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Preschool Child Care Services and Social Behavior During Elementary School:

Support for a Social Group Adaptation Hypothesis

Abstract

We examined the contribution of non-parental child care services received during the preschool years (i.e. between 5 months and 5 years) to the development of social behavior between kindergarten and the end of elementary school (i.e. between 6 and 12 years) with a birth cohort from Québec, Canada (N=1544). Mothers reported on the use of child care services, while elementary school teachers rated children's shyness, social withdrawal, prosociality, opposition and aggression. Children who received non-parental child care services during the preschool years were less shy, less socially withdrawn, more oppositional and more aggressive at school entry (age 6 years). However, these differences disappeared during elementary school as children who received exclusive parental care during the preschool years caught up with those who received non-parental care services. We discuss this "catch-up" effect from the perspective of children's adaptation to the social group.

Keywords: Child care, primary school, social behaviors, shyness, social withdrawal, prosociality, opposition and aggression.

The use of non-parental child care services during the preschool years is now the norm rather than the exception and this new reality is raising interrogations regarding the effect of those services on children' social development (Ahnert & Lamb, 2003; Lamb & Ahnert, 2006; Linting & van IJzendoorn, 2009; Sagi, Koren-Karie, Gini, Ziv, & Joels, 2002). We use the term 'non-parental child care services' or 'child care services' to refer to the preschool care and education services provided on a regular basis by a person other than the parent.

The human and non-human attachment literature has emphasized that maternal proximity and availability during infancy are essential for the offspring adjustment, suggesting potential adverse effects of child care services, in particular intensive child care services in the first year of life (Aviezer & Sagi-Schwartz, 2008; Belsky, 2006; Dallaire & Weinraub, 2007; NICHD Early Child Care Research Network, 2001; Sagi et al., 2002). However, initial research on attachment also highlighted the unique importance of peers for social development throughout early childhood (Harlow, 1972; Suomi, Harlow, & McKinney, 1972). Later research confirmed the crucial role of peers in children's social development, be it beneficial or harmful (Barker et al., 2008; Boivin, Hymel, & Hodges, 2001; Boivin, Vitaro, & Poulin, 2005; Goldstein, Arnold, Rosenberg, Stowe, & Ortiz, 2001; K. H. Rubin, Coplan, & Bowker, 2009). Some authors argued that the social environment in child care services, and peers' influence in particular, could be one of the mechanisms explaining negative effects of child care services on social behavior (Averdijk, Besemer, Eisner, Bijleveld, & Ribeaud, 2011; Boivin, Vitaro, et al., 2005; Fabes, Hanish, & Martin, 2003; McCartney et al., 2010).

Child care and social behavior: shyness, social withdrawal and prosociality

Short-term studies examining infants' and toddlers' behavior during the first six months in child care services show an initial increase in negative behaviors followed by an increase in positive interactions with peers. Specifically, children initially exhibit negative affect, immobility, solitary passive play with objects and the search for adult comfort, presumably as a consequence of parental unavailability. These behaviors decrease subsequently as children adapt to their environment and begin interacting with their peers (Fein, Gariboldi, & Boni, 1993). These observations suggest that children receiving non-parental child care services during the preschool years would exhibit lower levels of shyness as compared to children who remain in parental care. Indeed, shyness is characterized by wariness and reticence in social situations (e.g. meeting unfamiliar children) (Heiser, Turner, & Beidel, 2003). Shyness is associated with social withdrawal (Boivin, Petitclerc, Feng, & Barker, 2010; K. H. Rubin et al., 2009), which has been conceptualized as an umbrella term describing various forms of solitary behaviors (Boivin et al., 2010; K. H. Rubin et al., 2009). However, only two studies are consistent with the notion that preschool children who received child care services are less shy and socially withdrawn than those who have been cared for at home by their parents (Guedeney, Foucault, Bougen, Larroque, & Mentré, 2008; Herba et al., 2013). To our knowledge, no study has yet investigated the associations between child care services, shyness and social withdrawal at school age. Very few studies are also available regarding the effect of child care on prosociality. Although the increase in positive interactions with peers in the first months of child care (Fein et al., 1993) might suggest an association between child care and prosociality, previous studies did not detect any association (Liang, Pickles, Wood, & Simonoff, 2012; Vitaro, Desmarais-Gervais, Tremblay, & Gagnon, 1992).

Child care and social behavior: aggression and opposition

Aggression emerges as early as the first year of life, is normative in early childhood, and is an important element of children's social repertoire (Côté, Vaillancourt, LeBlanc, Nagin, & Tremblay, 2006; Tremblay et al., 1999 in Criminal behaviour and Mental Health; Naerde et al., 2014 Dev Psych; NICHD Early Child Care Research Network, 2004; Tremblay, 2010; Tremblay, Provost, & Strayer, 1985). For example, aggression is central in the establishment of dominance relationships, which are an important feature of social groups in preschoolers (Strayer & Strayer, 1976; Tremblay et al., 1985). Throughout toddlerhood, aggression also retains a clear instrumental value in social interactions: Children can use aggression to coerce peers in order to achieve their aim – for instance obtaining a coveted object (Boivin & Vitaro, 1995; Boivin, Vitaro, et al., 2005; Hay, 2005; Hay, Castle, & Davies, 2000; Hay & Ross, 1982; Patterson, Reid, & Eddy, 2002; Pingault & Blatier, 2013). As a social behavior, aggression is responsive to social cues including positive reinforcement provided by peers or adults throughout early childhood (Boivin, Dodge, & Coie, 1995; Goldstein et al., 2001; Kellam, Ling, Merisca, Hendricks, & Ialongo, 1998; Pingault & Blatier, 2013). Social environments like group-based child care settings seem particularly propitious for the early expression of aggression and opposition. Indeed, aggressive and oppositional behaviors are regularly displayed in day care and children are often exposed to relevant social cues (Boivin, Vitaro, et al., 2005; Goldstein et al., 2001; Restoin et al., 1985). Studies have indeed shown that the use of child care services is associated with high levels of aggressive and oppositional behaviors (Averdijk et al., 2011; Belsky, 2006; NICHD Early Child Care Research Network, 2004). However, follow-up studies into middle and late childhood are crucial to fully appreciate the long-term reach of child care experience as some effects fade away or are even reversed with time (Côté et al., 2007 in AGP; Côté et al., 2010; Côté, Doyle, Petitclerc, & Timmins, 2013).

Social Group Adaptation and fading child care effects

All children enter group-based settings at some point in their life, whether it is during the preschool or in the elementary school years. Children with no child care experience during the preschool years may undergo adaptation processes to the group setting when they enter kindergarten that are similar to those experienced by children in child care services during the preschool years. As adaptation unfolds during the elementary school years, any initial differences between children who experienced child care and those that did not may progressively fade away. Long-term follow-ups from early childhood to the end of elementary school are necessary to detect these developmental differences. However, very few studies examining the role of child care services have followed children into elementary school. The successive follow-ups of NICHD SECCYD have yielded mixed results: using child care services was associated with aggressive behaviors in kindergarten, but not in third grade (NICHD Early Child Care Research Network, 2004). In the follow-up between ages 4 years and 12 years (Belsky et al., 2007), the initial statistically significant contribution of time in child care services to externalizing behaviors had disappeared by 12 years, except for children in center-based services. To explain the difference in the changes in externalizing behaviors between children with and without child care experience, Belsky (2009) proposed the following "diffusion" hypothesis: child care services leads to higher levels of aggression in children who receive child care services; higher aggression then diffuses to children who did not receive child care services when all children enter kindergarten, resulting in converging levels of aggression. Alternatively, we propose that the converging levels of externalizing behavior may be explained by a social group adaptation process. Children who start to experience living in a social group – either in child care during the preschool years or later in kindergarten – undergo a transition that impacts their social behavior. Based on previous studies, we propose that: a) children with child care experience when they enter kindergarten, compared to those without child care experience, will initially display higher levels of

opposition and aggression and lower levels of shyness and social withdrawal; b) these initial differences in kindergarten should decrease as children with no child care experience undergo their own social group adaptation during elementary school.

The purpose of this study was to test this hypothesis with longitudinal data on five social behaviors: aggression, prosociality, opposition, shyness, social withdrawal, from kindergarten to the end of primary school (grade 6). We compared behavioral changes during the elementary school years in children with and without preschool child care experience to document the developmental course of effects that are being attributed to child care services. We specifically measured the pace at which differences in social behavior during kindergarten decrease from 6 to 12 years of age. . These differences may decrease either linearly (i.e. regular decrease) or in a non-linear fashion (e.g. quick decrease in the first few years). We examined the associations between the development of social behavior and four features of preschool child care experience: 1) receiving any preschool child care services versus remaining in parental care; 2) the intensity of the child care services (number of hours per week); 3) the type of child care services (e.g. center-based versus family-based), and 4) the age at which the child first received child care services (Averdijk et al., 2011; Belsky, 2006; Côté et al., 2013; Jacob, 2009). Finally, we controlled for a host of confounders including children's personal characteristics, family socioeconomic characteristics, structure and context, family functioning and parenting.

The current study is correlational so that no causal inference can be drawn, despite the care taken in controlling for potential confounds. The term "effect" only refers to the statistical effects of childcare predictor variables on the study outcomes and not to causal effects.

Methods

Context and participants

In the Canadian province of Québec where the study was conducted, more than 80% of children receive child care services before they start full time kindergarten at 5 years (Côté et al., 2007). The vast majority of children receive services in center-based child care or family-based settings, with a minority receiving individual care by a family member (e.g. grand mother) or a nanny (see below for figures in the present study). The likelihood of receiving center-based child care services is higher for older children (Japel, Tremblay, & Côté, 2005). This is mainly due to the increasing availability of center-based spaces as the teacher:child ratios change with age. In center-based care, children are of similar ages and the groups have the following ratios: 1:5 between 3 months and 1½ years; 1:8 between 1 ½ years and 4 years. In family-based settings, children vary in age, usually between 1 and 4 years, and the ratios is 1:6. In most family-based settings, 2 child care workers are present (the owner of the house and an assistant) and the groups vary between 6 and 12 children. In 1997, the provincial government gradually implemented a network of publicly funded child care services. Services were available at a low cost -5$ per day initially, now 7$ per day- in family-based or center-based settings. The roll out of the program was gradual, stating with 4 years old children in 1997-1998; 3years old in 1999-2000; 2 years old in 2001-2002 and 1 year old children in 2003-2004. ELDEQ families benefited from the low-cost spaces from the ages of 2 ½ to 5 years. Despite an increase in the global number of places in the Quebec child care preschool services, the number of places in the public network was always lower than the demand, and the social selection of families into the low cost spaces was similar to the selection operating before the public network. That is, families with more personal and financial resources succeeded in obtaining a place in the highly coveted and low cost 'early childhood centers' (Geoffroy et al., 2012; Japel et al., 2005).

Participants were enrolled in the Québec Longitudinal Study of Child Development (QLSCD), coordinated by the *Direction Santé Québec* of the *Institut de la Statistique du*

Québec. QLSCD participants were drawn from the Quebec Birth Registry using stratification procedures. The resulting sample (N = 2940) was representative of singleton live births registered in the Québec live births registry in 1997-1998. This representative sample was reduced due to non-response, inability to contact, or not meeting study criteria. The resulting 2120 families constituted the initial QLSCD sample that was then surveyed annually or biennially. Details regarding sampling procedures and criteria can be found elsewhere (Jetté & Des Groseilliers, 2000). The QLSCD protocol was approved by the Quebec Institute of Statistics (Quebec City, Quebec, Canada) and the St Justine Hospital Research Center (Montreal) ethics committees. Written informed consent was obtained from the primary caregiver (mostly mothers) at each data collection. Data regarding child care were collected at ages 5 months, and $1^{1/2}$, $2^{1/2}$, $3^{1/2}$, 4 and 5 years. Teachers rated the child's social behavior 5 times starting from kindergarten (age 6, 7, 8 10, 12 years). Analyses were conducted on 1518 to 1544 participants who had relevant child care and behavioral data (depending on the behavior). Table 1 shows that when compared to non-participants (N = 576), the 1544 participants in the study (72.8% of the initial QLSCD sample) were less likely to be male and more likely to come from intact families with a higher socioeconomic status. Their mother was also less likely to be immigrant and more likely to be working at the time of the first assessment. The largest effect size was for socioeconomic status (Hedges g = -0.26). A summary of sample size for each analysis is presented in the *Analyses* section.

Measures

Child care. At each age, the person most knowledgeable about the child (PMK; the mother in 98% of cases) answered questions regarding whether her child received child care services regularly or not as well as the type of child care services.

The use of non-parental Child care services. Every year during the preschool years (i.e. 5 months, 1 1/2, 2 ½ , 3 ½ and 4 ½ years and 5 years) , the person most knowledgeable about

the child (PMK; the mother in 98% of cases) answered questions regarding the use of child

care services. The PMK answered the following question: Do you currently use child care

such as daycare, babysitting or care by a relative or other caregiver while you (and your

spouse/partner) are at work or studying? The variable use of child care distinguished between

children who never received child care services on a regular basis during the preschool years

(N = 103) from those who received services at least once at any of the 6 measurement times

(coded 1, N = 1797). Eighty two children were excluded because they received services only

on an occasional basis (for e.g. occasional baby sitter). Other children (n=138) were

excluded because they were never rated as using child care services regularly but classifying

them as never using child care services may have been misleading because they had at least

one missing data point (N = 138). Characteristics of these children excluded based on

irrelevant child care data (total N = 220) are presented in Table 1 and are partly consistent

with the fact that families who left the study before the child's fifth birthday had more at risk

compared to those who were excluded based on behavioral data in elementary school (see

Analyses section).

Intensity of the non-parental child care services (hours in child care). We estimated

trajectories based on the mean number of hours in child care services per week between the

ages of 5 months and 5 years. To estimate the trajectories, a non-parametric procedure, K-

means for longitudinal data, was used; see Genolini & Falissard (2011) for details on this

procedure and Herba et al. (2013) for a recent publication using this approach. Trajectories of

hours in child care are presented in Figure 1. Apart from the 103 children who never received

child care services, the three trajectories of hours in child care were as follows. First, 729

children followed a high trajectory of hours in child care, with a rapid increase from 5 months

to $1^{1/2}$ followed by a stable trajectory between 30 and 40 hours a week from $1^{1/2}$ to 5 years.

Second, 574 children were on a rising trajectory with regularly increasing hours in child care,

almost joining with the high trajectory at 4 and 5 years. Finally, a low trajectory of child care grouped 494 children, with mean hours in child care usually below 10; however, the trajectory rose slightly at age 5 years to reach 14 weekly hours, about half the time in the rising and the high trajectory at 5 years.

Age at entry in child care services. The variable age at entry was created based on attendance at each assessment point. For instance, a child who received child care services at the 17 months assessment but not at the 5 months assessment was assigned to the 17 months age at entry category. Note that this child may have first received child care services at any time point after the 5 months assessment and before the 17 months assessment. Four categories were created: exclusive parental care during the preschool years (N = 103); using child care services at the 5 months assessment (age range at assessment: 4-8 months, N = 290); first time use at the 17 months assessment (age range at assessment: 16-19 months, N = 969); first use at any of the following assessment times (age range at assessments: 28-68 months, N = 538).

Type of child care. At each assessment time, the PMK was asked about the main child care arrangement, that is, the one used for the most hours. In the course of early childhood, most children used more than one type of child care. Because we wanted to estimate the specific contribution of the type of child care, we first restricted our analyses to children who had exclusively used one type of child care during the preschool years, thereby excluding those having used more than one type of child care. We allowed only one missing data point on the six time points in order to reduce misclassification. Children were coded as having used either center-based care (N = 248); family-based child care, i.e. group-based child care in the home of a person unrelated to the child (N = 292); individual child care (e.g. a nanny or a grand-parent, N = 127). Dummy variables were created to compare each type to the children in exclusive parental care and between themselves. Complementary analyses

relaxing the conditions for missing data and for using exclusively one type of child care are briefly presented in the complementary analyses section in the Results.

Behavioral outcomes. Most of the behavioral items used in QLSCD came from the Canadian National Longitudinal Study of Children and Youth (Statistics-Canada, 1995), which incorporated items from the Child Behavior Checklist (Achenbach, Edelbrock, & Howell, 1987), the Ontario Child Health Study scales (Offord, Boyle, & Racine, 1989), the Preschool Behavior Questionnaire (Tremblay, Desmarais-Gervais, Gagnon, & Charlebois, 1987) and Asendorpf's questionnaire (Asendorpf, 1993). Shyness was rated by teachers using 4 items: was shy with children he/she did not know; readily approached children he/she did not know (reversed item); took a long time to warm up to children he/she did not know; excessively shy. Social withdrawal was assessed with 4 items: tended to do things on his/her own, was rather solitary; preferred to play alone rather than with other children; sought the company of other children (reversed item); showed little interest for activities involving other children. Prosociality was assessed with 3 items: tried to help someone who has been hurt; comforted a child who was crying or upset; helped other children who were feeling sick. Opposition was assessed with 4 items: was defiant or refused to comply with adults' requests or rules; did not seem to feel guilty after misbehaving; punishment did not change his/her behavior; had temper tantrums or hot temper. Aggression was assessed with ten items including physical aggression items (e.g. got into fights) proactive aggression items (e.g. scared other children to get what he/she wanted); and reactive aggression (e.g. reacted in an aggressive manner when teased). All items were coded from 0 to 2 (never or not true=0, sometimes or somewhat true=1, and often or very true=2). We computed the scores for each behavior – using mean imputation – when teachers had scored half or more of the items. For shyness however, more teachers did not score some items among the ones including "children he/she did not know". This is because teachers see children mostly in a classroom setting

where children know each other. The item "excessively shy" had less missing data. To maximize the available n, we allowed up to 3 missing items for shyness. Cronbach alphas at the five assessment points were between: 0.69 and 0.77 for shyness; 0.67 and 0.73 for social withdrawal; 0.78 and 0.85 for prosociality; 80 and 84 for opposition; and between 0.89 and 0.91 for aggression.

Potential confounding variables. Child and family socioeconomic characteristics as well as family functioning and parenting were considered as potential confounding variables. All were assessed by the PMK when the child was 5 months except for information on the Cumulative Score for Neonatal Risk (CSNR) which was obtained from hospital records.

Child characteristics. Sex was coded 1 for boys, and 0 for girls. The CSNR was created to reflect the overall health condition at birth of the infants in the QLSCD study. It includes birth weight, length of gestation, intrauterine growth retardation, retardation of cranial perimeter growth, congenital abnormalities, APGAR score and neonatal complications. The CSNR has been shown to be statistically significantly associated with other indicators of health at birth such as length of hospital stay (Séguin et al., 2001). *Difficult infant temperament* was assessed using 7 items from the difficult temperament subscale of the Infant Characteristics Questionnaire (Bates, Freeland, & Lounsbury, 1979).

Family socioeconomic characteristics, structure and context. The *socioeconomic status (SES)* of the family was derived from five variables including mother' years of schooling, spouse's years of schooling, mother's occupational status, spouse's occupational status and household income. The occupational status was measured with the modified version of the scale developed by Pineo and al. (1977) based on Statistics Canada Standard occupational classification 1980 (Statistics Canada, 1981). The final SES composite was standardized (Willms & Shields, 1996). Table e1 in the online material provides additional information and descriptive statistics regarding the SES composite and the five aforementioned variables.

Work status of the mother was coded 1 when she was working when the child was 5 months and 0 otherwise. *Immigrant status of the mother* referred to immigrant (coded 1) versus non-immigrant (0). *Family structure* was coded 1 if the family was non-intact (i.e. reconstituted families or single-parent families) and 0 if the family was intact (i.e. the child lives with his/her two biological parents). *Presence of (at least) one sibling* (yes = 1). Two variables measured the perception of the neighborhood (Thibault, Jetté, & Desrosiers, 2001). Neighborhood safety and cohesion was measured by 7 items as "safe to walk alone" and "people around here are willing to help their neighbors" (score from 0 to 4 with higher scores indicating lower safety). The *social problem* measure included 6 items regarding for instance drug selling or use or excessive drinking in public in the neighbourhood (score from 0 to 4 with *lower* scores indicating more problems).

  Family functioning and parenting. Family functioning was measured at 5 months using 12 items concerning communication, problem resolution, expression of affection, and control of disruptive behavior (Statistics-Canada, 1995). Parenting was measured with 4 dimensions of the parental Cognitions and Conduct Toward the Infant Scale (Boivin, Pérusse, et al., 2005): perceived parental self-efficacy (4 items), perceived parental impact (5 items), coercive parenting (3 items), and overprotection (4 items). Items from the Infant-Toddler *Home Observation for Measurement of the Environment* (HOME) (Caldwell & Bradley, 1984) were used to assess *Emotional and verbal responsivity of the mother* (10 items) and *Maternal involvement with child* (5 items). Both scores ranged from 0 to 10; higher scores indicate a better environment. Finally, maternal depressive symptoms were assessed using a short version of the Center for Epidemiologic Studies Depression Scale (Radloff, 1977).

Analyses

  Sample size for analyses. Among the 1900 children with relevant child care data, 1544 had at least one assessment for each of shyness, social withdrawal, and opposition between 6

and 12 years and were thus included in analyses with and without covariates. A subset of

1543 out of the 1544 participants were included for aggression and a subset of 1518 out of the

1544 participants were included for prosociality. Analyses regarding type of child care

services included: 640 participants for shyness, social withdrawal, opposition and aggression

and 633 for prosociality (see *Type of child care* in the *Measures* section).

Statistics. Latent Growth Curves were used to model the contribution of child care

services to the initial levels (at 6 years) and the change (from 6 to 12 years) of raw scores of

shyness, social withdrawal, opposition and aggression and prosociality. For each behavior, we

first estimated a baseline model without covariates and with child care use as the only

predictor, which allowed us to model the behavioral development of users versus non-users.

In particular, we examined the possibility of non-linear behavioral development in the two

groups. Once an adequately fitting baseline model was obtained for each behavior, we

estimated a model controlling for the contributions of all confounding variables to the

intercept and the growth parameter(s). We did not exclude control variables based on

bivariate relations as it may mask multivariate effects (Linting & van IJzendoorn, 2009). The

models without and with covariates were estimated for each of the 4 child care variables, i.e.

use, intensity, age at entry and type of child care. Full Information Maximum Likelihood was

used to handle missing data. Maximum Likelihood (ML) estimator can be used for values of

skewness under 2 and kurtosis under 7 (Curran, West, & Finch, 1996). Shyness, social

withdrawal, prosociality and opposition satisfied these conditions at all measurement points.

Aggression kurtosis was also under 7 at all times, but skewness was above 2 at four time

points (maximum 2.26). Therefore, a Maximum Likelihood Robust (MLR) estimator, with

robust standard errors and an adjusted chi-square, was used for aggression. The models' fit

was assessed using the model chi-square: a non-significant model chi-square indicates good

fit, in particular in larger samples. We also report three approximate fit indexes (Bentler,

2007; Kline, 2011): CFI (Comparative Fit Index) for which values close to 1 indicate better fit; RMSEA (Root Mean Square Error of Approximation) and SRMR (Standardized Root Mean Square Residual), for the two latter, values close to 0 indicate better fit. No consensus exists on cutoff values for these indexes, but values close to .95 for CFI, 0.06 for RMSEA and 0.08 for SRMR have been suggested to conclude that there is a relatively good fit between the model and the data (Hu & Bentler, 1999). Kline (2011) recommended to never ignore the possibility of specification error indicated by a significant chi-square even when approximate fit indices look favorable and to check that each correlation residual is under 0.10. Correlation residuals indicate the discrepancy between the model predicted correlations and the observed correlations. Effect sizes were calculated following Hancock's (2001) approach for latent variables (e.g. the unstandardized estimate of the effect of the binary predictor on the intercept is divided by the square root of the residual variance of the intercept). Analyses were conducted with *R 3.0.1* (R Development Core Team, 2013), using the package *lavaan 0.5-13* to fit the growth curves (Rosseel, 2012) and the package *Kml 2.2* to estimate trajectories of hours in child care (Genolini & Falissard, 2011).

Complementary analyses

Sensitivity analysis. Assessments of shyness, social withdrawal, prosociality, opposition and aggression were not available at 5 months. Not controlling for baseline behaviors before entry into child care might introduce a bias due to a child effect (McCartney et al., 2010). For instance, shy and withdrawn children may react more strongly to attempts to place them in child care, so that parents may be tempted to keep these children at home; consequently, the group differences in kindergarten would not be due to the effect of child care but to an initial difference maintained over time. However, controlling for the first behavioral assessment available (PMK ratings at the 17 months assessment) is also problematic. Indeed, a majority of the children in the sample had received child care services by 17 months. Consequently,

any behavioral differences at this age could already be due to exposure to child care services (e.g. children in child care were already less shy due to their child care experience). Controlling for these behaviors would therefore unduly under-estimate the contribution of child care and null findings would not equate to a null contribution of child care (McCartney et al., 2010). Potential confounders should be measured before the exposure to the predictor of interest, here child care services (Ho, Imai, King, & Stuart, 2007; D. B. Rubin, 2001). Therefore, we decided not to include the 17 months behavioral assessments in the main analyses. However, as a sensitivity analysis, we re-run the models with covariates measuring the contribution of child care whilst including the 17 months assessment (e.g. 17 months shyness in the shyness model with covariates). Shyness, opposition and prosociality were rated by the PMK at age 17 months with the same instrument. Social withdrawal was not available and only physical aggression was available and was thus used in the sensitivity analysis for aggression. Additional analyses regarding type of child care and analyses with multiple child care services variables are also reported in the *Complementary analyses* section in the results.

Propensity score matching. To test whether the results were sensitive to the use of regression analyses to adjust for covariates, we reanalyzed the statistically significant results using propensity score matching. In brief, the analyses involved three steps using three additional R packages. First, 50 data sets were imputed using package *Mice 2.22* (van Buuren & Groothuis-Oudshoorn, 2011). Second, propensity score matching was implemented on each data set using package *MatchIt 2.4-21* (Ho, Imai, King, & Stuart, 2011). Matching was conducted with all covariates as well as with the four behavioural scores assessed at age 17 months (see sensitivity analysis above). Third, the weights obtained from the matching procedure were used to reanalyze the latent growth models using package lavaan.survey 1.1.1 (Oberski, 2014). This package combines the weighted latent growth model estimates across

the imputed data sets and implements robust standard errors to account for the use of weights.

Procedures are described in details in the online material.

Results

Fit indices for all models are shown in the online Table e2. Detailed results are provided in Table 2 for each model. In Table 2, the contribution of each child care variable (i.e. use, intensity, age at entry, type of services) has been estimated separately, controlling for all confounders. Complementary analyses including several child care variables are reported below. Here, we provide parameter estimates, 95% confidence intervals, p-value and standardized effect sizes for the statistically significant findings.

Shyness. We first fitted the baseline model without covariates, with child care use as the sole predictor. A model with a linear slope fitted the data well as shown by a non-significant chi-square and adequate fit indices. Figure 2a shows the close correspondence between model-based predicted means and the observed means from 6 to 12 years. Children having used child care at least once between 5 months and 5years were less likely to be seen as shy in kindergarten. Table 2 presents the results (controlling for the contributions of all covariates on the intercept and on the slope) and shows that the contribution of child care use to the intercept was statistically significant (-0.80 [-1.18; -0.41] p < .001, d = 0.62), whereas the positive contribution to the slope was not. Online Table e3 shows the contribution of all covariates to childhood levels of shyness.

With respect to intensity, children in all trajectories had statistically significant lower initial shyness levels when compared to children in exclusive parental care: low trajectory (-0.56 [-0.97; -0.15] p = .008, d = 0.44), rising (-0.91 [-1.32; -0.51] p < .001, d = 0.72) and high (-0.94 [-1.35; -0.52] p < .001, d = 0.74). In addition, children in the rising and high trajectories had similar levels of shyness, both being statistically significantly lower than levels for children in the low trajectory. Compared to children who never used preschool child

care services, those who did were initially less shy irrespective of their age at entry. All children also had lower initial levels of shyness irrespective of the type of child care services they received (see Table 2).

To evaluate if the differences in shyness would be maintained at age 12 years, the same models were tested again with the intercept at 12 years. Children in the high trajectory of hours in child care (-0.46 [-0.92; -0.01] p = 0.047, d = 0.49) as well as children with age at entry at 5 months (-0.65 [-1.20; -0.01] p = 0.02, d = 0.69) were still statistically significantly less shy at age 12 years.

Social withdrawal. As for shyness, a linear model fitted the data adequately (see Figure 2b). In analyses with covariates (see Table 2), child care use predicted lower initial social withdrawal (-0.60 [-0.95; -0.26] p = .001, d = 0.60) but the contribution to the slope was not statistically significant. Online Table e4 shows the contribution of all covariates to childhood levels of social withdrawal. Children in the low (-0.46 [-0.82; -0.09] p = 0.014, d = 0.46), rising (-0.69 [-1.06; -0.33], p < .001, d = 0.70) and high trajectories (-0.66 [-1.03; -0.30], p < 0.001, d = 0.66) of hours in child care services had lower initial levels of social withdrawal. In addition, children in the rising child care hours trajectory had statistically significantly lower levels of social withdrawal than children in the low trajectory. Note that a similar pattern was observed for the high trajectory but did not not reach statistical significance at conventional values). All children having used child care services during the preschool years had lower initial levels of social withdrawal irrespective of age at entry or type of services received (see Table 2). None of these associations maintained their significance at 12 years.

Prosociality. We retained a linear model for prosociality (additional comments on model fitting are presented in online material). In analyses with covariates, no contribution was detected whether for use, intensity, age at entry or type of child care (see Table 2). Online Table e5 shows the contribution of all covariates to childhood prosociality.

Opposition. As illustrated in Figure 2c, children who never used child care services before age 5 years started with lower levels of opposition in kindergarten but rapidly caught up with children who had used child care services. The two groups had then virtually identical flat levels of opposition from age 8 years onwards. We freed the last two times loadings to capture this non-linear change. Figure 2c shows the correspondence between fitted and observed means, indicating that this model effectively captured the non-linear change in the non-users (additional comments are provided online).

In analyses with covariates (see Table 2), children having used child care services had higher levels of opposition at 6 years (0.70 [0.30; 1.11] p = .001, d = 0.44) and their slope from 6 to 8 years was statistically significantly less sharp than for children who never received non-parental child care services. Online Table e6 displays the contribution of all covariates.

The pattern of results displayed in Figure 2c was observed irrespective of age at entry. Furthermore this pattern of results was observed only for family-based and center-based services and not for individual child care services. Specifically, children in family-based and center-based services had statistically significantly higher levels of opposition than those in individual care but did not differ between themselves (see Table 2). Regarding hours in child care, children in the low (0.50 [0.07; 0.94] p = .022, d = 0.32), rising (0.76 [0.33; 1.18] p = .001, d = 0.48) and high hours trajectories (0.89 [0.46; 1.32] p < .001, d = 0.57) statistically significantly differed from the children in exclusive parental care for both for the intercept and the slope. In addition, consistent with a dose effect, children in the high trajectory had statistically significantly higher initial levels of opposition, when compared to children in the low trajectory.

As seen in Figure 2c, children who used child care services during the preschool years had similar levels of opposition to those in exclusive parental care at 8 years. We re-evaluated

the aforementioned models by setting the intercept at age 8 years to see if differences observed at age 6 years remained statistically significant. No more statistically significant difference was observed at 8.

Aggression. Figure 2d shows a change in aggression in the group of children who did not receive preschool child care services that is similar to the one found for opposition and cannot be summarized only with a linear slope. We made use of a piecewise growth model, which consisted in including two linear slopes: the first modelled the change from 6 to 8 years (three time points) and the second captured the change from 8 to 12 years. Figure 2d shows that predicted means were close to observed means in this model, which was not the case in the previous models.

Children who used child care services had statistically significantly higher initial levels of aggression (1.65 [0.96-2.45] p < .001, d = 0.52) than children who did not and their slope from age 6 to 8 years also differed. As can be seen in Figure 2d, from age 8 to 12 years, the change is very similar in the two groups and no contribution to the second slope was detected. To summarize, children who did not receive non-parental child care services during preschool started kindergarten with lower levels of aggression and then caught up rapidly until age 8 years, where they followed the same course as children who received child care services during the preschool years. Online Table e7 shows the contributions of all covariates to childhood levels of aggression.

Although children having who received child care services earlier (at 5 months and 17 months) had higher initial levels of aggression compared to those who received the services later (i.e. at 30 months or after), the differences were not statistically significant. Children in the low, rising and high trajectories of hours in preschool child care services all differed from children who did not use the services with effects similar to those displayed in Figure 2d: low trajectory, 1.25 [0.49; 2.01] p = 0.001, d= 0.40, rising trajectory, 1.87 [1.09; 2.65] p < .001, d

= 0.58, and high trajectory, 1.87 [1.10; 2.64] p < .001, d = 0.58). In addition, children in both

the rising and high trajectories had higher initial levels of aggression compared to children in

the low trajectory. Regarding the type of child care, effects similar to those displayed in

Figure 2d were found for those receiving center-based services and for those receiving family-

based services but not for those receiving individual services. In particular, initial levels of

aggression were higher in children in center-base services (2.02 [1.10; 2.94], p < .001, d =

0.62) and family-based services 0.71 [1.25 [0.42; 2.07], p = .003, d = 0.38), but not for those

using individual services. In addition, the difference between children in center-based care

and individual care was statistically significant. No difference in aggression levels remained

statistically significant at 8 years

Complementary analyses

    Sensitivity analysis. We controlled for the 17 months behavioral measures in models

with covariates assessing the contribution of child care use (e.g. controlling for shyness at 17

months in the shyness model with covariates). PMK ratings of shyness, opposition, physical

aggression (but not prosociality) at 17 months were statistically significantly associated with

their corresponding behavior at age 6 years (i.e. with the intercept of the model with

covariates). All statistically significant contributions of child care use to the initial level or to

the slope in the models with covariates (see Table 2) remained statistically significant after

controlling for behavior at 17 months and none of the estimate decreased by more than 6.3%.

Type of child care services. In order to be more inclusive in the analyses regarding type of

child care services, we considered combinations of types: 1) group care only, with children

having received services exclusively in a group setting, i.e. they used both center and family-

based services during the preschool years; 2) other combinations, with children who received

a mix of individual services and services in a group setting (i.e. center and/or family-based

services). Results were: 1) very similar to the results presented in the manuscript for children

using exclusively one type of child care despite relaxing the missing data condition and; 2) estimates for combination of types were consistent with estimates for the exclusive types (e.g. for the Family-based/Center combination the estimate was between the estimates for the pure types Family-based and Center). The only exception was that children in center-based services had statistically significantly higher initial levels of opposition and aggression not only when compared with children who did not receive preschool child care services and children in individual care, as in the main analyses, but also, to a lesser extent, when compared to children in family-based services. Results are further detailed in Table e8 in the online material.

Multiple child care variables. As stated above, the contribution of each child care variable was estimated separately (see Table 2). For shyness and social withdrawal, child care type and age at entry did not make any contribution, leaving only the statistically significant contributions of use of child care services and intensity. Because the intensity variable (trajectories of hours in child care) is a refinement of the binary use of child care services variable, including them in the same model is not informative. For opposition and aggression however, type of child care services and intensity of child care made a statistically significant contribution. Therefore, the two variables were included together to test whether children in center-based services still have elevated levels of aggression when the intensity of care is controlled for. The results were essentially unchanged for type of care. Children in the high trajectory of hours in child care services still had statistically significantly higher initial levels of opposition compared to children in the low trajectory. The same pattern was observed for aggression but it did not reach statistical significance at conventional values. Detailed results are presented in the online material, Table e9.

Propensity score matching. Results are briefly described below and detailed in the online material. Three sets of analyses were conducted. First, results regarding the contribution of

child care services use were reanalyzed by matching children who used with those who did not use child care services.. To assess matching efficiency, the mean differences between the two groups for all covariates before and after matching are presented in Table e10. Differences between the two groups were drastically reduced after matching. Final analyses are presented in Table e11 and results were very close to those obtained with covariate adjusted analyses. Next, the contribution of trajectories of hours in child care services was reanalyzed. Because the pattern of results was very similar for the rising and the high hour trajectories (see Table 2), we compared children in the low trajectory to those in the rising/high trajectory (see Table e12). Estimates were similar to those resulting from regression analyses (Table e13) and were statistically significant for shyness and social withdrawal and marginally statistically significant for opposition and aggression. Finally, we tested whether the contribution of the type of child care services to opposition and aggression was maintained when using propensity score matching analysis. Specifically, we tested whether children in center-based services still differed from children in individual services. Results are presented in Tables e14 and e15; estimates were very similar to those found in regression analyses and statistically significant for both aggression and opposition. Overall, results were remarkably similar when using either: 1) Full Information Maximum Likelihood to deal with missing data and regression analyses to control for covariates in the main analyses or 2) multivariate imputation by chained equation and propensity score matching in the complementary analyses, which we briefly discuss in the online material.

Discussion

The purpose of this study was to examine whether the use of regular non-parental child care services during the preschool years (i.e. before entry in kindergarten at age 5 years) predicted shyness, social withdrawal, prosociality, opposition and aggression in kindergarten

and elementary school. Compared to those who remained in parental care throughout the preschool years, children who received child care services at least once between 5 months and 5 years were rated by their kindergarten teacher as less shy, less socially withdrawn, more oppositional and more aggressive. However, these initial differences dissipated with age. We first discuss the results for each behavior before discussing alternative developmental perspectives to explain the dissipation of the effects over time.

Shyness and social withdrawal

Compared to children who remained in exclusive parental care, children who received child care services during the preschool years were seen by kindergarten teachers as less shy and less socially withdrawn. Consistent with a dose effect, children spending more hours in child care services were also less shy and less socially withdrawn than children spending less hours in child care. However, most of these associations had disappeared by the end of elementary school (i.e. grade 6, age 12 years). To the best of our knowledge, children who received child care services during the preschool years have lower levels of shyness and social withdrawal in kindergarten compared to children who did not. Research has shown that shy children may avoid activities and social events and have poor social skills (Kingery, Erdley, Marshall, Whitaker, & Reuter, 2010). Shyness thus tends to be self-reinforcing. Child care services can create a context where children have to confront their social wariness early in life. As such, it may have effects that are similar to intervention programs that support children in progressively overcoming their social wariness rather than avoid social situations (Rapee, Schniering, & Hudson, 2009). There is also evidence that children's behaviors change substantially in the first 6 months of child care, from negative affect and comfort contact with adults towards more positive interactions with peers (Fein et al., 1993). This suggests that children, reluctant at first, get progressively acquainted to a new type of interaction in a non-familial environment. As a result, children having experienced child care are likely to be more

prepared for social interactions and thus be seen by their kindergarten teachers as less shy and socially withdrawn than those having never experienced child care services.

Opposition and aggression

In contrast to the results reported for shyness and social withdrawal, children in who received child care services, compared to those who did not (remained in parental care throughout the preschool years), displayed higher levels of opposition and aggression, especially those spending more hours in child care services. However, children not exposed to child care services before kindergarten steadily caught up with those who did, reaching the levels of aggression and opposition of children with child care experience around age 8 years. For both opposition and aggression, the contributions were statistically significant for children in center-based care and those using family-based services; however, this was not the case for children in individual child care. Overall, these results are consistent with studies that have reported a link between child care services and aggression and defiant behaviors in kindergarten (e.g. Averdijk et al., 2011; NICHD Early Child Care Research Network, 2004). Early childhood is an important period for the expression and the development of aggression (Tremblay, 2010). Children receiving child care services have more opportunities to experience conflicts with peers and adults and express aggressive and oppositional behaviors. This is consistent with the fact that we found higher levels of aggression and opposition for children in both types of group-based child care services (family-based and center-based) but not for children in individual services. Averdijk et al. (2011) reported similar results and McCartney et al. (2010) demonstrated that exposition to larger groups of peers was a potential process explaining the association between child care and higher externalizing behaviors.

Selection, dose effect and causality

Because the present study is correlational, no claim about causality can be made. However, in non-experimental studies, elements consistent or inconsistent with causality can

be pointed out (Imai, King, & Stuart, 2008), in particular threats to the plausibility of causality. One such potential threat is selection effects. Different methods have been used to account for selection effects in the child care literature (e.g. regression with covariates or propensity score techniques) and variations in methods have led to more or less conservative estimates of child care services contributions or even to changes in directions of the associations. However, in the present study, using regression or propensity score matching techniques to adjust for potential confounds yielded very similar results. In addition, if social selection remained after adjustment in the present study, children from high SES families would be expected to do better in kindergarten due to their SES level rather than to their child care experience per se. However, the results showed more initial problems with aggression and opposition in children who received child care services (being of higher SES families) than in children who did not receive child care services (lower SES families). Such a pattern of results is the opposite of that predicted by social selection for opposition and aggression. In addition to social selection, "child effect", e.g. pre-existing temperamental or behavioral differences influencing whether a child receive services or not, could represent another type of selection. However a previous study on externalizing behaviors has detected no such effect (McCartney et al., 2010) and, in the present study, a sensitivity analysis has shown this is not likely the case. Finally, our main finding is that children who did not receive child care services catch up with those who did in terms of social behavior, and that the positive (for shyness and social withdrawal) or negative effects (for opposition and aggression) of child care fade out during the elementary school years. Such effects are unlikely to be explained by social selection or child effects as we would expect such selection processes to lead to enduring differences between children having received children services during the preschool years versus those in exclusive parental care. Finally, misidentification represents another threat to the plausibility of causality. For instance, in the present study, we cannot rule out the

possibility that the results may be as much a function of having working parents as it is of receiving child care services.

McCartney et al. (2010) have argued that, to be consistent with causality, a dose-response relation between time spent in child care and outcomes should be observed (an alternative being that any exposure to child care at any developmental stage is equivalent in producing outcomes). In the present study, hours spent in child care provided some evidence of a dose-response effect. Children following a low trajectory of hours in child care differed from children never using child care services; in turn, children in the high and rising trajectories differed from children in the low hours trajectory.

A social group adaptation hypothesis

We first propose to interpret the apparent dissipation effect from the perspective of a social group adaptation hypothesis, and then contrast this hypothesis with the diffusion hypothesis proposed by Belsky (2009) for externalizing behavior problems.

Whether in early childhood or later, all children integrate social group settings (child care, kindergarten, elementary school) and have to adapt their social behavior accordingly. In the case of early entry into group-based child care setting, living in a social group is new to all children in the group. In such a context, children initially tend to manifest shy and withdrawn behaviors. As they become familiar with the social group, they progressively become less shy and less socially withdrawn. At the same time, the social group offers opportunities to engage in aggressive and oppositional behaviors due to the increased social interactions and the increased likelihood of conflicts. When children first integrate a social group later than other children, for instance in kindergarten, the social setting is new for them but may not be new for most children in the group. The experience of children entering late into a group-based setting is thus different from those who enter early: The former are confronted with a pre-

existing context, i.e. they are entering a group where most children have already adapted to living in a social group. As such, not only do these children have to adapt to a group situation per se, but they have to adapt to a group situation with already experienced children. In such a context, the adaptation to the group may take the form of a "regression to the group mean". This was particularly striking in the case of aggression (as illustrated in Figure 2d). Specifically, children not exposed to child care services before kindergarten (i.e. remained in parental care) started at lower levels of aggression in kindergarten and steadily increased until they caught with children who received child care services, at around 8 years. The growth curve then took a sharp turn and started to decrease, mimicking the change in children with previous child care experience. Based on this social group adaptation hypothesis, the behavioral consequences of having received child care services might be better conceived as the result of an adaptation to group settings rather than as specific effects of child care. Whether this adaptation occurs in early childhood (i.e. child care) or at school entry (i.e. kindergarten), may not be as relevant: children with no preschool child care experience seemed to have completed their social transition by age 12 years and be largely similar to children with child care experience.

Belsky (2009) suggested that high levels of aggression in children having received child care services do not dissipate later on, but that instead, levels of aggression in children without child care experience increase at the contact of children with child care experience. In other words, the adverse effects of child care on children's levels of aggression diffuse to children without child care history when they enter kindergarten (Belsky, 2009; Linting & van IJzendoorn, 2009). Our results are partly consistent with this proposition in that children who did not use child care services during the preschool years catched up with those who had use child care services when they entered kindergarten (see Figure 2d). However, our study shows that this putative diffusion effect was not restricted to externalizing behaviors such as

opposition and aggression but was also observed for shyness and social withdrawal (i.e. children in with no preschool child care experience manifested progressively lower levels of both behaviors). Furthermore, children in who received child care services during the preschool years, despite being more aggressive and oppositional in kindergarten, were not less prosocial than children who remained in parental care.

Although our data are consistent with both the diffusion hypothesis and the social group adaptation hypothesis for externalizing behaviors, the two hypotheses differ conceptually and with respect to policy implications. According to the diffusion hypothesis, non-parental child care services represent an early risk factor that increases the likelihood of later aggression so that, at a population level, lower prevalence of child care use implies lower prevalence of aggression. Policy implications would be to reduce the prevalence of child care use, particularly in the early years (for an example, see Jacob, 2009). However, according to the social group adaptation hypothesis, lower use of child care services during the preschool years only postpones the social transition, as children go through the adaptation process later in child care or in kindergarten, as shown in the present study. In other words, social group adaptation is accompanied by changes in social behaviors whether this transition happens earlier or later. As such, policy implications would rather be to facilitate the transition to social groups whenever it happens.

One approach to testing the diffusion and social group adaptation hypotheses would be to use experimental studies of kindergarten classrooms with different ratios of children with and without extensive center-based child care experience (Linting & van IJzendoorn, 2009). Indeed, if a kindergarten classroom included only children with exclusive parental care during the preschool years,, there could be no diffusion of aggression and, therefore, aggression levels should not change (for example, in Figure 2d, the exclusive parental care group would

not have this sharp rise in aggression during the first 2 years of elementary school).

Conversely, the social group adaptation hypothesis would still predict change in aggression

levels over time in this scenario. In addition, the social group adaptation hypothesis would

predict that the levels of aggression of the newcomers depend on the levels of aggression of

the pre-existing group. If only a few children with previous extensive experience in child care

join a classroom with a large number of children previously in exclusive parental care, a

similar "regression to the group mean" should be observed. In such a case, the levels of

aggression in children with previous extensive child care experience would decrease (i.e. no

diffusion of aggression).

According to this social group adaptation perspective, it is also possible to understand

why some studies did not detect meaningful associations between child care experience and

externalizing behaviors (Jaffee, Van Hulle, & Rodgers, 2011; Linting & van IJzendoorn,

2009; Zachrisson, Dearing, Lekhal, & Toppelberg, 2013). In some environments, for instance

small groups of peers with adequate high child–adult ratio (McCartney et al., 2010), children

may rapidly learn alternatives to aggression and thus the impact of child care services on

aggression may be small and\or temporary; children joining later would adapt to a social

group where aggression levels are already low.

Finally, the social group adaptation hypothesis does not exclude potential long term

effects of child care. Even if social transition should affect social behaviors irrespective of the

age, it is still possible that timing matters. For instance, a very early transition may have long-

term adverse or beneficial effects (e.g. children having entered child care at the 5 months

assessment were still statistically significantly less shy at age 12 years although the size of the

effect had decreased). However, the effects of child care services should still partly fade away

with time as all children will undergo a social transition at some point.

Assessing child care effects: further perspectives

As shown in this study, both short and long term developmental perspectives are essential in assessing child care effects. Some of the "catch-up" effects reported in this study were noticed within only two years. A previous study even suggested that changes take place in the first months of child care experience (Fein et al., 1993). As such, close repeated assessments in the first year of child care experience may provide new perspectives on child care effects. Second, the use of broad categories like internalizing and externalizing behavior may hide important effects. We propose to focus on behaviors that have a clear social dimension, possibly more susceptible to be affected by child care (e.g. focus on social anxiety instead of anxiety). Third, more direct measures of the amount and nature (e.g. aggressive versus non-aggressive) of peer interactions outside the family, within child care settings or not, will be useful to test the alternative hypotheses discussed above.

Limitations

The long follow-up and the use of teacher ratings yielded attrition. As such, the study sample should not be considered representative and attrition may have biased the results. We were unable to account for the role of quality in the present study. The extant literature is mixed regarding the role played by child care quality in the prediction of externalizing behaviors, with, overall, null or small effect sizes (Belsky, 2006; Belsky et al., 2007). However, quality may have played a role for other social behaviors. Finally, although the initial contributions of child care variables to social behaviors had dissipated by age 12 years, "sleeper effects" may emerge at a later developmental stage (Belsky et al., 2007; Vandell, Belsky, Burchinal, Steinberg, & Vandergrift, 2010).

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Table 1: Characteristics of participants versus non-participants

	Participants (N = 1544) % or Mean (SD)	Non participants (N = 576) % or Mean (SD)	Effect sizes[1]	P-values
Male sex	48.6	57.3	0.078	.000
Socioeconomic status	0.06 (0.98)	-0.19 (1.04)	-0.256	.000
Work status (mother working)	19.3	12.7	0.079	.000
Immigrant Status (mother immigrant)	7.6	19.4	0.170	.000
Family structure (non intact)	17.9	22.6	0.054	.015

Note. [1]Hedges g (an equivalent of Cohen d for unequal sample sizes) was used for socioeconomic status. For other variables a phi-coefficient is presented. Among the non-participants, a subset of 220 was first excluded because they did not have relevant child care data (see Method section). These participants had the following characteristics: Male sex (51.8%), Socioeconomic status (-0.58 [1.06]), Work status (4.1%), Immigrant status (23.6%) and Family structure (28.2%).

Table 2: Contribution of non-maternal child care to childhood behaviors, controlling for covariates

	Child Care[1] :	Intercept				Slope			
		Estimate	95%CI Lower	95%CI Upper	p-value	Estimate	95%CI Lower	95%CI Upper	p-value
Shyness	Use	-0.80	-1.18	-0.41	0.000	0.07	-0.03	0.16	0.166
	Hours: low vs no	-0.56	-0.97	-0.15	0.008	0.04	-0.06	0.14	0.418
	Hours: rising vs no	-0.91	-1.32	-0.51	0.000	0.08	-0.02	0.18	0.113
	Hours: high vs no	-0.94	-1.35	-0.52	0.000	0.08	-0.02	0.18	0.116
	Hours: rising vs low	-0.35	-0.60	-0.10	0.006	0.04	-0.02	0.10	0.200
	Hours: high vs low	-0.38	-0.62	-0.13	0.003	0.04	-0.02	0.10	0.193
	Entry: 5m vs no	-0.67	-1.18	-0.16	0.010	0.00	-0.12	0.12	0.946
	Entry: 17m vs no	-0.87	-1.27	-0.47	0.000	0.07	-0.02	0.17	0.140
	Entry: 29+m vs no	-0.75	-1.15	-0.34	0.000	0.07	-0.03	0.17	0.153
	Entry: 5m vs 17m	0.20	-0.16	0.55	0.276	-0.07	-0.15	0.01	0.100
	Entry: 29+m vs 17	0.13	-0.11	0.36	0.290	0.00	-0.06	0.05	0.960
	Type: family-based vs no	-0.72	-1.16	-0.28	0.001	0.05	-0.06	0.15	0.360
	Type: center vs no	-0.68	-1.13	-0.23	0.003	0.03	-0.08	0.14	0.610
	Type: individual vs no	-0.57	-1.08	-0.06	0.030	0.08	-0.04	0.21	0.205
	Type: family-based vs center	-0.05	-0.39	0.30	0.800	0.02	-0.06	0.10	0.645
	Type: individual vs center	0.11	-0.32	0.54	0.621	0.05	-0.05	0.16	0.339
Social Withdrawal	Use	-0.60	-0.95	-0.26	0.001	0.07	-0.02	0.17	0.124
	Hours: low vs no	-0.46	-0.82	-0.09	0.014	0.06	-0.04	0.16	0.263
	Hours: rising vs no	-0.69	-1.06	-0.33	0.000	0.10	0.00	0.19	0.058
	Hours: high vs no	-0.66	-1.03	-0.30	0.000	0.07	-0.03	0.17	0.197
	Hours: rising vs low	-0.24	-0.46	-0.02	0.036	0.04	-0.02	0.10	0.199
	Hours: high vs low	-0.20	-0.42	0.02	0.069	0.01	-0.05	0.07	0.764
	Entry: 5m vs no	-0.45	-0.90	0.00	0.051	0.01	-0.11	0.13	0.910
	Entry: 17m vs no	-0.63	-0.99	-0.28	0.000	0.05	-0.05	0.14	0.343
	Entry: 29+m vs no	-0.60	-0.96	-0.24	0.001	0.12	0.02	0.21	0.020
	Entry: 5m vs 17m	0.19	-0.13	0.50	0.244	-0.04	-0.12	0.04	0.337
	Entry: 29+m vs 17	0.04	-0.17	0.24	0.736	0.07	0.01	0.12	0.013
	Type: family-based vs no	-0.57	-0.97	-0.18	0.005	0.04	-0.06	0.15	0.428

	Type: center vs no	-0.64	-1.05	-0.23	0.002	0.08	-0.03	0.19	0.157
	Type: individual vs no	-0.75	-1.22	-0.29	0.001	0.12	0.00	0.25	0.048
	Type: family-based vs center	0.06	-0.25	0.38	0.692	-0.04	-0.12	0.05	0.385
	Type: individual vs center	-0.12	-0.51	0.27	0.561	0.06	-0.06	0.15	0.385
Prosociality	Use	0.13	-0.19	0.44	0.427	-0.02	-0.11	0.08	0.731
	Hours: low vs no	0.18	-0.16	0.51	0.303	-0.04	-0.14	0.07	0.485
	Hours: rising vs no	0.12	-0.21	0.46	0.470	0.00	-0.10	0.10	1.000
	Hours: high vs no	0.07	-0.27	0.41	0.680	-0.01	-0.12	0.09	0.805
	Hours: rising vs low	-0.05	-0.26	0.16	0.616	0.04	-0.03	0.10	0.276
	Hours: high vs low	-0.11	-0.31	0.10	0.321	0.02	-0.04	0.09	0.473
	Entry: 5m vs no	-0.02	-0.44	0.40	0.909	0.04	-0.09	0.16	0.571
	Entry: 17m vs no	0.13	-0.20	0.45	0.440	-0.02	-0.12	0.08	0.682
	Entry: 29+m vs no	0.15	-0.18	0.48	0.371	-0.02	-0.12	0.08	0.731
	Entry: 5m vs 17m	-0.15	-0.45	0.15	0.316	0.06	-0.03	0.15	0.210
	Entry: 29+m vs 17	0.02	-0.17	0.22	0.820	0.00	-0.06	0.06	0.920
	Type: family-based vs No	0.07	-0.30	0.44	0.713	0.00	-0.12	0.11	0.983
	Type: center vs no	0.21	-0.17	0.59	0.285	0.01	-0.13	0.11	0.870
	Type: individual vs no	0.17	-0.27	0.60	0.446	-0.02	-0.16	0.12	0.795
	Type: family-based vs center	-0.14	-0.43	0.16	0.373	0.00	-0.10	0.09	0.979
	Type: individual vs center	-0.04	-0.41	0.33	0.835	-0.02	-0.14	0.11	0.790
Opposition	Use	0.70	0.30	1.11	0.001	-0.30	-0.51	-0.08	0.007
	Hours: low vs no	0.50	0.07	0.94	0.022	-0.26	-0.49	-0.04	0.023
	Hours: rising vs no	0.76	0.33	1.18	0.001	-0.30	-0.53	-0.08	0.009
	Hours: high vs no	0.89	0.46	1.32	0.000	-0.33	-0.56	-0.11	0.004
	Hours: rising vs low	0.25	-0.01	0.52	0.061	-0.04	-0.18	0.10	0.597
	Hours: high vs low	0.39	0.12	0.65	0.004	-0.07	-0.21	0.07	0.329
	Entry: 5m vs no	0.70	0.17	1.24	0.010	-0.27	-0.55	0.01	0.060
	Entry: 17m vs no	0.79	0.36	1.21	0.000	-0.33	-0.56	-0.11	0.003
	Entry: 29+m vs no	0.61	0.19	1.04	0.005	-0.26	-0.48	-0.03	0.024
	Entry: 5m vs 17m	-0.08	-0.46	0.30	0.670	0.07	-0.13	0.26	0.510
	Entry: 29+m vs 17	-0.17	-0.42	0.07	0.165	0.08	-0.05	0.20	0.244
	Type: family-based vs no	0.55	0.08	1.02	0.023	-0.28	-0.52	-0.03	0.027
	Type: center vs no	0.84	0.34	1.32	0.001	-0.35	-0.61	-0.09	0.008
	Type: individual vs no	0.30	-0.24	0.85	0.277	-0.24	-0.53	0.05	0.099
	Type: family-based vs center	-0.29	-0.66	0.09	0.129	0.07	-0.12	0.27	0.452
	Type: individual vs center	-0.53	-1.00	-0.07	0.024	0.11	-0.13	0.35	0.367
Aggression	Use	1.65	0.96	2.35	0.000	-0.61	-1.09	-0.13	0.012

Hours: low vs no	1.25	0.49	2.01	0.001	-0.56	-0.98	-0.14	0.008
Hours: rising vs no	1.87	1.09	2.65	0.000	-0.67	-1.10	-0.25	0.002
Hours: high vs no	1.87	1.10	2.64	0.000	-0.65	-1.06	-0.23	0.002
Hours: rising vs low	0.62	0.05	1.18	0.034	-0.11	-0.39	0.17	0.428
Hours: high vs low	0.62	0.08	1.16	0.025	-0.09	-0.36	0.18	0.523
Entry: 5m vs no	1.99	0.98	3.00	0.000	-0.74	-1.35	-0.13	0.018
Entry: 17m vs no	1.84	1.10	2.57	0.000	-0.63	-1.13	-0.13	0.014
Entry: 29+m vs no	1.41	0.65	2.16	0.000	-0.58	-1.09	-0.07	0.025
Entry: 5m vs 17m	0.15	-0.65	0.96	0.708	-0.11	-0.55	0.32	0.605
Entry: 29+m vs 17	-0.43	-0.96	0.10	0.111	0.05	-0.25	0.35	0.755
Type: family-based vs no	1.25	0.42	2.07	0.003	-0.61	-1.12	-0.09	0.021
Type: center vs no	2.02	1.10	2.94	0.000	-0.74	-1.27	-0.21	0.006
Type: individual vs no	0.71	-0.22	1.64	0.139	-0.36	-0.98	0.25	0.246
Type: family-based vs center	-0.78	-1.55	0.00	0.050	0.13	-0.28	0.55	0.530
Type: individual vs center	-1.31	-2.18	-0.45	0.008	0.38	-0.13	0.89	0.144

Note. The table presents the contribution of each child care variable to the intercept and the slope of shyness, social withdrawal, prosociality, opposition and aggression. The contribution of each child care variable was estimated in separate models (e.g. the Age at entry model did not include the Type variable). All models controlled for the contributions of all confounding variables to the intercept and the slope. [1]In this column, "Use" refers to the contribution of having received non-parental child care services at least once between 5 and 60 months, contrasted with having remained in exclusive parental care. Contrasts are mentioned in each row for "Hours", "Entry" and "Type". For instance, "Entry: 29+m vs 17m" means entering in child care at the 29 months assessment versus entering at the 17 months assessment. In addition to the contribution of each child care category the Table shows additional pairwise contrasts. For instance, regarding type of child care, three main estimates are presented for: (a) family-based vs no child care, (b) center vs no child care and, lastly, (c) individual vs no child care services (i.e. exclusive parental care). Two additional contrasts are also presented: family-based vs center and individual vs center. Note that the latter two estimates do not correspond to additional predictors but simply to additional contrasts between existing categories.

Figure caption

Figure 1. Behaviors from 6 to 12 years according to early child care use.

Legend. Fitted mean values (lines) based on models without covariates and observed mean values (points) were plotted for two groups: children receiving child care services and children in exclusive parental . Contributions of the use of child care services to the intercepts were statistically significant for all four behaviors. Statistically significant contributions to the slopes were detected for opposition and aggression but not for shyness and social withdrawal (although they reached significance in propensity score matching analyses, see Table e10 in the online material). Note that the four graphs represent the baseline models for the variable use of child care services. Refer to the text for a finer understanding of the results for other variables (e.g. the trajectory of aggression for children who received child care services depend on the type of child care).