of care, some studies (Belsky et al. 2007) point to adverse developmental consequences in line with attachment theory (Thompson 1988; Bowlby 1969). Therefore further evidence is needed on how the consequences of day care attendance vary by the age when children start day care.

We focus on potential effects of the time of day care entry on non-cognitive skills during primary school age, as an increasing number of economic studies suggest that non-cognitive skills are important predictors of later educational achievements, health outcomes, and labour market success during adulthood (e.g., Blanden et al. 2007; Carneiro et al. 2007; Currie and Stabile 2006; Heckman et al. 2013; Prevoo and ter Weel 2015; Cobb-Clark and Schurer 2013). Cunha and Heckman (2007) even find that non-cognitive skills promote the formation of cognitive skills but not vice versa. Heckman et al. (2006) also show that non-cognitive skills are as important for school enrolment decisions as cognitive skills. Nevertheless, few economic studies so far have focused on the effects of day care on non-cognitive skills. There is one prominent exception, a reanalysis of Heckman and co-authors of the Perry Preschool Project, an early intervention study targeted at disadvantaged children. Heckman et al. (2013) show, that non-cognitive skills explain more of the variance in later outcomes than cognitive skills, in particular for boys. Nevertheless, as pointed out in many studies (see e.g. Baker et al. 2008; Havnes and Mogstad 2011), these results cannot be transferred to more universal programs. We focus on potential effects of day care attendance for all children, not only disadvantaged groups. We investigate children's non-cognitive skills at two time points during the primary school period, as several previous studies

on children's development have shown effects to vary by developmental period. Some previous studies find evidence of effects fading out over time (e.g., Cascio and Schanzenbach 2013), whereas others find stable effects (Apps et al. 2013) or even point to stronger associations during later developmental periods, sometimes referred to as 'sleeper effects' (e.g., Vandell and NICHD Research Network 2005; Magnuson et al. 2007). The latter patterns may be due to greater variability in children's development or stronger compensating support from teachers during some phases, such as transitions to school, which may make it more difficult to discern effects of previous day care attendance (Magnuson et al. 2007).

Concerning the mechanisms through which earlier day care exposure might affect non-cognitive skills two perspectives from social psychology provide further insights. Social learning theory (e.g. Bandura 1989) suggests that children who as a result of day care attendance have had more opportunities to observe and interact with peers of similar age would be expected to be more comfortable with peers and hence more sociable and show more positive affect towards other children. Likewise from a social-cognitive perspective, earlier day care entry may provide children with more frequent opportunities of exchanges with peers. In a context of competent adult supervision, such exchanges are considered to enhance children's social and emotional knowledge, and their communication and social problem solving skills (Rubin and Rose-Krasnor 1992). On the whole, these skills are assumed to result in less frequent displays of aggression and conduct problems, more positive peer interactions, and more prosocial behaviour with peers. These are some of the outcomes we look at.

Rather than using simply an overall index of socio-emotional behaviour as most previous economic studies do, we differentiate also between individual dimensions, such as social versus emotional development. This allows a better understanding of the mechanisms how day care environments affect some non-cognitive skill dimensions more than others and to disentangle which dimensions drive the overall associations. Furthermore, we focus on the heterogeneity of our estimates by gender and parental socio-economic background. Child gender is likely to matter as social-psychological perspectives (e.g. Block 1982) have argued that boys may be more affected by environmental variations than girls because of both differential socialization histories

and biological make-up. Boys may be more likely to respond to environmental variation, such as exposure to day care, by accommodating, that is by altering ongoing personality and cognitive structures. By contrast, girls tend to assimilate, thus conserving existing structures and providing more continuity with the past. As a result, we would expect a stronger association of early day care for boys than girls. In line with these perspectives, several previous studies have found differential responses of boys and girls to day care influences (e.g. Carneiro et al. 2007; Datta Gupta and Simonsen 2010).

In addition we explore the assumption and the result of other studies that earlier day care experience is more beneficial for children from disadvantaged family backgrounds (for a summary of empirical studies, see Ruhm and Waldfogel 2011). If disadvantaged children were to benefit in particular, policies to promote their earlier entry might be one way to reduce the large developmental gap that exists between children from different socio-economic backgrounds already at school entry age.

To contribute to the understanding of potential effects of starting age on socio-emotional behaviour, we aim at identifying relationships, which point to causality, by using propensity score matching. An advantage of propensity score methods is that estimates are less dependent on the functional form in the model, i.e. assumption of a linear relationship compared to OLS. Propensity Score Matching has also been used in several recent papers that investigate the determinants of child outcomes in the economic literature (e.g., Berger et al 2005; Goodman and Sianesi 2005; Ruhm 2008; and Apps et al. 2013). However, the results from propensity score matching can only be interpreted as causal under the strong assumption that all relevant factors are observed. Although we utilise a rich set of variables (see chapter 3), we mainly refer to our results as associations, to acknowledge that other unobservable factors might matter. In particular, some parental attitudes which influence the timing of day care entry may be difficult to measure.

2 Related literature

Many economic studies have investigated effects of universal day care services on children. Given our research focus, in this review we first of all focus only on studies investigating the effects on non-cognitive skills (for studies analysing day care effects on cognitive outcomes or health outcomes see e.g. Brilli et al 2011; Fitzpatrick 2008; or Magnuson et al. 2007; Drange and Havnes 2015; Datta Gupta and Simonsen 2015). Second, as we observe short- and medium-term outcomes of children, we review in detail only studies with a similar time frame. Studies looking at long-run effects of day care experience in adulthood, for instance, find effects on tertiary education, income, social assistance and other outcomes with differences by groups of children who are affected (for studies on effects in adulthood, see e.g. Bingley and Westergard-Nielsen 2010; Dumas and Lefranc 2010; Havnes and Mogstad 2011, for effects on adolescents see e.g., Apps et al. 2013; and Section 1)[4]. Third, we concentrate on studies considering age at day care entry or the duration of the day care experience rather than studies on the effects of any day care attendance (e.g. Magnuson et al. 2007 focus on behavioural outcomes, but do not on age of entry). Moreover, only a few studies explicitly analyse the heterogeneity of these effects for different groups.

Among the few studies that investigate specifically the duration of day care and focus on socio-emotional outcomes, the study by Datta Gupta and Simonsen (2010) is the most comparable. Based on Danish survey data, they investigate the effects of a Danish policy reform on children's non-cognitive skills at age 7 using the same overall measure as we do.[5] Although they do not explicitly focus on age of entry, their results can roughly speaking be interpreted as the effects of enrolling in preschool one year earlier. They find no overall effects of attending preschool respectively day care earlier on the socio-emotional behaviour of children, not even for subgroups. The authors only use one measure to capture the socio-emotional behaviour and do

[4] For a very good summary on various studies see Ruhm and Waldfogel (2011). As one of the few studies, Apps et al. (2013) also investigate non-cognitive skills of adolescents and they show mixed results. They do not find any evidence of improvement in psychological well-being but in health behaviour.

[5] This reform led to differences in the take up of preschool day care or family day care, respectively, between municipalities after they introduced guaranteed access.

not differentiate between the emotional or social behaviour of children. In a later study by the same authors (2012) they use the same reform as an instrument. This study focuses on a set of various non-cognitive and cognitive measures at age eleven. Again they find almost no significant effects of attending preschool at age three on socio-emotional behaviour[6].

Another study by Baker et al. (2008) uses a reform in Canada's largest province Quebec to identify the effects of a large extension of access to a full-day place at a day care institution for children of different age groups. With respect to non-cognitive skills their estimates indicate that behaviour deteriorated in the treated province. However, they do not examine the age of entry. This is done in the study by Kottelenberg and Lehrer (2014), which extends the study by Baker et al. (2008). Kottelenberg and Lehrer (2014) explicitly focus on differences in the age children got access to subsidized child care. Their estimates show that children who got earlier access experience significantly larger negative impacts on motor-social development scores and behavioural outcomes. However, their further subgroup analysis shows that access to day care at 3 years of age may benefit the most disadvantaged. Furthermore the reform led to a sharp increase in day care quantity but not necessarily in quality (see also Datta Gupta and Simonsen 2010: 43).

A study based on US data from the Early Childhood Longitudinal Study Kindergarten-Class (ECLS-K) (Loeb et al. 2007) explicitly takes into account differences in day care starting age. They identify effects using OLS, matching, and instrumental variables for five-year-old children. The authors find that on average, attending centre care is associated with positive gains in cognitive skills, but negative for social behaviour: Starting earlier than age 2 is related to more pronounced negative social effects. However, for some disadvantaged children, the socio-behavioural effects are neutral.

Studies on the effect of (early) day care attendance on non-cognitive skills using German data report different results. Based on data of the German Socio-Economic Panel Study (SOEP) and focusing on the same outcome measure we use, Müller et al. (2013) show that children

[6] They only find one significant effect: children attending day care liked school more.

attending day care before the age of three have less socio-emotional problems at primary school age (5- to 10-year-old children). Using an instrumental variable approach and based on the 'DJI children panel', Schlotter (2012) estimates a positive effect of an earlier day care entry on children's assertiveness and ability to form friendships. In a recent study, Felfe and Lalive (2014) analyse the effect of early day care entrance based on administrative data for one German state. Using a marginal treatment effects framework, they show that early day care is more beneficial for developing socio-emotional maturity for children of less educated mothers than for children of highly educated mothers.[7]

3 Institutional context

In this paper we focus on the UK, and, more specifically, on England. While all UK countries share similar early childhood education and care systems, countries within the UK have considerable autonomy in the way they fund, organise and regulate services. In particular, compulsory schooling starts one year earlier in Northern Ireland, while in Scotland primary schools do not offer full-day provision the year before compulsory schooling as England and Wales do. Moreover, quality regulation and curricula differ across the countries (for summaries for Wales, Scotland, and Northern Ireland, see EACEA 2009, OECD 2000).

We restrict our analysis to potential effects on children attending day care (or preschool institutions) in England in order to reduce the contextual variation in early childhood education and care institutions. The following brief description will discuss day care policies for children from birth until they reach compulsory school age, which is age five in England. We focus on the years between 2000 and 2005, which are the ones observed in the empirical analysis, and also coincide with several reforms and initiatives by the Labour government in power at the time. In the UK, mothers of children born in 2000 or 2001, the cohort we focus on, were entitled to 14

[7] Apart from the economic literature there are many other studies, mainly by educational scientists, on the effectiveness of day care programs on child outcomes (for recent meta-analysis see e.g. Burger 2010 or Camilli et al. 2010). Some using these studies use the same outcome measure as we do. The study by Jensen et al. (2013), for instance, shows that children who attended high-quality day care developed fewer emotional symptoms and conduct problems, became less hyperactive and were more attentive.

weeks, 18 weeks, or 29 weeks of maternal leave, depending on the length of their employment tenure with the same employer (Moss and O'Brien 2006; Ringen 1997).

Historically, day care provision in England was a matter for local decision and dominated by a market economy of child care. In England providers of early education and care have included organisations from the public, private and voluntary sectors, such as nursery schools, nursery classes, infant classes, and reception classes based in primary schools, day nurseries, preschool/playgroups, and child minders (West 2006, OECD 2000). Generally, day care providers offered services throughout the year on a full-time basis, while services based in primary schools were open only during term time and are often part-time. Another important difference concerns child to staff ratios and staff educational qualification requirements. Non-school settings, such as private day nurseries, required lower child-teacher-ratios than reception classes, nursery classes, and nursery schools, where pedagogic staff had higher education levels.

Common across all types of setting was however the Foundation Stage – a standardized curriculum covering all provision for children from age three and a system of regular inspections (West 2006). Many children attend more than one type of day care during their preschool years, and the transition ages and combinations of providers vary. Therefore, we focus on the age at which children started to attend any of these types of day care.

A local system of planning was introduced in 1998 to try and ensure that there was adequate provision to meet demand. Furthermore, a free, part-time entitlement to an early years education place for all 4-year olds was introduced in 1999. All 3-year olds were guaranteed the same free, part-time entitlement to an early years education place by 2004. Parents could top up the free place with additional fee-paying hours in the same or another setting.[8] Besides funding going directly to service providers, parents also received financial support. In particular the Childcare Tax Credit (CTC) was paid to the low-paid, working more than 16 hours per week and

[8] As part of the Sure Start Programme, additional funding was allocated for extending the provision in disadvantaged neighbourhoods to counteract the large differences in day care attendance rates of different social groups (Bell and Finch 2004).

receiving the Working Family Tax Credit. The CTC covered up to 70 per cent of formal childcare costs with a registered provider up to a certain maximum.

Day care attendance rates of children under the age of three were low in the early 2000s. About 20 per cent of this age group had access to licensed services, of which most were two-year olds. Younger children were mostly cared for by informal carers or child minders and only few attended private day-nurseries (OECD 2000; OECD 2006). The percentage of three-year olds attending day care rose from 86 per cent to 99 per cent between 2000 and 2003 (Department for Education and Skills 2003). Full enrolment was reached for all four year olds already in 2000 (Lewis 2003).

Furthermore, attendance rates varied significantly between socio-economic groups. Whereas 7 per cent of three- and four-year old children with parents earning less than £ 10,000 did not attend any day care services in 2002, this was the case for only two per cent of children whose parents earned £ 30,000 or more (Bell and Finch 2004). For children who had just turned three years, this difference was even larger (23 per cent versus 5 per cent). Previous studies and parent surveys suggested that the high costs of private provision and limited availability of affordable public provision limited low income families' choices in terms of early years education for their children (West 2006). In 2008, the free-entitlement beginning the term after children's third birthday was extended to 38 weeks of the year, and in 2010 it rose to 15 hours per week. Since 2013, the entitlement has been extended to 2-year-olds looked after by the local authority or from low-income families who would be eligible for free school meals (for details on eligibility, see Brewer et al. 2014).

4 Empirical strategy

Our empirical strategy aims at identifying the potential effect of later day care entry on non-cognitive skills of children at age 5 and 7. But in general, estimating the causal effect of later day care entry on children's outcomes raises various problems, among them the missing counterfactual problem.

Equation 1 summarizes the linear relationship of later day care entry (our treatment) on children's non-cognitive skills:

$$Y_i = ß_1 + ß_2\ TREATMENT_i + ß_3\ X_i + \upsilon_i \quad (1)$$

Y_i denotes *child i's non-cognitive skills* and X_i is the vector of conditioning variables.

The *Treatment* variable is defined as a binary measure, which equals 1 if a child enters day care at the age of 31 months or older and 0 if day care is started prior or equal to the age of 2.5 years (i.e. 30 months). This cut-off is driven by recent day care policy developments in England and by the actual distribution in starting age (see Section 5). There has been a continuing debate whether universal access to a day care place granted to children from age three years should be extended to all, and not just to disadvantaged, two-year-olds (as done since 2013). If such a guarantee for a place were introduced, due to fixed day care starting dates mainly in September and April children would in practice start sometime between age 2 and 2.5 depending on the month of their birth.

The effect of later day care entry may be estimated correctly through OLS if the "selection on observables" assumption is satisfied (see Heckman 1979). This means that all variables which predict both later day care entry and children's non-cognitive skills must be included in our model. Furthermore, for OLS to consistently estimate the effect of later day care entry, the underlying model must be correctly specified. However, the assumption that the relationship between later day care entry and a child's non-cognitive skills is linear or additive is really hard to verify when including several explanatory variables.

In this study we apply propensity score matching methods to address the missing counterfactual problem. We need to exclude the possibility that a child who starts day care later may have unobserved characteristics that also affect a child's non-cognitive development. Furthermore parents who decided to send their child to day care later may be systematically different from those who did so earlier. A prevalent method to increase similarity between two groups is propensity score matching (e.g. Blundell and Costa Dias 2000; Rosenbaum and Rubin

1983). One advantage of this approach is that we do not have to restrict our analysis to compliers of a reform (as done e.g. by Datta Gupta and Simonsen 2010; 2012; Baker et al. 2008; Kottelenberg and Lehrer 2014).

Propensity score matching assumes that conditional on observable characteristics assignment to treatment and control group is as good as random. To obtain a "random sample", we estimate a child's propensity to start day care later than at the age of 2.5 years. Based on a set of relevant characteristics (X_i) we obtain a comprehensive measure of all covariates for each child. Propensity score matching methods enable us to reweight individuals of the control group based on the propensity score to match treatment observations for the average treatment effect of the treated (ATT). Non-matched individuals are dropped from the analysis. We use kernel matching[9] to obtain the weight that reweights the control group observations to match the treatment group and to compare nearly identical children either starting day care early or later.

We use propensity score methods to estimate two parameters of interest: the average treatment effect of the treated (ATT) and the average treatment effect of the untreated (ATU). The ATT measures the difference between the average outcome for children who enter later and the average outcome assuming they had not entered later: $ATT = E(Y_1 \mid D=1) - E(Y_0 \mid D=1)$, whereas the ATU in our paper compares the difference in outcomes assuming the children had entered day care earlier: $ATU = E(Y_1 \mid D=0) - E(Y_0 \mid D=0)$.

Equation 2 depicts the average treatment effect of the treated (ATT) using a regression-adjusted matching approach[10]:

$$ATT = \sum_{i \epsilon T} W_i \left[(Y_{1i} - x_i \hat{\beta}) - \sum_{j \epsilon C} W_{i,j} (Y_{0j} - x_j \hat{\beta}) \right] \quad (2)$$

[9] Matching is implemented in Stata 13 using the program psmatch2 provided by Leuven and Sianesi (2003). We use kernel matching with an Epanechnikov kernel function and a bandwidth parameter of 0.06.

[10] This regression-adjustment decreases the standard errors of the treatment effect estimates, since the weighting leads to mean-independent treatment (see Stuart 2010).

In Equation 2, $W_{i,j}$ is the weight placed on *individual j* (of the control group) to be comparable to *individual i* (of the treatment group). The weight $W_{i,j}$ includes values obtained from kernel matching.

However, for our results to be interpretable as causal, one has to assume that there are no unobserved variables that simultaneously influence children's socio-emotional behaviour and the probability of starting day care later. Meaning that in the absence of variation in the age of entry in day care, the non-cognitive skills of treated children and matched controls would be identical. If this unconfoundedness assumption is violated, i.e. if children who are treated differ systematically from children who are not treated in terms of unobservable characteristics, our model suffers from endogeneity. To make the unconfoundedness assumption more plausible, we include several measures of children's cognitive and non-cognitive skills at the age of 9 months, which might influence both a child's socio-emotional behaviour and starting day care later (see next section). Moreover, we include maternal non-cognitive skill measures (namely mother's education behaviour and personality traits). For the implementation of matching, we predict a child's propensity to enter day care later than age 2.5 years. Since our day care definition covers all care arrangements outside the home of the child, there is less risk of bias due to the potential correlation between different types of day care, age at entry and child's non-cognitive skills than in other studies which, for instance, differentiate between family day care and preschool with different average starting ages.

5 Data

In order to analyse the potential effects of our treatment (later entry into day care) on our child outcome measure, we use data from the Millennium Cohort Study (MCS). The Millennium Cohort Study is a representative sample of births covering children born in the UK between September 2000 and January 2002 (Hansen 2012). The sample is clustered geographically and disproportionately stratified to over-represent: (1) the three smaller countries of the UK – Wales, Scotland and Northern Ireland; (2) areas of high child poverty; (3) within England only, areas with high concentration of ethnic minorities (Plewis 2007). The first wave of MCS occurred when

children were aged about nine months, gathering information from the parents of 18,818 children, about themselves and the babies (e.g. problems during pregnancy, birth weight). Since then, families have been interviewed again five times. Here we use data from the first four waves, which took place when the children were aged 9 months, three years, five years (thus entering compulsory schooling) and seven years.

We restrict our sample to children living in England, so that the childcare supply is similar for all children observed (see Section 3). Furthermore, we keep in our sample only children who are not twins or triplets, whose mothers responded to the survey and who have valid information on non-cognitive skills at wave 3 and 4 and on their age at day care entry. This reduces the sample to 6460 children. Furthermore we restrict our sample to children who have non-missing information on children's early skill measures 'temperament of the child': 5448 children have non-missing information on this conditioning variable. The drop in sample size is driven by item non-response[11]. Predicting the propensity of later entry based on this skill measure and other relevant conditioning variables (see description below) leaves us with 4825 or 4687 observations respectively in the matched sample. The latter sample is used for sensitivity testing.

5.1 Day care entry measures

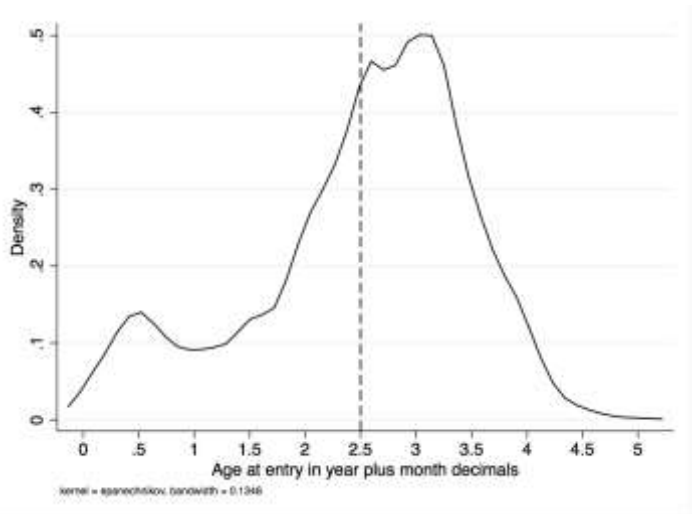
To investigate the potential effect of later day care entry on the socio-emotional behaviour, we use information on the year of first day care attendance provided by mothers. In the MCS, the day care history is surveyed at Wave 2 and, more comprehensively, at Wave 3 (when children are 3 and 5 years old, respectively). Based on the provider type mothers mentioned first, the majority of children, 51 per cent, attended nursery schools or nursery classes, 15 per cent a play group, 16 per cent a preschool, 3 per cent a child minder, and the remaining 15 per cent were cared for by day nurseries or some other than the before mentioned institutions. We consider all these types of care as day care, including preschools, as in England preschool education and day care in a more

[11] In our sensitivity analysis section we report results for "relaxed" sample restrictions and remove 'temperament of the child' as conditioning variable from our estimations. By doing this, we infer if item non-response influences our estimations.

narrow sense are intertwined. Moreover the information collected from mothers about the type of day care is insufficient to distinguish systematically between all relevant settings with varying quality dimensions. Therefore our treatment covers a variety of extra-familial care arrangements, which are all subject to some quality regulations (see Section 3) (for the same approach in the UK context, see e.g. Goodman and Sianesi 2005 and Apps et al. 2013, in a US context see Magnuson et al. 2007). From a methodological point of view this definition allows us a large enough sample of children in day care and a clear distinction between treatment and control group. We do not have any further information about day care quality. Thus we are clearly estimating an effect of average exposure. Moreover, we focus on age at entry and do not take into account different intensity of day care attendance, i.e. full-time or part-time care.

The treatment group comprises children who enter day care later, namely later than the age of 2.5 years. This treatment cut-off reflects the distribution of entry age in our sample with 42 per cent of children entering day care prior or equal to the age of 2.5 years and 58 per cent of children entering later (see Figure 1).

Figure 1: Distribution of age at entry in full sample



Note: This figure displays the distribution of starting age in the overall sample.
The dashed line marks the cut-off point used in our empirical strategy. Source: UK MCS.

The control group consists of children who attend day care early, namely prior or equal to the age of 2.5 years. Similar to the treatment group children have to have valid non-cognitive skill information and their mothers have to have participated in the survey at Waves 1-4. The

control group does not include children who do not participate in day care, as all children in England are attending day care at some point in time; at the latest before they enter school (see Section 4). Children in the control group enter day care on average at 1.6 years (19 months) and children in the treatment group at 3.2 years (38 month). Thus children in the control group are on average 1.6 years longer in day care than children in our treatment group.

5.2 Measures of non-cognitive skills

To measure the outcome of interest, the socio-emotional behaviour of children, the Millennium Cohort Study (MCS) includes the Strength and Difficulties Questionnaire (SDQ), proposed by Goodman (1997). Research suggests that the SDQ and the well-known Rutter questionnaires (Rutter et al. 1970) correlate highly and do equally well in terms of classifying behaviour (see Goodman 1997). The SDQ is reported to have high test-retest reliability and good validity, and has been used in other large epidemiological, educational, psychological and, as indicated above, in a few economic studies.

We use measures of the SDQ at two points in time: at age five and seven. The SDQ is part of a self-completion module filled out mainly by mothers. It consists of statements to which the responses are: 'not true', 'somewhat true', and 'certainly true'. The socio-emotional behaviour is gathered through 25 items over five separate dimensions respectively subscales: Conduct Problems, Hyperactivity/Inattention, Emotional Symptoms, Peer Relationship Problems, and Prosocial behaviour. Higher scores on the first four of these subscales and lower scores on the pro-social subscale indicate greater problems. A 'total difficulties' score is generated by summing the first four scales and excluding the prosocial scale, which can be used as a positive counter measure to the overall SDQ score. The resultant score ranges from 0 to 40, the subscales from 0 to 10. For our analysis we use the overall SDQ score as well as its dimensions to cover various aspects of a child's socio-emotional behaviour. In the estimations, the SDQ and all subscales are standardized to have a mean of zero and a standard deviation of one.

Mothers' assessments of children's behaviour include a risk of measurement error. However, even if mothers' responses are biased, as long as this is unrelated to early or later day

care entry, it will not cause problems for our identification strategy. Since mothers are not asked to evaluate child behaviour directly in the context of day care entry but instead are likely to use other children at primary school age as the comparison group for their assessments[12], it is less likely that biases in mothers' responses will vary systematically with day care entrance age (see also Datta Gupta and Simonsen 2010).

Our measure of socio-emotional behaviour has been applied in many other studies, among them a few by economists (see, e.g. Andersen et al. 2007; Ermisch 2008; Datta Gupta and Simonsen 2010; 2012; Ermisch et al. 2012; Dearden et al. 2010; and Müller et al. 2013) as well as by researchers from other disciplines using the UK Millennium Cohort Study (e.g. Griffiths et al. 2011; Heikkilä et al. 2011; Kelly et al. 2011; McMunn et al. 2012). However, most studies mainly focus on the total SDQ without differentiating which dimension(s) might be driving the overall associations.

5.3 Conditioning variables

The empirical strategy relies on the assumption that the variables to predict day care entry and children's non-cognitive skills are observed. Therefore the set of variables used to condition on children's propensity to enter day care later is crucial for the identification strategy. The choice of conditioning variables is based on other empirical studies[13] investigating the associations of day care (entry) with child outcomes. Among these variables are children's cognitive and non-cognitive skills. For these skills we use information from the Developmental Denver Screening Test and the Carey Infant Temperament Scale measured at the age of nine months (for more information on these scales see Johnson 2012). The latter scale in particular covers items which are similar to the outcome measures we use at later ages. Moreover in sensitivity estimations we also match on measures for infant control/behaviour. In addition, other child characteristics around birth (e.g., birth weight, being breastfed), maternal characteristics that determine maternal preference for day care (e.g. employment status, education, ethnic background, age at birth,

[12] For a detailed overview of the dimensions and questions, see Table A1 in the Appendix.
[13] For other studies see Section 2 of this paper.

mental health and educational attitudes[14]) and household characteristics (e.g., household type, number of siblings and poverty status) are used as conditioning variables. The majority of our conditioning variables are measured at wave one, which means pre-treatment. Table A2 in the Appendix summarises the variables.

5.4 Descriptive Statistics

A first descriptive comparison between treatment and control group shows that a child's socio-emotional behaviour differs by age at entry (see Table 1). Overall 58 per cent of the children attend day care later than at the age of 2.5 years. The mean of children's overall SDQ score at age 5 and at age 7 is 0.6[15] score points lower for children who enter day care early. This difference is statistically significant and hinges towards a potentially adverse influence of later day care entry on children's socio-emotional behaviour, implying that they are less stable in respect to socio-emotional behavior. In general, Table 1 shows that children who enter later have a higher score on all SDQ dimensions. This negative relationship between later day care entry and children's levels of non-cognitive skills is descriptively found at age 5 and persists until age 7. These mean differences between treatment and control group show up for all sub-dimensions of the socio-emotional behaviour. The differences are larger for peer problems and relatively small for emotional problems. In addition, we have run appropriate tests to contrast covariate mean differences across our matched groups to ensure that adequate matches have been obtained. Results from the balancing tests are shown in Table A2 in the Appendix. They show that balancing children of the control group to match children of the treatment group was successful. We obtain a large reduction in the standardised per cent bias, which is the per cent difference of the sample means in the treatment and the matched control sample as a percentage of the square root of the average of the sample variances in both groups. Figure 2 shows the kernel density

[14] In a sensitivity test we further match on maternal personality traits.

[15] This translates into a difference between treatment and control group of 11 per cent of a standard deviation.

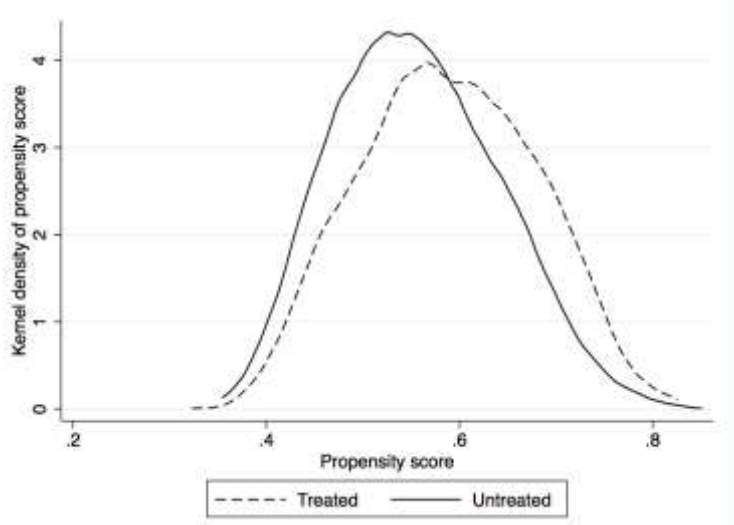
estimate of the obtained propensity score for treatment and control group. Both curves show an extensive overlap between the treatment and control groups.

Table 1: Differences in child's non-cognitive skills by age at entry (score points)

Outcomes		Full sample		Early entry (≤ 2.5 yrs)		Later entry (> 2.5 yrs)		Mean Difference
		Mean	SD	Mean	SD	Mean	SD	
Age 5	*Overall SDQ score*	7.21	4.89	6.87	4.61	7.40	5.04	-0.528***
	Conduct problems	1.46	1.47	1.40	1.42	1.49	1.50	-0.0919**
	Hyperactivity	3.26	2.34	3.16	2.26	3.32	2.40	-0.162***
	Emotional problems	1.36	1.57	1.30	1.49	1.39	1.60	-0.0966**
	Peer problems	1.13	1.42	1.02	1.34	1.20	1.47	-0.177***
	Prosocial behaviour	8.39	1.65	8.46	1.60	8.35	1.68	0.104**
Age 7	*Overall SDQ score*	7.42	5.34	7.06	5.03	7.65	5.53	-0.590***
	Conduct problems	1.35	1.51	1.28	1.44	1.40	1.55	-0.116***
	Hyperactivity	3.23	2.48	3.20	2.37	3.40	2.54	-0.196***
	Emotional problems	1.53	1.75	1.46	1.70	1.57	1.78	-0.107**
	Peer problems	1.22	1.54	1.12	1.45	1.29	1.60	-0.172***
	Prosocial behaviour	8.61	1.62	8.70	1.55	8.55	1.66	0.144***
	N	6,678		2,706		3,754		6,460

Source: UK MCS. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure 2: Kernel density of propensity score for treatment and control group in full sample



Note: This figure compares the overlap of the estimated propensity scores for treatment and control group in the full sample (N=4,825). Source: UK MCS.

5.5. Heterogeneous associations

We differentiate our analysis by gender of the child, by maternal education, and by a poverty threshold. We use information on maternal education based on the national vocational qualification framework, and distinguish between "low education" and "high education".[16] The poverty subgroup utilizes a measure taken directly from the Millennium Cohort Study. This measure is based on the equivalised household income according to the OECD equivalence scale. Households are defined as poor if their equivalised household income is less than 60 per cent of median household income. All indicators for the subgroups are measured at wave 1 to ensure pre-treatment information. We perform propensity score matching separately for each subgroup analysis, e.g., girls who enter late are matched to nearly identical girls who enter early based on the set of conditioning variables[17].

6 Results

This section presents the associations of later day care entry with socio-emotional behaviour using OLS and propensity score methods. We mainly interpret the results of our preferred specifications using propensity score matching and thus intend to get as close as possible to a causal interpretation.

Table 2 presents the results regarding the associations of later day care entry (entry > 2.5 years of age) with socio-emotional behaviour of children at age 5 and 7, respectively. Later day care entry is significantly associated with larger socio-emotional problems (SDQ) of children in the medium run (at age 7) but not in the short run (at age 5). A child's SDQ at age 7 is estimated to increase by 6.7 per cent of a standard deviation if she enters day care later than at the age of 2.5 years. The analysis of the sub-dimensions show that this is mainly driven by peer problems: A later entry is associated with an increase of peer problems of children by 8 per cent of a standard

[16] In our analysis we define "low education" if mothers have an educational level below A-levels, i.e. "none of these qualifications", "GCSE grades A-G", or "O-levels". Mothers are categorised "high educated" if their educational level is equal to or above A-levels, i.e. "A-levels", "diplomas in higher education", "first or higher degree".

[17] In each subgroup, we compare the covariate distribution across our matched groups to ensure that adequate matches have been obtained. Results from the balancing tests for each subgroup are available from authors upon request.

deviation. Thus the social dimensions are more strongly affected than the emotional ones. Moreover, the social dimensions matter for both age groups. Children who enter day care later also have more peer-problems at age 5 and behave less prosocial at age 5 and 7. The other sub-dimensions have no statistically significant relevance either at age 5 or at age 7. As shown by the ATU specifications, the associations of *late entry* with socio-emotional behaviour of children in the control group at age 5 and at age 7 is at most slightly smaller with respect to the size of the estimates and their statistical significance but shows the expected relationships.

A comparison of the strengths of the associations of the SDQ with later day care entry as opposed to those with maternal education and low birth weight, two commonly used control variables, suggests that the latter associations are about twice the size of the former.[18] A low level of education of the mother is associated with an increase in the overall SDQ at age 7 by almost 14 per cent of a standard deviation as compared to children with mothers with higher educational qualifications. The overall SDQ of children with low birth weight is 17 per cent of a standard deviation higher than the reference group.

Given different developmental patterns between girls and boys, in particular for their socio-emotional behaviour, we split the *sample by gender* (see Table 3). At age 7, we find large and significant associations for boys of a later entry age with their socio-emotional behaviour, whereas later entry does not seem to affect girls in the medium-term. The overall SDQ score of boys who enter day care later is almost 11 per cent of a standard deviation higher than those who enter earlier. This effect is mainly driven by greater conduct and peer problems of the "treated". Both at age 5 and 7 we find associations with more frequent peer-problems and reduced pro-social behaviour for boys.

[18] The results for the entire models are available from the authors upon request.

Table 2: Estimation of the association of later day care entry and child's socio-emotional behaviour at age 5 and at age 7

	Age 5			Age 7		
	OLS	**ATT**	**ATU**	**OLS**	**ATT**	**ATU**
Overall SDQ score	0.108***	0.039	0.033	0.110***	0.067**	0.044*
	(0.025)	(0.028)	(0.026)	(0.025)	(0.028)	(0.026)
Conduct problems	0.062**	-0.001	-0.011	0.077***	0.036	0.012
	(0.025)	(0.028)	(0.026)	(0.025)	(0.029)	(0.027)
Hyperactivity	0.069***	0.026	0.014	0.079***	0.050*	0.040
	(0.025)	(0.029)	(0.028)	(0.025)	(0.029)	(0.028)
Emotional problems	0.062**	0.012	0.016	0.061**	0.032	0.012
	(0.025)	(0.028)	(0.027)	(0.025)	(0.029)	(0.028)
Peer problems	0.124***	0.079***	0.084***	0.112***	0.081***	0.063**
	(0.025)	(0.028)	(0.027)	(0.025)	(0.028)	(0.028)
Prosocial behaviour	-0.063**	-0.063**	-0.050*	-0.089***	-0.089***	-0.066**
	(0.025)	(0.029)	(0.028)	(0.025)	(0.028)	(0.028)
Conditioning variables	No	Yes	Yes	No	Yes	Yes
N	6,460	4,825	4,825	6,460	4,825	4,825

Note: Each cell represents estimations from a separate regression analysis. ATT and ATU models include as control variables all conditioning variables as outlined in Section 5 of this article.
Standard errors in parentheses, all dependent variables in terms of one standard deviation (z-score), * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Source: UK MCS.

Table 3: Estimation of the association of later day care entry with socio-emotional behaviour at age 5 and at age 7 by gender (ATT)

	Boys		Girls	
	Age 5	**Age 7**	**Age 5**	**Age 7**
Overall SDQ score	0.041	0.105**	0.031	0.019
	(0.042)	(0.042)	(0.037)	(0.038)
Conduct problems	-0.005	0.085**	-0.011	-0.018
	(0.042)	(0.043)	(0.039)	(0.039)
Hyperactivity	0.028	0.073*	0.027	0.024
	(0.042)	(0.042)	(0.038)	(0.039)
Emotional problems	0.009	0.053	0.005	-0.001
	(0.040)	(0.042)	(0.042)	(0.042)
Peer problems	0.089**	0.105**	0.069*	0.046
	(0.042)	(0.042)	(0.038)	(0.038)
Prosocial behaviour	-0.094**	-0.152***	-0.038	-0.011
	(0.044)	(0.045)	(0.038)	(0.036)
N	2,444		2,379	

Note: Each cell represents estimations from a separate regression analysis. All models include as control variables all conditioning variables as outlined in Section 5 of this paper.
Standard errors in parentheses, all dependent variables in terms of one standard deviation (z-score), * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Source: UK MCS.

In a next step, we differentiate our analysis by two *socio-economic characteristics*, maternal educational attainment and poverty status. Table 4 comprises the estimates of the ATT at ages 5 and 7 differentiated by maternal education level and by the 60 per cent threshold of median household income.[19] These estimations show that children from lower educated mothers trigger the effect of later day care entry for both age groups. The associations with the SDQ at age 7 for children with low educated mothers are almost twice as strong as for the average child. The analysis of the sub-dimensions shows that this is driven by more frequent peer problems – again emotional problems seem to be unaffected. Overall this subgroup analysis provides support for a social gradient in the association of day care entry age with social behaviour[20].

The differentiated analyses by household income show similar patterns but the differences in the strengths of the associations with the SDQ at age 7 are even more pronounced for children from poor households than for children with low educated mothers (20 and 12 per cent of a standard deviation respectively). In particular at age 7, children in poor households who enter day care later do worse on all SDQ sub-dimensions with the exception of emotional problems.[21] By contrast, children living in households above the poverty line drive the association of later day care entry with prosocial behaviour. On this dimension, children of poor households appear not to be affected. For children with low educated mothers or those living in households below the poverty line further analyses show that the results at age seven are driven mainly by boys.[22]

[19] In these tables we restrict the various measures for the socio-emotional behavior to the overall score and the five subscales. Moreover we only present the average treatment effects on the treated, as the ATT is our preferred specification.

[20] There is one exception. Children of higher educated mothers have significantly more peer problems at age five if they enter day care later.

[21] Again there is one exception. Children living in households above the poverty line have significantly more peer problems at age five if they enter day care later.

[22] Only in the short run we find some significant associations for girls living in poverty. Nevertheless, they seem to fade out in the medium term.

7 Sensitivity Analysis

First we test if the results are sensitive to our age of entry cut-off age. We test an alternative cut-off which is solely data driven, the median age of entry, which is 2.7 years of age. Table A3 shows that the results remain the same.[23] Moreover, we match on a different set of conditioning variables to infer whether selection on omitted variables affects our results. Therefore we include one additional variable for pre-treatment child behaviour, namely the infant control battery, and variables covering maternal personality traits. Table A4 shows that the effect sizes remain fairly similar. Due to the smaller sample size, the statistical significance decreases in some cases.

In addition we test if our results are robust regarding outliers in the age of entry distribution – at the lower and the upper bound. To test whether children who enter day care very early, i.e. during the first year of their life, or relatively late, i.e. between the age of 49 and 60 months might bias our analysis, we re-estimate the treatment effect excluding these two small groups of children in separate steps. The results of these tests show that limiting the control group to those entering after 12 months or restricting the treatment group to entries between the age of 31 months and 48 months respectively, does not affect our estimates[24].

Furthermore we test if our sample restriction to valid observations for children's temperament at the age of 9 months or poverty threshold information – both confounding variables have particularly high non-response – might bias our results. Excluding and not matching on these variables increases our sample to 5568 and 5934, respectively, and renders similar results.

Since the Millennium Cohort Study is clustered geographically and disproportionately stratified, we further check the robustness of our results by estimating the propensity to enter day care later using the sampling weights provided by the MCS. To consider these sampling weights, we use propensity score weighting (Hirano and Imbens 2001)[25]. Compared to the treatment effect

[23] Only for the prosocial behaviour at age 5 and for hyperactivity at age 7 the statistical significance decreases from the 5-per cent to 10-per cent-level.
[24] Results are available by the authors upon request.
[25] A critical aspect of using the estimated propensity score as weight is its sensitivity to large estimated propensity scores which, however, decreases with sample size. By restricting the post-estimations to the common support area, the problem of "large propensity score values" should have only a minor impact.

obtained from propensity score matching in Table 2, the size of the estimates of the average treatment effect on the treated (ATT) is slightly larger but remains significant at the same significance level. We also re-estimate the probit regression of entering day care after 2.5 years of age using the sampling weights of the MCS. The results are robust and similar in size to whether we match conditioning on stratification criteria or whether we use the country specific weights using propensity score weighting.

Table 4: Heterogeneous associations of later day care entry with socio-emotional behaviour by maternal education and poverty status (ATT)

	Age 5				**Age 7**			
	Low education	High education	Below 60% median income	Above 60% median income	Low education	High education	Below 60% median income	Above 60% median income
Overall SDQ score	0.026 (0.045)	0.052 (0.033)	0.130* (0.071)	0.005 (0.029)	0.117*** (0.044)	0.019 (0.034)	0.195*** (0.069)	0.019 (0.030)
Conduct problems	-0.023 (0.047)	0.017 (0.034)	-0.028 (0.075)	-0.008 (0.030)	0.060 (0.045)	0.022 (0.035)	0.125* (0.074)	-0.003 (0.030)
Hyperactivity	0.058 (0.044)	-0.005 (0.036)	0.193*** (0.066)	-0.025 (0.032)	0.064 (0.044)	0.033 (0.037)	0.168** (0.066)	0.009 (0.032)
Emotional problems	-0.033 (0.046)	0.050 (0.035)	0.054 (0.069)	-0.003 (0.031)	0.087* (0.046)	-0.025 (0.036)	0.093 (0.070)	0.009 (0.032)
Peer problems	0.055 (0.045)	0.113*** (0.034)	0.098 (0.070)	0.072** (0.030)	0.147*** (0.042)	0.018 (0.037)	0.178*** (0.067)	0.045 (0.031)
Prosocial behaviour	-0.099** (0.044)	-0.029 (0.037)	-0.088 (0.070)	-0.054* (0.031)	-0.142*** (0.043)	-0.041 (0.037)	-0.072 (0.068)	-0.082*** (0.031)
N	2,307	2,513	1,091	3,732	2,307	2,513	1,090	3,732

Note all cells represent estimations from separate regression controlling for all conditioning variables used for propensity score matching. Columns display the ATT of each outcome. Standard errors in parentheses, all dependent variables in terms of one standard deviation (z-score), * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Source: UK MCS.

8 Conclusion

In this paper, we investigate how entering day care later than age 2.5 years compared to earlier is associated with socio-emotional behaviour of children as one particular measure of non-cognitive skills. A growing number of studies provide evidence of the importance of non-cognitive skills for educational, health, and labour market outcomes in the longer run. Thus we contribute to the literature on how children's early learning and care experiences in day care centres affect their non-cognitive skills. We extend previous studies by not simply focusing on the effects of day care in general, but on the age of entry. Furthermore, whereas the few previous studies using the same skill measures mostly use one composite score, we analyse several dimensions of socio-emotional behaviour to gain a more in-depth understanding of whether aspects of emotional development or social behaviour are driving the overall effect more strongly. We also extend the existing literature by performing detailed analysis of social gradients in the associations of later day care entry with children's development considering moderating factors of child gender, maternal education, and household income. Furthermore we focus on short- and mid-term associations, while most other studies only focus on a measure at one point in time. We use Ordinary Least Squares and Propensity Score Matching - given the richness of the MCS; we match on a rich set of confounding variables, covering for instance children's earlier skills and birth weight, mothers' parenting attitudes, health, educational level, and household characteristics.

Across the whole sample, we find that a day care entry past age 2.5 years is associated with adverse socio-emotional behaviour of children at age 7 but not at age 5. The average treatment effect on the untreated confirms that at the age of 7 children may benefit from an earlier entry. Looking at the SDQ sub-dimensions reveals that the effects at age 7 are mainly driven by relatively large effects of later day care entry on prosocial behaviour and peer problems. This shows that the social experiences rather than emotional behaviour are affected by day care entry. Although we find no overall effect at age 5, a detailed analysis of the different SDQ dimensions shows that children who enter day care later are less prosocial and have more peer problems already at age 5.

In general, these results for the full sample are in line with the results found by studies mainly based on German data. Our effects sizes at age 7 are very similar to what Felve and Lalive (2014) find for German children around age 6: For the whole sample, the association size in their models is 9.6 per cent of a standard deviation (compared to 6.7 per cent in our models) and 13.4 per cent for children from low educated mothers (compared to 11.7 per cent in our model). Baker et al. (2008) find negative associations; yet they use a different measure of non-cognitive skills and focus on younger children and on a reform in Quebec, which included strong incentives for full-day use of care and might have resulted in lower quality. Our estimates differ to the results of Datta-Gupta and Simonsen (2010 and 2012), who do not find any significant effects for their overall sample in Denmark. First of all, this might be due to their use of different cut-off ages for day care entry. Secondly, we can only speculate about another reason which we cannot test given the lack of comparable data on the quality of preschools and home learning environments of different groups of families in the UK and Denmark. Either the quality of day care environments may be relatively better or the family environment in families with low educated mothers or poor household relatively worse in the UK than in Denmark. This may explain why we found positive associations of earlier day care experience especially for disadvantaged groups, whereas Datta-Gupta and Simonsen (2010) did not. The US study by Magnuson et al. (2007) supports explanations in this direction: They show that negative day care effects on child behaviour turn out to be not apparent once the focus is laid on high quality centres. Nevertheless, the associations of earlier versus later day care entry with socio-emotional behaviour of children are smaller than those of other predictors, such as, low birth weight or low level of maternal education.

In respect to social gradients in the effect of day care entry age, later entry mainly seems to have adverse medium-term effects on children from disadvantaged families in terms of low maternal education levels and even more pronounced in terms of household income below the poverty threshold. Our study also provides further evidence of the importance to focus on the heterogeneity of the effects on different groups of children. The stronger associations found at age 7 compared to age 5 may point to potential sleeper effects. One possible explanation may be that during the transition to school, children's social and emotional development at age 5

may generally be more variable than later at age 7. Possibly advantages of children who attended day care early may be more difficult to discern during periods of generally greater change and where teachers put a particular focus on compensating such developmental issues for all children. The latter is particularly likely in the first year of school at child age 5 when teachers may focus on ensuring that all students manage adequately during the transition to school in terms of social integration in the new class and emotional self-regulation. The advantages resulting from earlier day care may not be fully realized until later grades, when more focus is on instruction of more advanced material rather than social integration. These reasons, however, are speculative and deserve further investigation in future studies.

In general our results provide support for the hypothesis that day care institutions provide important environments where children can learn to interact with each other. Entering day care relatively late increases the probability of them developing more peer-problems and being less prosocial. Our results indicate that day care entry before or after age 2.5 years is less strongly related to developing emotional or conduct problems. By analysing several developmental dimensions, our study is able to pinpoint more in detail than previous studies how the day care entry age impacts children's formation of non-cognitive skills.

It should be noted that our estimates based on propensity score matching rely on the strong assumption that there are no unobserved factors biasing our results. Despite the richness of our data set, it is still possible that some child or parent characteristics which are difficult to measure may lead some parents to enrol their children into day care earlier than others. In this literature strand the issue of such unobserved factors still requires further investigation. Furthermore, our measure of early entry mainly covers children entering day care after their first birthday and thus does not focus on children entering very early for whom more negative effects of long hours of day care have been found (e.g. Loeb et al. 2007 or for a non-economic study Belsky et al. 2007). Another limitation of our study is that it only follows children until the age of 7. Further research is needed to see how long the effects last. Thus we agree with Kottelenberg and Lehrer (2014: 360) who suggest that 'more work is needed to explore differences in the timing

at which treatments are received and investments are made, and how they interact with child characteristics'.

As most other economic studies (with the exception of Bauchmüller et al. 2014 or Müller et al. 2013), we cannot control for the quality of the day care institutions which the children attended. Nevertheless, according to educational studies this is most important for the skill formation of children (Anders et al. 2012; Vandell et al. 2010; Anders et al. 2011, Sammons et al. 2008). We also do not consider the daily intensity of children's attendance at day care institutions, which may matter as well (e.g. Loeb et al. 2007; DeCicca 2007). Future research should therefore aim to consider more detailed day care histories covering aspects of entry age, daily intensity over the children's preschool years and at least some indicators on day care quality.

Provided that future research confirms our findings also for children's longer-term development, this would emphasize the importance of public investments in earlier day care in England. This seems justified as improved social skills of children have been shown to benefit not only the individual child but also society as a whole in the long-term (Heckman et al. 2010). Given our findings of stronger benefits for children from disadvantaged families, the recent extension of the free day care entitlement to 2-year-olds in low income families (for details on eligibility see Brewer et al. 2014) seems like a promising investment.

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Appendix

Table A1: Items of the Strength and Difficulties Score (SDQ) and Subscales. The parents rank each item to be "not true", "somewhat true" or "certainly true"

Subscales	Items
Conduct problems scale	Often has temper tantrums or hot tempers… Generally obedient… Often fights with other children… Often lies or cheats… Steals from home, school or elsewhere…
Hyperactivity scale	Restless, overactive… Constantly fidgeting or squirming… Easily distracted, concentration wanders… Thinks things out before acting… Sees tasks through to the end…
Emotional problems scale	Often complains of headaches… Many worries… Often unhappy, downhearted… Nervous or clingy in new situations… Many fears, easily scared…
Peer problems scale	Rather solitary, tends to play alone… Has at least one good friend… Generally liked by other children… Picked on or bullied… Gets on better with adults than with other children…
Prosocial scale	Considerate of other people's feelings … Shares readily with other children… Helpful if someone is hurt… Kind to younger children… Often volunteers to help others…

Source: Scoring the Strengths/Difficulties Questionnaire for age 4-17, August 2014, www.sdqinfo.com (download: October 2014) for further details.

Table A2: Quality of matching

	Mean			
	Treatment	**Matched Control**	**Standardised bias**	**p > |t|**
Child				
Age[1]	37.445	37.405	1.7	0.531
Girl	0.484	0.483	0.2	0.931
Birth weight	3.389	3.391	-0.3	0.914
Low birth weight	0.057	0.056	0.2	0.951
Mother ever tried to breastfeed	0.743	0.749	-1.6	0.550
Developmental Denver Screening Test : Child …				
…smiles	1.0051	1.0048	0.4	0.881
…sits up	1.041	1.039	0.8	0.760
…stands up holding on	1.429	1.424	0.7	0.796
…puts hands together	1.228	1.228	0.0	0.998
…grabs objects	1.004	1.005	-0.5	0.842
…holds small objects	1.135	1.131	0.9	0.731
…passes a toy	1.059	1.057	0.6	0.820
…walks a few steps	2.814	2.806	1.6	0.560
…gives toy	1.537	1.534	0.4	0.870
…waves bye-bye	1.964	1.956	0.9	0.725
…extends arms	1.234	1.229	0.8	0.748
…nods for yes	2.777	2.781	-0.7	0.787
Carey Infant Temperament Scale	-1.491	-1.493	0.4	0.876
Mother				
Age	29.883	29.972	-1.6	0.566
Age squared	926.28	931.31	-1.5	0.585
White	0.881	0.883	-0.6	0.810
Low education	0.515	0.506	1.7	0.519
Ref.: Full time employed				
Part time employed[a]	0.440	0.446	-1.2	0.663
Not employed[a]	0.475	0.469	1.3	0.643
Depressive symptoms	0.135	0.132	0.7	0.803
Depression diagnosed	0.243	0.237	1.4	0.604
Mother's belief whether crying baby should be picked up immediately	3.048	3.051	-0.3	0.898
Household				
Single parent	0.116	0.115	0.0	0.991
Ref:. No sibling				
One sibling	0.378	0.378	-0.1	0.982
Two siblings	0.159	0.155	1.1	0.685
More siblings	0.069	0.066	1.3	0.636
HH Income	5.607	5.618	-1.6	0.553
Poor	0.254	0.248	1.3	0.623
Living in London	0.155	0.150	1.4	0.599
Living in London[a]	0.139	0.135	1.3	0.622
Ref.: England - Advantaged				
Region: England - Disadvantaged	0.3726	0.374	-0.3	0.910
Region: England - Ethnic	0.108	0.104	1.2	0.626

Note: All variables are measured pre-treatment – at Wave 1 if not indicated otherwise.
[a] These variables are measured at Wave 2. The third column displays the standardised per cent bias after matching. It is the per cent difference of the sample means in the treatment and the matched control sample as a percentage of the square root of the average of the sample variances in both groups. The fifth column shows the p-value of the likelihood ratio test of the joint insignificance of all relevant variables after matching. Source: UK MCS.

Table A3: Sensitivity analysis using median of age at entry as cut-off (median=2.7 years of age) (ATT)

	Age 5	**Age 7**
Overall SDQ score	0.036 (0.028)	0.064** (0.028)
Conduct problems	-0.012 (0.029)	0.030 (0.029)
Hyperactivity	0.033 (0.029)	0.043 (0.029)
Emotional problems	0.002 (0.029)	0.028 (0.029)
Peer problems	0.081*** (0.029)	0.093*** (0.029)
Prosocial behaviour	-0.052* (0.029)	-0.099*** (0.029)
N	4,825	4,825

Note: Each cell represents estimations from a separate regression analysis. All models include as control variables all conditioning variables as outlined in Section 5 of this article.
Standard errors in parentheses, all dependent variables in terms of one standard deviation (z-score), * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Source: UK MCS.

Table A4: Sensitivity analysis matching on maternal personality traits and the infant control battery (ATT)

	Age 5	**Age7**
Overall SDQ	0.034 (0.027)	0.050* (0.027)
Conduct problems	-0.002 (0.028)	0.026 (0.028)
Hyperactivity	0.031 (0.028)	0.042 (0.028)
Emotional problems	-0.004 (0.029)	0.012 (0.029)
Peer problems	0.070** (0.028)	0.067** (0.028)
Prosocial behaviour	-0.052* (0.029)	-0.076*** (0.029)
N	4,686	4,687

Note: Each cell represents estimations from a separate regression analysis. All models include as control variables all conditioning variables as outlined in Section 5 of this article. In addition, all models
Standard errors in parentheses, all dependent variables in terms of one standard deviation (z-score), * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Source: UK MCS.