Title:

Child Care and Social Behavior During Elementary School: Support for a Social Group Adaptation Hypothesis

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Abstract

We examined the contribution of non-parental child care services received during the preschool years to the development of social behavior between kindergarten and the end of elementary school 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 Children who received non-parental child care services were less shy, less socially withdrawn, more oppositional and more aggressive at school entry (age 6 years).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 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, elementary 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 questions regarding the effect of those services on children' social development (Lamb & Ahnert, 2006; Linting & van IJzendoorn, 2009; Sagi, Koren-Karie, Gini, Ziv, & Joels, 2002).The human and non-human attachment literature has emphasized that maternal proximity and availability during infancy are essential for 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). Later research confirmed the crucial role of peers in children's social development, be it beneficial or not (Boivin, Vitaro, & Poulin, 2005; Goldstein, Arnold, Rosenberg, Stowe, & Ortiz, 2001; 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 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). We use the term 'non-parental child care services' or 'child care services' to refer to preschool care and education services provided on a regular basis by a person other than the parent.

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

Infants and toddlers' behavioral change during the first six months in child care services presumably reflects both the initial consequences of parental unavailability and the increasing role played by peers. Infants and toddlers initially exhibit negative affect, immobility, solitary passive play with objects and the search for adult comfort. These

behaviors decrease subsequently whereas positive interactions with peers increase as children adapt to their environment (Fein, Gariboldi, & Boni, 1993). These observations suggest that children receiving non-parental child care services during the preschool years may 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 (Rubin et al., 2009), which has been conceptualized as an umbrella term describing various forms of solitary behaviors (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. Similarly, very few studies are 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 (Nærde, Ogden, Janson, & Zachrisson, 2014; Tremblay, 2010). For example, aggression is central in the establishment of dominance relationships, which are an important feature of social groups in preschoolers (Hay & Ross, 1982; Strayer & Strayer, 1976). 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,

et al., 2005; Hay, 2005; Hay & Ross, 1982; Patterson, Reid, & Eddy, 2002; Pingault & Blatier, 2013). As a social behavior, aggression is responsive to social clues including positive reinforcement provided by peers or adults throughout early childhood (Goldstein et al., 2001; Pingault & Blatier, 2013). Social environments like group-based child care settings seem particularly propitious for the early expression of aggression and opposition. Aggressive and oppositional behaviors are regularly displayed in day-care and children are often exposed to relevant social clues (Boivin, Vitaro, et al., 2005; Goldstein et al., 2001). 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., 2010).

Social group adaptation and fading child care effects

All children enter group-based settings at some point in their life whether it is during preschool or in 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 who received child care services during the preschool years. As adaptation unfolds during elementary school years, any initial difference associated with having used child care (or not) may progressively fade away. Long-term follow-ups are necessary to detect these putative fading effects after kindergarten. However, with the exception of the National Institute of Child Health and Human Development Study of Early Child Care and Youth Development (NICHD SECCYD), very few studies examining the role of child care services have followed children into elementary school (Averdijk et al., 2011). 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 dissipated by 12 years, except for children in center-based services. To explain this fading difference in externalizing behaviors such as aggression between children with and without child care experience, Belsky (2009) proposed a 'diffusion' hypothesis: child care services lead to higher levels of aggression in children who receive these services; when all children enter kindergarten, higher aggression then diffuses to children who did not receive child care services, resulting in converging levels of aggression (see comment by Linting & van IJzendoorn, 2009). Alternatively, we propose that the converging levels of aggression may be explained by a social group adaptation process. Children who start to experience living in a social group – either earlier during the preschool years because they receive child care services or later in kindergarten – undergo a transition that impacts their social behavior. Based on previous studies, we propose that children who received child care services during the preschool years, in particular in group settings, should initially display in kindergarten lower levels of shyness and social withdrawal, as well as higher levels of opposition and aggression than those with no such experience. Then, these initial differences in kindergarten should dissipate when children with no previous child care experience undergo their own social group adaptation, during elementary school.

The main purpose of this study was to examine the predictive associations between child care during the preschool years and five social behaviors – shyness, social withdrawal, prosociality, opposition and aggression – from kindergarten to the end of elementary school (grade 6). We compared behavioral changes during the elementary school years in children with and without preschool child care experience to document the potential fading effects of child care services. The pace at which putative initial differences in social behaviors may fade

away was investigated. These differences may fade away either linearly (i.e. regular decrease) or in a non-linear fashion (e.g. quick decrease in the first few years of elementary school). We examined the associations between the development of social behaviors and four features of preschool child care services: 1) receiving any preschool services versus remaining in parental care; 2) the intensity of child care services (number of hours per week); 3) the type of 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; Jacob, 2009). Finally, we controlled for a host of confounders including children's personal characteristics, family socioeconomic characteristics, family structure, 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 child care 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 to child ratio changes 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 ratio 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-year-old children in 1997-1998; 3-year-old in 1999-2000; 2-year-old in 2001-2002 and 1-year-old children in 2003-2004. The families in the present study (i.e., the Québec Longitudinal Study of Child Development, QLSCD) benefited from the low-cost spaces between 2 ½ and 5 years. Despite an increase in the total 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 educated parents and with more 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).

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 ethics committees of Santé Québec (Montréal, Canada), the Quebec Institute of Statistics (Montréal, Canada), and the St Justine Hospital Research Center (Montreal). 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

children'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 an 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. Every year during the preschool years, 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. The PMK answered the following question regarding the use of child care services: 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 specific formulation of the questions on child care in our study varied slightly from year to year but were consistently aiming to assess the use of a regular child care arrangement and to distinguish it from occasional babysitting. The interviewers were trained to help parents answer about the most regular and consistent child care arrangement. In our dataset, approximately 25% of families using regular nonparental child care at each time point had a mother who was not working. This clearly indicates that child care was not only used by families with both working parents.

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 (e.g. occasional baby sitter). Other children 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 were excluded based on child care data before the child's fifth birthday were more at risk compared to those who were excluded based on behavioral data in elementary school.

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 the high trajectory at 4 and 5 years. Finally, a low trajectory of hours in 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 care compared to the rising and the high trajectories at 5 years).

Age at entry in child care services. This variable was based on child care use 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, i.e. the one used for the most hours. Most children used more than one type of main child care arrangement between 5 months and 5 years (e.g. family-based at 5 months and center-care at 17 months). 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 main child care arrangement during the preschool years (e.g. exclusively family-based), 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 the different types of child care services to 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 social inhibition questionnaire (Asendorpf, 1993). Shyness was rated by teachers using 4 items: (1) was shy with children he/she did not know; (2) readily approached children he/she did not know (reversed item); (3) took a long time to warm up to children he/she did not know; (4) excessively shy. Social withdrawal was assessed with 4 items: (1) tended to do things on his/her own, was rather solitary; (2) preferred to play alone rather than with other children; (3) sought the company of other children (reversed item); (4) showed little interest for activities involving other children. Prosociality was assessed with 3 items: (1) tried to help someone who has been hurt; (2) comforted a child who was crying or upset; (3) helped other children who were feeling sick. Opposition was assessed with 4 items: (1) was defiant or refused to comply with adults' requests or rules; (2) did not seem to feel guilty after misbehaving; (3) punishment did not change his/her behavior; (4) 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 including "children he/she did not know". This is because teachers saw children mostly in a classroom setting where children are well acquainted. 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; 0.80 and 0.84 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 through PMK ratings when the child was 5 months except for information on the Cumulative Score for Neonatal Risk (CSNR, see below), which was obtained from hospital records.

Child characteristics. Sex was coded 1 for boys, and 0 for girls. The CSNR reflected the overall health condition at birth of infants, as indexed by 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 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: 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 through the modified version of the scale (Pineo, Porter, & Mcroberts, 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 lived 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 was a composite of 6 items, including drug selling or use or excessive drinking in public in the neighborhood (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), hostile-reactive 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 the 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 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 a good fit, in particular in larger samples. We also report three approximate fit indexes (Kline, 2011): CFI (Comparative Fit Index) for which values close to 1 indicate a 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*, 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. Shyness, social withdrawal, prosociality, opposition and aggression were not assessed at 5 months, which precludes a control for baseline levels of the target behaviors before entry into child care. This lack of control might introduce a bias due to a child effect (McCartney et al., 2010); for example, shy and withdrawn children may react to attempts to place them in child care, leading parents to keep them at home. If this was the case, any group differences in kindergarten could reflect initial differences maintained over time rather than the effect of child care. Controlling for the first behavioral assessment available (PMK ratings at the 17 months assessment) is also problematic as the majority of participating children had received child care services by 17 months. Consequently, behavioral differences at that age could already be due to exposure to child care services and

controlling for these behaviors would unduly under-estimate the contribution of child care (McCartney et al., 2010). Potential confounders should be measured before the exposure to the predictor of interest, i.e., child care services in the present case (Ho, Imai, King, & Stuart, 2007). Therefore, although we did not include the 17 months behavioral assessments in the main analyses, we re-ran the models with covariates measuring the contribution of child care use including the 17 months assessment as covariates (e.g. 17 months shyness in the shyness model with covariates). Shyness, opposition, prosociality and physical aggression (used as proxy for later aggression) were rated by the PMK at age 17 months. However, social withdrawal was not available. Additional complementary analyses are 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 5 years 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 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 were maintained 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 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 compared to 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 trajectories (0.89 [0.46; 1.32] p < .001, d = 0.57) statistically significantly differed from the children in exclusive parental care for both 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-assessed the aforementioned models by setting the intercept at age 8 years to see if differences observed at age 6 years remained statistically significant. There was no more statistically significant difference at 8.

Aggression. Figure 2d shows a change in aggression similar to that found for opposition for children who did not receive preschool child care services. This change could not be

summarized with a linear slope. We used a piecewise growth model, which consisted in including two linear slopes: the first modeled 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.

Compared to children who did not, children who used child care services had statistically significantly higher initial levels of aggression (1.65 [0.96-2.45] $p < .001$, $d = 0.52$). Their slope from age 6 to 8 years also differed. As illustrated 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 child care services during preschool started kindergarten with lower levels of aggression but then caught up rapidly until age 8 years when 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 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, patterns 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 (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 the type of child care services, we considered combinations of main child care arrangements: 1) group care only, with children exclusively in group settings, i.e. during the preschool years they used both center and family-based services; 2) other combinations, with children who received a mix of individual services and services in a group setting (i.e. attended individual care and center and/or family-based services). Results were: 1) very similar to the results presented above for children using exclusively one type of main child care arrangement across the preschool years, 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-based care). 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 specification of the binary use of child care services variable, including them in the same model is not informative. For opposition and aggression however, the 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 had elevated levels of aggression when the intensity of care was controlled for. The results were essentially unchanged for type of care. In addition, 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 use were reanalyzed by matching children who did not use child care services with those who did. 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 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 the predictive association between the use of regular non-parental child care services and social behaviors 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 considering alternative developmental hypotheses to explain the dissipating association 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 differences had disappeared by the end of elementary school (i.e. grade 6, age 12 years). Shy children tend to avoid activities and social events (Kingery, Erdley, Marshall, Whitaker, & Reuter, 2010). Child care services can create a context where shy children have to deal with their social wariness early in life. Therefore, child care services may work in a similar fashion to intervention programs that provide support for shy 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 frequent displays of 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 better prepared for social interactions and may be seen by their kindergarten teachers as less shy and socially withdrawn than those having never experienced child care services.

Opposition and aggression

The patterns found for opposition and aggression were quite different to those found for shyness and social withdrawal. Children who received child care services, compared to those who remained in parental care, displayed higher levels of opposition and aggression, especially those spending more hours in child care services. However, children not exposed to child care services steadily caught up with those who were, 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 development of aggression (Tremblay, 2010). Children receiving child care services have more opportunities to experience conflict 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) suggested 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

Given the correlational nature of the present study, no definite 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 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 contribution. However, in the present study, regression and propensity score matching techniques to adjust for potential confounds yielded very similar results. Furthermore, it would be expected that any social selection effect remaining after statistical adjustments would play in favor of children from high SES families

showing less behavior problems in kindergarten. Instead, our results showed more initial problems with aggression and opposition in children who received child care services (more likely of higher SES families) than in children who did not receive child care services (more likely of lower SES families). One could argue that "child effect", e.g. pre-existing temperamental or behavioral differences influencing whether a child receives services or not, could also play out in selection. However, consistent with a previous study which found no such effect on externalizing behaviors (McCartney et al., 2010) the sensitivity analysis suggested that this type of effect was not likely in the present study. Finally, our main finding is 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, because children who did not receive child care services catch up with those who did. Such effects are not compatible with social selection or child effects, as we would expect such selection processes to lead to enduring differences between these two groups of children. Misidentification is another potential threat to the inference of causality. For example, in the present study, we cannot rule out the possibility that the results might be a function of having working parents as it is of receiving child care services. Finally, 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 (the alternative being that any exposure to child care at any developmental stage produce similar outcomes). In the present study, hours spent in child care showed signs of a dose-response effect.

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, 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 a group-based child care setting, living in a social group is generally new for 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, the increased likelihood of conflict and the rules set by teachers. When children first integrate a social group later, for instance in kindergarten, the social setting is new for them but generally not 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 experienced children. In this 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. they remained in parental care) started at lower levels of aggression in kindergarten and steadily increased until they caught up, at around age 8 years, with children who had received child care services. The growth curve then took a sharp turn and started to decrease, mimicking the change in children with previous child care experience. From this "social group adaptation hypothesis", the presumed behavioral consequences of child care services might be better conceived as resulting from an adaptation to social 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 own social transition by age 12 years and are largely similar to children with child care experience.

Belsky (2009) suggested that high levels of aggression in children having received child care services does 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, during elementary school, children who had not used child care services during the preschool years caught up with those who had used child care services (see Figure 2d). However, our study shows that any such diffusion effect could not be restricted to externalizing behaviors such as opposition and aggression as it was also observed for shyness and social withdrawal (i.e. children with no preschool child care experience manifested progressively lower levels of both behaviors). Furthermore, children 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 opposition and aggression, 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 (see Côté et al., 2010, for a similar developmental phenomenon concerning infections). 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 an initial increase in aggression levels in this scenario due to the adaptation to the social group setting. 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 could decrease, instead of remaining high and diffusing to other children.

According to this social group adaptation perspective, it is also possible to understand why some studies did not detect associations between child care experience and externalizing behaviors (Linting & van IJzendoorn, 2009; Zachrisson, Dearing, Lekhal, & Toppelberg, 2013). In some environments, for instance small groups of peers with a high adult to child

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 of short duration; 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 impact social behaviors irrespective of 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 undergo a social transition at some point.

Assessing child care effects: further perspectives

As shown in this study, short and long term developmental perspectives based on repeated assessments over time 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 as they may be more affected by child care (e.g. focus on social anxiety instead of anxiety). Finally, more direct measures of the amount and nature (e.g. aggressive versus non-aggressive) of peer interactions inside and outside child care settings will help to test the alternative hypotheses discussed above.

Limitations

The long follow-up and 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 child care quality. The 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).

References

Achenbach, T., Edelbrock, C., & Howell, C. (1987). Empirically based assessment of the behavioral/emotional problems of 2- and 3-year-old children. *Journal of Abnormal Child Psychology*, *15*(4), 629–650.

Asendorpf, J. B. (1993). Beyond temperament: A two-factorial coping model of the development of inhibition during childhood. In *Social withdrawal, inhibition, and shyness in childhood* (pp. 265–289). Hillsdale, NJ: Erlbaum.

Averdijk, M., Besemer, S., Eisner, M., Bijleveld, C., & Ribeaud, D. (2011). The relationship between quantity, type, and timing of external childcare and child problem behaviour in Switzerland. *European Journal of Developmental Psychology*, *8*(6), 637–660. http://doi.org/10.1080/17405629.2011.571846

Aviezer, O., & Sagi-Schwartz, A. (2008). Attachment and non-maternal care: towards contextualizing the quantity versus quality debate. *Attachment & Human Development*, *10*(3), 275–285. http://doi.org/10.1080/14616730802366699

Bates, J. E., Freeland, C. A., & Lounsbury, M. L. (1979). Measurement of infant difficultness. *Child Development*, *50*(3), 794–803.

Belsky, J. (2006). Early child care and early child development: Major findings of the NICHD Study of Early Child Care. *European Journal of Developmental Psychology*, *3*(1), 95–110.

Belsky, J. (2009). Classroom composition, childcare history and social development: Are childcare effects disappearing or spreading? *Social Development*, *18*(1), 230–238.

Belsky, J., Vandell, D. L., Burchinal, M., Clarke-Stewart, K. A., McCartney, K., Owen, M. T., & The NICHD Early Child Care Research Network. (2007). Are there long-term effects of early child care? *Child Development*, *78*(2), 681–701. http://doi.org/10.1111/j.1467-8624.2007.01021.x

Boivin, M., Pérusse, D., Dionne, G., Saysset, V., Zoccolillo, M., Tarabulsy, G. M., … Tremblay, R. E. (2005). The genetic-environmental etiology of parents' perceptions and self-assessed behaviours toward their 5-month-old infants in a large twin and singleton sample. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, *46*(6), 612–630. http://doi.org/10.1111/j.1469-7610.2004.00375.x

Boivin, M., Vitaro, F., & Poulin, F. (2005). Peer relationships and the development of aggressive behavior in early childhood. In *Developmental origins of aggression* (pp. 376–397). New York, NY: Guilford Press.

Caldwell, B. M., & Bradley, R. H. (1984). *Home Observation for Measurement of the Environment*. Little Rock: Little Rock: University of Arkansas at Little Rock.

Côté, S. M., Boivin, M., Nagin, D. S., Japel, C., Xu, Q., Zoccolillo, M., … Tremblay, R. E. (2007). The role of maternal education and nonmaternal care services in the prevention of children's physical aggression problems. *Arch Gen Psychiatry*, *64*(11), 1305–1312. http://doi.org/10.1001/archpsyc.64.11.1305

Côté, S. M., Petitclerc, A., Raynault, M.-F., Xu, Q., Falissard, B., Boivin, M., & Tremblay, R. E. (2010). Short- and long-term risk of infections as a function of group child care attendance: An 8-year population-based study. *Archives of Pediatrics & Adolescent Medicine*, *164*(12), 1132–1137. http://doi.org/10.1001/archpediatrics.2010.216

Curran, P. J., West, S. G., & Finch, J. F. (1996). The robustness of test statistics to nonnormality and specification error in confirmatory factor analysis. *Psychological Methods*, *1*(1), 16–29.

Dallaire, D. H., & Weinraub, M. (2007). Infant-mother attachment security and children's anxiety and aggression at first grade. *Journal of Applied Developmental Psychology*, *28*, 477–492.

Fabes, R. A., Hanish, L. D., & Martin, C. L. (2003). Children at play: The role of peers in understanding the effects of child care. *Child Development*, *74*(4), 1039–1043.

Fein, G. G., Gariboldi, A., & Boni, R. (1993). The adjustment of infants and toddlers to group care: The first 6 months. *Early Childhood Research Quarterly*, *8*(1), 1–14. http://doi.org/10.1016/S0885-2006(05)80095-X

Genolini, C., & Falissard, B. (2011). KmL: A package to cluster longitudinal data. *Computer Methods and Programs in Biomedicine*, *104*(3), e112–121. http://doi.org/10.1016/j.cmpb.2011.05.008

Geoffroy, M.-C., Séguin, J. R., Lacourse, E., Boivin, M., Tremblay, R. E., & Côté, S. M. (2012). Parental characteristics associated with childcare use during the first 4 years of life: results from a representative cohort of Québec families. *Canadian Journal of Public Health = Revue Canadienne De Santé Publique*, *103*(1), 76–80.

Goldstein, N. E., Arnold, D. H., Rosenberg, J. L., Stowe, R. M., & Ortiz, C. (2001). Contagion of aggression in day care classrooms as a function of peer and teacher responses. *Journal of Educational Psychology*, *93*(4), 708–719. http://doi.org/10.1037/0022-0663.93.4.708

Guedeney, A., Foucault, C., Bougen, E., Larroque, B., & Mentré, F. (2008). Screening for risk factors of relational withdrawal behaviour in infants aged 14-18 months. *European Psychiatry*, *23*(2), 150–155. http://doi.org/10.1016/j.eurpsy.2007.07.008

Hancock, G. R. (2001). Effect size, power, and sample size determination for structured means modeling and mimic approaches to between-groups hypothesis testing of means on a single latent construct. *Psychometrika*, *66*(3), 373–388. http://doi.org/10.1007/BF02294440

Harlow, H. F. (1972). Love created, love destroyed, love regained. In *Modèles animaux du comportement humain* (Editions du CNRS, pp. 13–60). Paris.

Hay, D. F. (2005). The beginnings of aggression in infancy. In *Developmental Origins of Aggression* (pp. 107–132). New York ; London: The Guildford Press.

Hay, D. F., & Ross, H. S. (1982). The social nature of early conflict. *Child Development*, *53*(1), 105–113. http://doi.org/10.2307/1129642

Heiser, N. A., Turner, S. M., & Beidel, D. C. (2003). Shyness: relationship to social phobia and other psychiatric disorders. *Behaviour Research and Therapy*, *41*(2), 209–221.

Herba, C. M., Tremblay, R. E., Boivin, M., Liu, X., Mongeau, C., Séguin, J. R., & Côté, S. M. (2013). Maternal depressive symptoms and children's emotional problems: Can early child care help children of depressed mothers? *JAMA Psychiatry*, 1–9. http://doi.org/10.1001/jamapsychiatry.2013.1361

Ho, D. E., Imai, K., King, G., & Stuart, E. A. (2007). Matching as nonparametric preprocessing for reducing model dependence in parametric causal inference. *Political Analysis*, *15*(3), 199 –236. http://doi.org/10.1093/pan/mpl013

Ho, D. E., Imai, K., King, G., & Stuart, E. A. (2011). MatchIt: Nonparametric preprocessing for parametric causal inference. *Journal of Statistical Software*, *42*(8), 1–28.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1–55.

Imai, K., King, G., & Stuart, E. A. (2008). Misunderstandings between experimentalists and observationalists about causal inference. *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, *171*(2), 481–502. http://doi.org/10.1111/j.1467-985X.2007.00527.x

Jacob, J. I. (2009). The socio-emotional effects of non-maternal childcare on children in the USA: a critical review of recent studies. *Early Child Development and Care*, *179*(5), 559–570. http://doi.org/10.1080/03004430701292988

Japel, C., Tremblay, R. E., & Côté, S. (2005). [The quality of child care services: Results of the Québec Longitudinal Study of Child Development]. *Éducation et Francophonie*, *XXXIII*(2), 7–27.

Jetté, M., & Des Groseilliers, L. (2000). *Survey description and methodology of the Longitudinal Study of Child Development in Québec (ELDEQ 1998-2002)*. Québec QC: Institut de la Statistique du Québec.

Kingery, J. N., Erdley, C. A., Marshall, K. C., Whitaker, K. G., & Reuter, T. R. (2010). Peer experiences of anxious and socially withdrawn youth: an integrative review of the developmental and clinical literature. *Clinical Child and Family Psychology Review*, *13*(1), 91–128. http://doi.org/10.1007/s10567-009-0063-2

Kline, R. B. (2011). *Principles and practice of structural equation modeling*. New York: Guilford Press.

Lamb, M. E., & Ahnert, L. (2006). Nonparental Child Care: context, concepts, correlates, and consequences. In *Handbook of Child Psychology* (Sixth, Vol. IV, pp. 950–1016). New Jersey: John Wiley and Sons.

Liang, H., Pickles, A., Wood, N., & Simonoff, E. (2012). Adolescent emotional and behavioural outcomes of nonparental preschool childcare. *Social Psychiatry and Psychiatric Epidemiology*, *47*(3), 399–407. http://doi.org/10.1007/s00127-011-0351-2

Linting, M., & van IJzendoorn, M. H. (2009). Dissipating or diffusing aggression after non-maternal childcare? Commentary on a novel hypothesis. *Social Development*, *18*(1), 239–246.

McCartney, K., Burchinal, M., Clarke-Stewart, A., Clarke-Stewart, A., Bub, K. L., Owen, M. T., … NICHD Early Child Care Research Network. (2010). Testing a series of causal propositions relating time in child care to children's externalizing behavior. *Developmental Psychology*, *46*(1), 1–17. http://doi.org/10.1037/a0017886

Nærde, A., Ogden, T., Janson, H., & Zachrisson, H. D. (2014). Normative development of physical aggression from 8 to 26 months. *Developmental Psychology*, *50*(6), 1710–1720. http://doi.org/10.1037/a0036324

NICHD Early Child Care Research Network. (2001). Child-care and family predictors of preschool attachment and stability from infancy. *Developmental Psychology*, *37*(6), 847–862.

NICHD Early Child Care Research Network. (2004). Trajectories of physical aggression from toddlerhood to middle childhood: Predictors, correlates, and outcomes. *Monographs of the Society for Research in Child Development*, *69*(4), vii, 1–129. http://doi.org/10.1111/j.0037-976X.2004.00312.x

Oberski, D. (2014). lavaan.survey: An R Package for complex survey analysis of Structural Equation Models. *Journal of Statistical Software*, *57*(1), 1–27.

Offord, D., Boyle, M., & Racine, Y. (1989). Ontario Child Health Study: Correlates of disorder, *28*(6), 856–860.

Patterson, G. R., Reid, J. B., & Eddy, J. M. (2002). A brief history of the Oregon model. In *Antisocial behavior in children and adolescents. A developmental analysis and model for intervention* (pp. 3–21). Washington, DC: American Psychological Association.

Pineo, P. C., Porter, J., & Mcroberts, H. A. (1977). The 1971 Census and the Socioeconomic Classification of Occupations*. *Canadian Review of Sociology/Revue Canadienne de Sociologie*, *14*(1), 91–102. http://doi.org/10.1111/j.1755-618X.1977.tb00333.x

Pingault, J.-B., & Blatier, C. (2013). [An observational study of the mother's role in regulating child conflict]. *Devenir*, *25*(2), 93–116.

Radloff, L. S. (1977). The CES-D Scale A Self-Report Depression Scale for research in the general population. *Applied Psychological Measurement*, *1*(3), 385–401. http://doi.org/10.1177/014662167700100306

Rapee, R. M., Schniering, C. A., & Hudson, J. L. (2009). Anxiety disorders during childhood and adolescence: origins and treatment. *Annual Review of Clinical Psychology*, *5*, 311–341. http://doi.org/10.1146/annurev.clinpsy.032408.153628

Rosseel, Y. (2012). lavaan: An R Package for Structural Equation Modeling. *Journal of Statistical Software*, *48*(2), 1–36.

Rubin, K. H., Coplan, R. J., & Bowker, J. C. (2009). Social withdrawal in childhood. *Annual Review of Psychology*, *60*, 141–171. http://doi.org/10.1146/annurev.psych.60.110707.163642

Sagi, A., Koren-Karie, N., Gini, M., Ziv, Y., & Joels, T. (2002). Shedding further light on the effects of various types and quality of early child care on infant-mother attachment relationship: the Haifa Study of Early Child Care. *Child Development*, *73*(4), 1166–1186.

Séguin, L., Kantiébo, M., Xu, Q., Zunzunegui, M.-V., Potvin, L., Frohlich, K., & Dumas, C. (2001). Part I - Poverty, health conditions at birth and infant health. In *Longitudinal Study of Child Development in Québec (ELDEQ 1998-2002)* (Vol. 1, No 3). Québec: Institut de la statistique du Québec.

Statistics Canada. (1981). *Standard occupational classification 1980*. Ottawa: Supply and Services Canada.

Statistics-Canada. (1995). *Overview of Survey Instruments for 1994-95 Data Collection, Cycle 1.* Ottawa, ON: Statistics Canada.

Strayer, F. F., & Strayer, J. (1976). An ethological analysis of social agonism and dominance relations among preschool children. *Child Development*, *47*, 980–989.

Thibault, J., Jetté, M., & Desrosiers, H. (2001). *Concepts, Definitions and Operational Aspects, Part II – Data and Variables" in Longitudinal Study of Child Development in*

Québec (ÉLDEQ 1998-2002) (Vol. 1, n° 12). Québec: Institut de la statistique du Québec.

Tremblay, R. E. (2010). Developmental origins of disruptive behaviour problems: The 'original sin' hypothesis, epigenetics and their consequences for prevention. *Journal of Child Psychology and Psychiatry*, *51*(4), 341–367. http://doi.org/10.1111/j.1469-7610.2010.02211.x

Tremblay, R. E., Desmarais-Gervais, L., Gagnon, C., & Charlebois, P. (1987). The Preschool Behavior Questionnaire: Stability of its factor structure between cultures, sexes, ages and socioeconomic classes, *10*(4), 467–484.

Van Buuren, S., & Groothuis-Oudshoorn, K. (2011). mice: Multivariate Imputation by Chained Equations in R. *Journal of Statistical Software*, *45*(3), 1–67.

Vandell, D. L., Belsky, J., Burchinal, M., Steinberg, L., & Vandergrift, N. (2010). Do effects of early child care extend to age 15 Years? Results from the NICHD study of early child care and youth development. *Child Development*, *81*(3), 737–756. http://doi.org/10.1111/j.1467-8624.2010.01431.x

Vitaro, F., Desmarais-Gervais, L., Tremblay, R. E., & Gagnon, C. (1992). [Social adaptation at school entry and child care in preschool]. *Revue Des Sciences de L'éducation*, *18*(1), 1–15.

Willms, J., & Shields, M. (1996). *A measure of socioeconomic status for the National Longitudinal Survey of Children.* Atlantic Center for Policy Research in Education: University of New Brunswick and Satistics Canada.

Zachrisson, H. D., Dearing, E., Lekhal, R., & Toppelberg, C. O. (2013). Little evidence that time in child care causes externalizing problems during early childhood in Norway. *Child Development*, *84*(4), 1152–1170. http://doi.org/10.1111/cdev.12040

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

	Intercept	Slope

	Child Care[1] :	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, (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 captions

Figure 1: Trajectories of hours in child care

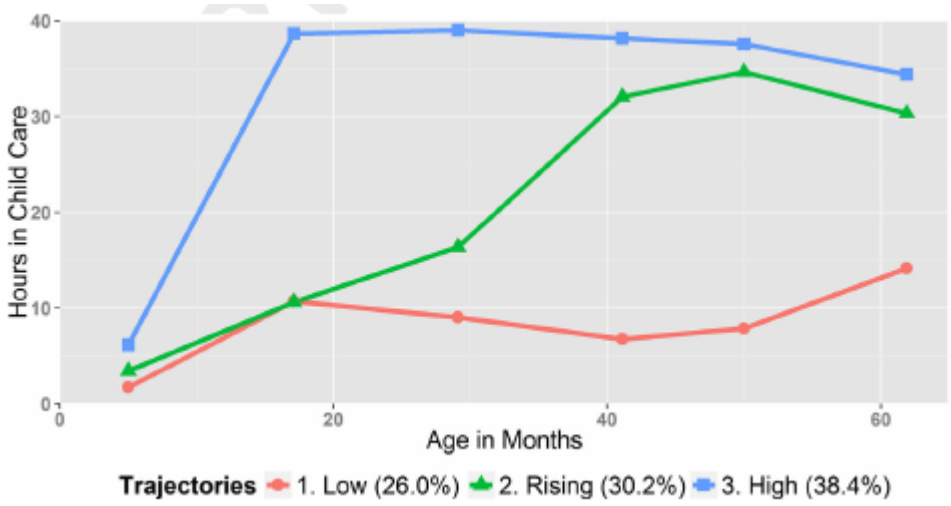

Figure 2. Social behaviors from 6 to 12 years according to early child care use.

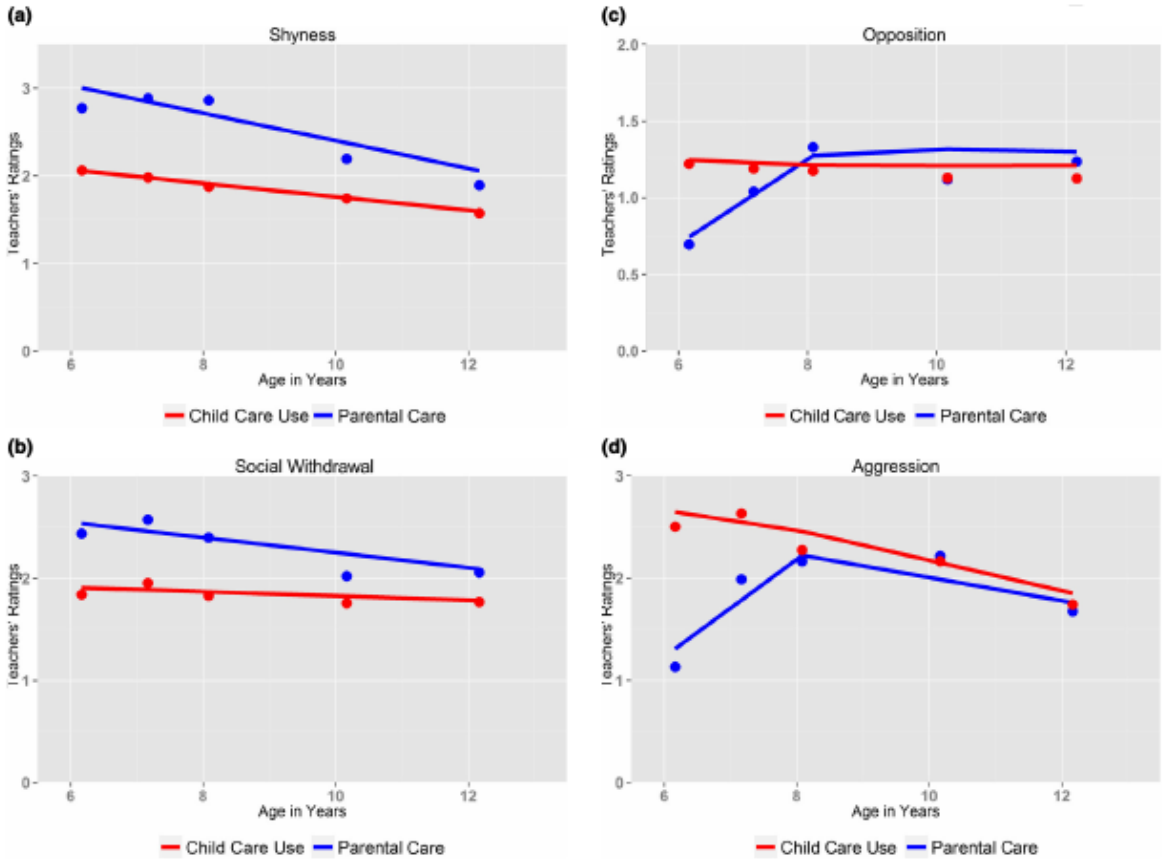

Figure 2a: Shyness. Figure 2b: Social Withdrawal. Figure 2c: Opposition. Figure 2d: Aggression

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).

Online Material

Early Nonparental Care and Social Behavior in Elementary School:

Support for a Social Group Adaptation Hypothesis

Published in *Child Development*

Authored by Jean-Baptiste Pingault, Richard E. Tremblay, Frank Vitaro, Christa Japel, Michel Boivin, Sylvana M. Côté

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Additional information on the socioeconomic status composite

Table e1 below presents descriptive values for the SES composite and the five variables included in the composite. The descriptive statistics are provided for the study sample and for children using child care services versus children in exclusive parental care. Mothers' and spouse's education were expressed in years of schooling starting from the first year of primary school. Annual family income was divided in 9 categories, all in Canadian dollars (in thousands): 1 = [0-10k[; 2 = [10-15k[; 3 = [15-20k[; 4 = [20-30k[; 5 = [30-40k[; 6 = [40-50k[; 7 = [50-60k[; 8 = [60-80k[; 9 = 80k or more. Occupational prestige was organized in 16 categories, from 1 being the category with more prestige to 16 being the category with the lowest prestige (as such, lower scores in the table corresponds to higher prestige). The categories were as follows, from 16 to 1: farm labourer (16), unskilled manual (15), unskilled clerical/sales/service (14), semi-skilled manual (13), semi-skilled clerical/sales (12), farmer (11), skilled crafts and trade (10), skilled clerical/sales/service (9), foreman/forewoman (8), supervisor (7), middle manager (6), technician (5), semi-professional (4), high-level management (3), employed professional (2), self-employed professional (1). All 5 variables were standardized and then averaged (the prestige variables being reversed). Additional details on how the categorical variables were transformed before standardization and how the SES composite was computed for the present study are available in Willms & Shields (1996).

Table e1: Variables included in the socioeconomic status composite

	Study sample (N = 1544)	Using (N= 1451)	Not using (N=93)	Test
SES composite	0.06 (0.98)	0.10 (0.98)	-0.52 (1.00)	5.4***
Maternal education	10.84 (1.04)	10.86 (1.01)	10.48 (1.46)	2.5*
Paternal education	10.75 (1.09)	10.77 (1.05)	10.51 (1.46)	1.6
Maternal prestige	7.80 (4.41)	7.76 (4.40)	9.29 (4.69)	1.7
Paternal prestige	8.75 (4.38)	8.68 (4.36)	10.04 (4.62)	2.5*
Family income	6 (4)	6 (3)	5 (3)	87038***

Note. For all variables, the mean (SD) are presented, except for the Family income for which the median and the interquartile range are provided. To compare using versus non-using children, we utilized student t-test for all variables except family income, where a non-parametric Mann-Whitney test for independent sample was used. Despite having many categories, the maternal and paternal prestige are also ordered categorical variables. However, the results were robust to the use of a Mann-Whitney test instead of a Student t-test: the difference between using and non-using children regarding maternal prestige remained non-significant whereas the difference for paternal prestige remained significant.

Details on model fitting for prosociality, opposition and aggression

Prosociality. The fit of the linear model without covariates was not perfect: the chi-square was significant at the .05 level ($\chi^2 = 24.7$, df = 13, p = .026) and the CFI was equal to 0.93; however, other indices were well in line with the recommended cutoff values. Furthermore, the chi-square was not significant anymore in the linear model with covariates used to estimate the contribution of child care use, so that a linear model was still retained (see Table e2 below for fit indices).

Opposition. A linear model did not fit the data perfectly as shown by a highly significant chi-square ($\chi^2 = 44.1$, *df* = 13, p < .001), even if the approximate fit indexes were in line with the recommended cut-offs. As illustrated in Figure 1c, non-using children started with lower levels of opposition in kindergarten but rapidly caught up with children who used child care. The two groups had then virtually identical flat levels of opposition from age 8 years onwards. To capture this non-linear change, we freed the last two time loadings. The chi-square, although still significant, was greatly improved ($\chi^2 = 21.9$, *df* = 11, p = .025). The maximum residual correlation also decreased from 0.08 to 0.04 and approximate fit indices improved (see Table e2 below). In addition, all models with covariates based on this pattern had non-significant chi-squares and adequate fit indices (see Table e2).

Aggression. Similarly to opposition, a simple linear model did not fit the data properly (robust $\chi^2 = 34.4$, *df* = 13, p = .001). Figure 1d shows a change of aggression in the non-using group that is similar to opposition and cannot be summarized only with a linear slope. However, freeing the last two loadings did not suffice to reach an adequate fit as in the case of opposition. We thus 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. The chi-square of the piecewise model was greatly reduced and just below the p =.05 significance level ($\chi^2 = 15.9$, df = 8, p = 0.044), approximate fit indices also improved (see Table e2 below), the maximum residual correlation went from 0.08 to 0.05 and, importantly, Figure 1d shows that predicted means were close to observed means in this model (which was not the case in the previous models). In addition, all models with covariates based on this piecewise model had non-significant chi-square (see Table e2 below).

Table e2: Fit indices for all models

Two lines are presented for each model, the first line corresponds to the model without covariates and the second line to the model with covariate.

		Chi Square	DF	pvalue	CFI	SRMR	RMSEA	RMSEA lower	RMSEA upper
Shyness	Use	6.623	13	0.921	1.000	0.013	0.000	0.000	0.009
	Use	67.036	67	0.476	1.000	0.012	0.001	0.000	0.015
	Hours	9.036	19	0.973	1.000	0.012	0.000	0.000	0.000
	Hours	70.091	73	0.575	1.000	0.011	0.000	0.000	0.013
	Age at Entry	11.075	19	0.921	1.000	0.013	0.000	0.000	0.008
	Age at Entry	76.399	73	0.370	0.995	0.012	0.005	0.000	0.016
	Type	17.874	19	0.531	1.000	0.030	0.000	0.000	0.032
	Type	70.087	75	0.639	1.000	0.020	0.000	0.000	0.019
Social Withdrawal	Use	11.580	13	0.562	1.000	0.019	0.000	0.000	0.023
	Use	68.649	67	0.421	0.997	0.013	0.004	0.000	0.016
	Hours	15.380	19	0.698	1.000	0.018	0.000	0.000	0.017
	Hours	71.765	73	0.519	1.000	0.012	0.000	0.000	0.014
	Age at Entry	12.308	19	0.872	1.000	0.015	0.000	0.000	0.012
	Age at Entry	72.473	73	0.495	1.000	0.012	0.000	0.000	0.014
	Type	27.294	21	0.161	0.973	0.039	0.021	0.000	0.042
	Type	87.043	75	0.161	0.953	0.021	0.016	0.000	0.028
Prosocial Behaviors	Use	24.651	13	0.026	0.927	0.034	0.024	0.008	0.039
	Use	65.451	67	0.531	1.000	0.015	0.000	0.000	0.015
	Hours	30.446	19	0.046	0.927	0.030	0.020	0.003	0.033
	Hours	72.830	73	0.484	1.000	0.015	0.000	0.000	0.015
	Age at Entry	30.364	19	0.047	0.927	0.029	0.020	0.002	0.033
	Age at Entry	75.644	73	0.393	0.99	0.015	0.005	0.000	0.016

	Type	10.762	19	0.932	2 1.000	0.030	0.000	0.000	0.010
	Type	62.167	73	0.813	1.000	0.021	0.000	0.000	0.015
Opposition	Use (linear[1])	44.053	13	0.000	0.981	0.037	0.039	0.027	0.052
	Use (free loadings)	21.877	11	0.025	0.993	0.038	0.025	0.009	0.041
	Use	67.221	65	0.401	0.999	0.014	0.005	0.000	0.016
	Hours	26.054	17	0.073	0.995	0.031	0.019	0.000	0.032
	Hours	70.373	71	0.499	1.000	0.013	0.000	0.000	0.015
	Age at Entry	24.439	17	0.108	0.996	0.031	0.017	0.000	0.031
	Age at Entry	70.406	71	0.498	1.000	0.013	0.000	0.000	0.015
	Type	13.916	17	0.673	1.000	0.032	0.000	0.000	0.029
	Type	64.093	71	0.706	1.000	0.017	0.000	0.000	0.018
Aggression	Use (linear[1])	34.434	13	0.001	0.975	0.049	0.033	0.022	0.043
	Use (piecewise)	15.893	8	0.044	0.991	0.029	0.025	0.010	0.040
	Use	51.826	44	0.195	0.995	0.011	0.011	0.000	0.021
	Hours	25.725	13	0.019	0.988	0.029	0.025	0.013	0.037
	Hours	55.153	48	0.222	0.995	0.011	0.010	0.000	0.020
	Age at Entry	18.872	12	0.092	0.993	0.023	0.019	0.000	0.033
	Age at Entry	52.634	48	0.299	0.997	0.010	0.008	0.000	0.018
	Type	8.216	12	0.768	1.000	0.021	0.000	0.000	0.023
	Type	47.146	48	0.508	1.000	0.014	0.000	0.000	0.024

Note. [1]Linear models did not fit properly for opposition and aggression so that all subsequent models were based on the model in the second line (free two last loadings for opposition and piecewise growth model for aggression, see *Results* section). [2]As MLR estimator was used for aggression, all indexes except SRMR were scaled accordingly.

Table e3: Contribution child care use and covariates to childhood shyness

	Intercept				Slope			
	Estimate	95%CI lower	95%CI Upper	p-value	Estimate	95%CI lower	95%CI Upper	p-value
Child Care Use	-0.80	-1.18	-0.41	0.000	0.07	-0.03	0.16	0.166
Sex	-0.24	-0.43	-0.06	0.010	0.02	-0.03	0.06	0.492
CSNR	-0.05	-0.13	0.03	0.229	0.02	0.00	0.04	0.044
Difficult Temperament	0.02	-0.05	0.08	0.618	0.00	-0.02	0.01	0.822
Socioeconomic status	-0.20	-0.32	-0.09	0.000	0.02	0.00	0.05	0.084
Work Status	-0.13	-0.37	0.11	0.275	0.02	-0.04	0.07	0.540
Immigrant Status	0.43	0.06	0.80	0.023	-0.03	-0.12	0.06	0.457
Family structure	-0.18	-0.44	0.08	0.179	0.04	-0.02	0.10	0.183
Sibling(s)	0.03	-0.17	0.22	0.780	-0.03	-0.07	0.02	0.237
Unsafe Neighbourhood	0.08	-0.11	0.28	0.414	-0.01	-0.05	0.04	0.693
Little Social Problems	0.26	-0.07	0.58	0.124	-0.09	-0.17	-0.01	0.021
Family Functioning	0.03	-0.04	0.11	0.411	0.00	-0.02	0.01	0.719
Efficacy	-0.09	-0.18	0.00	0.054	-0.01	-0.03	0.01	0.307
Impact	0.01	-0.05	0.06	0.795	-0.01	-0.02	0.01	0.258
Hostile-reactive	-0.11	-0.18	-0.04	0.002	0.01	0.00	0.03	0.131
Overprotection	0.03	-0.01	0.08	0.123	0.00	-0.01	0.01	0.402
Verbalization	-0.06	-0.14	0.01	0.103	0.01	-0.01	0.03	0.350
Involvement	0.05	0.00	0.10	0.040	-0.02	-0.03	0.00	0.010
Maternal Depression	-0.01	-0.09	0.07	0.797	0.01	-0.01	0.03	0.527

Table e4: Contribution of child care use and covariates to childhood social withdrawal

	Intercept				Slope			
	Estimate	95%CI lower	95%CI Upper	p-value	Estimate	95%CI lower	95%CI Upper	p-value
Child Care Use	-0.60	-0.95	-0.26	0.001	0.07	-0.02	0.17	0.124
Sex	0.25	0.08	0.41	0.003	0.03	-0.01	0.08	0.126
CSNR	-0.05	-0.12	0.02	0.193	0.01	-0.01	0.03	0.164
Difficult Temperament	0.01	-0.04	0.07	0.611	-0.01	-0.02	0.01	0.508
Socioeconomic status	-0.04	-0.14	0.06	0.416	-0.01	-0.04	0.01	0.300
Work Status	0.11	-0.10	0.32	0.302	-0.05	-0.10	0.01	0.090
Immigrant Status	-0.18	-0.51	0.15	0.289	-0.01	-0.10	0.09	0.909
Family structure	0.15	-0.08	0.38	0.202	0.01	-0.06	0.07	0.832
Sibling(s)	-0.13	-0.30	0.04	0.136	0.01	-0.04	0.05	0.785
Unsafe Neighbourhood	0.11	-0.06	0.28	0.194	-0.03	-0.08	0.01	0.165
Little Social Problems	-0.09	-0.37	0.20	0.550	-0.02	-0.10	0.06	0.639
Family Functioning	-0.04	-0.10	0.03	0.301	0.00	-0.02	0.02	0.872
Efficacy	-0.06	-0.14	0.02	0.144	0.00	-0.02	0.02	0.908
Impact	-0.02	-0.07	0.03	0.472	0.00	-0.01	0.01	0.928
Hostile-reactive	-0.05	-0.11	0.01	0.129	0.02	0.00	0.04	0.017
Overprotection	0.04	0.00	0.08	0.040	0.00	-0.01	0.01	0.446
Verbalization	-0.03	-0.10	0.03	0.337	0.01	-0.01	0.03	0.229
Involvement	0.03	-0.02	0.07	0.197	-0.01	-0.02	0.00	0.052
Maternal Depression	0.08	0.01	0.15	0.037	0.00	-0.02	0.02	0.749

Table e5: Contribution of child care use and covariates to childhood prosocial behaviors

	Intercept				Slope			
	Estimate	95%CI lower	95%CI Upper	p-value	Estimate	95%CI lower	95%CI Upper	p-value
Child Care Use	0.13	-0.19	0.44	0.427	-0.02	-0.11	0.08	0.731
Sex	-0.75	-0.90	-0.59	0.000	0.01	-0.04	0.06	0.720
CSNR	-0.03	-0.10	0.03	0.314	0.01	-0.02	0.03	0.675
Difficult Temperament	0.05	-0.01	0.10	0.084	-0.01	-0.03	0.00	0.136
Socioeconomic status	0.04	-0.05	0.14	0.377	0.02	-0.01	0.04	0.285
Work Status	0.12	-0.08	0.32	0.235	-0.04	-0.10	0.03	0.240
Immigrant Status	-0.02	-0.33	0.29	0.918	-0.04	-0.14	0.06	0.466
Family structure	0.08	-0.14	0.30	0.494	-0.04	-0.11	0.03	0.301
Sibling(s)	0.04	-0.12	0.20	0.639	0.03	-0.02	0.09	0.186
Unsafe Neighbourhood	-0.12	-0.28	0.04	0.139	0.04	-0.01	0.09	0.096
Little Social Problems	-0.33	-0.60	-0.06	0.018	0.02	-0.07	0.11	0.628
Family Functioning	-0.02	-0.08	0.04	0.515	0.00	-0.02	0.02	0.857
Efficacy	-0.01	-0.09	0.07	0.797	0.02	0.00	0.05	0.058
Impact	0.05	0.00	0.10	0.036	-0.02	-0.04	0.00	0.012
Hostile-reactive	0.01	-0.05	0.07	0.789	0.01	-0.01	0.02	0.550
Overprotection	-0.01	-0.05	0.02	0.535	0.00	-0.01	0.01	0.675
Verbalization	0.03	-0.03	0.10	0.326	0.00	-0.02	0.02	0.683
Involvement	0.01	-0.03	0.06	0.506	0.00	-0.02	0.01	0.759
Maternal Depression	0.00	-0.07	0.07	0.932	-0.01	-0.03	0.01	0.448

Table e6: Contribution of child care use and covariates to childhood opposition

	Intercept				Slope			
	Estimate	95%CI lower	95%CI Upper	p-value	Estimate	95%CI lower	95%CI Upper	p-value
Child Care Use	0.70	0.30	1.11	0.001	-0.30	-0.51	-0.08	0.007
Sex	0.84	0.65	1.04	0.000	0.03	-0.08	0.13	0.633
CSNR	0.03	-0.05	0.12	0.433	-0.02	-0.07	0.02	0.304
Difficult Temperament	-0.05	-0.11	0.02	0.140	0.02	-0.01	0.05	0.260
Socioeconomic status	-0.12	-0.25	0.00	0.051	-0.05	-0.11	0.02	0.132
Work Status	-0.30	-0.55	-0.05	0.020	0.19	0.05	0.32	0.007
Immigrant Status	-0.34	-0.74	0.06	0.091	0.03	-0.19	0.24	0.795
Family structure	0.29	0.02	0.57	0.039	0.08	-0.07	0.22	0.290
Sibling(s)	-0.12	-0.32	0.09	0.268	0.08	-0.03	0.19	0.132
Unsafe Neighbourhood	0.20	0.00	0.41	0.050	-0.06	-0.16	0.05	0.306
Little Social Problems	-0.11	-0.45	0.23	0.524	0.11	-0.07	0.29	0.232
Family Functioning	-0.02	-0.10	0.07	0.709	-0.01	-0.05	0.03	0.638
Efficacy	0.03	-0.07	0.12	0.587	0.01	-0.04	0.06	0.797
Impact	-0.09	-0.15	-0.03	0.004	0.03	0.00	0.06	0.088
Hostile-reactive	0.02	-0.05	0.09	0.603	-0.02	-0.06	0.02	0.377
Overprotection	-0.03	-0.08	0.01	0.162	0.02	-0.01	0.04	0.169
Verbalization	0.06	-0.02	0.14	0.150	-0.03	-0.08	0.01	0.122
Involvement	-0.07	-0.12	-0.01	0.015	0.02	-0.01	0.05	0.118
Maternal Depression	0.16	0.07	0.24	0.000	-0.02	-0.06	0.03	0.481

Table e7: Contribution of child care use and covariates to childhood aggression

	Intercept				Slope			
	Estimate	95%CI lower	95%CI Upper	p-value	Estimate	95%CI lower	95%CI Upper	p-value
Child Care Use	1.65	0.96	2.35	0.000	-0.61	-1.09	-0.13	0.012
Sex	1.77	1.35	2.19	0.000	-0.03	-0.28	0.21	0.797
CSNR	0.01	-0.17	0.20	0.892	0.00	-0.11	0.11	0.993
Difficult Temperament	-0.07	-0.20	0.06	0.285	0.00	-0.08	0.07	0.913
Socioeconomic status	-0.32	-0.57	-0.07	0.012	-0.02	-0.17	0.13	0.808
Work Status	-0.28	-0.76	0.21	0.263	0.30	0.00	0.61	0.050
Immigrant Status	-0.47	-1.24	0.31	0.237	-0.15	-0.63	0.32	0.527
Family structure	0.51	-0.15	1.16	0.132	0.05	-0.34	0.44	0.806
Sibling(s)	-0.49	-0.93	-0.05	0.031	0.29	0.04	0.54	0.025
Unsafe Neighbourhood	0.45	-0.02	0.92	0.062	-0.09	-0.34	0.16	0.492
Little Social Problems	-0.01	-0.92	0.91	0.985	0.08	-0.34	0.50	0.699
Family Functioning	-0.09	-0.27	0.08	0.306	0.03	-0.07	0.13	0.511
Efficacy	-0.04	-0.26	0.18	0.749	0.09	-0.04	0.21	0.166
Impact	-0.23	-0.38	-0.08	0.003	0.07	-0.02	0.15	0.115
Hostile-reactive	0.02	-0.15	0.18	0.845	-0.02	-0.10	0.07	0.741
Overprotection	-0.07	-0.17	0.03	0.160	0.01	-0.05	0.06	0.865
Verbalization	0.09	-0.09	0.26	0.320	-0.03	-0.13	0.07	0.544
Involvement	-0.15	-0.26	-0.04	0.006	0.05	-0.01	0.11	0.091
Maternal Depression	0.37	0.15	0.58	0.001	-0.11	-0.23	0.00	0.059

Note. In this table, we do not show the results regarding the link between covariates and the second slope as none was significant (see the *Results* section in the manuscript for an explanation of the first and the second slope).

Table e8: Complementary analyses regarding the type of child care

Analyses presented in this table complement the manuscript analyses in two ways. First, in the manuscript analyses, on the six data points available, only one was allowed to be missing in order to reduce misclassification. This condition was relaxed here. Second, in the manuscript, only "pure" types of child care were considered. In the present analyses, in addition to all "pure" types, two combinations were considered: 1) a group care condition with children having used family-based and center-based child care, excluding individual child care; 2) all other combinations, including individual child care and either/or family-based and center-based care. All these conditions were compared to children never having used child care first (five first rows for each behavior). As in the manuscript, additional contrasts were computed comparing each of the condition with children in center-based care only (five last rows for each behavior).

Ns were as follows: no child care (103), Family-based only (386), Center only (329), Individual only (205), Family-based/Center (387), Other combinations (483). Total N was thus 1893. The difference of 7 participants with N for child care use analyses in the manuscript was due to children having used child care but with no information on the type at any time point. Ns for the final behavioral analyses were also very close to the ones reported in the manuscript for child care use analyses (from 1514 to 1540).

Behavior		Intercept				Slope			
		Estimate	95%CI Lower	95%CI Upper	p-value	Estimate	95%CI Lower	95%CI Upper	p-value
Shyness									
	Family-based only vs no	-0.735	-1.142	-0.328	0.000	0.051	-0.048	0.150	0.312
	Center only vs no	-0.748	-1.162	-0.333	0.000	0.065	-0.037	0.168	0.211
	Individual only vs no	-0.562	-1.020	-0.103	0.016	0.085	-0.027	0.197	0.138
	Family-based/Center vs no	-0.843	-1.252	-0.434	0.000	0.035	-0.065	0.135	0.492
	Other combinations vs no	-0.892	-1.293	-0.492	0.000	0.071	-0.026	0.169	0.153
	Family-based only vs center	0.013	-0.282	0.308	0.930	-0.014	-0.086	0.057	0.692
	Individual only vs center	0.186	-0.174	0.547	0.311	0.019	-0.069	0.108	0.670
	Family-based/Center vs center	-0.095	-0.386	0.196	0.521	-0.030	-0.102	0.042	0.409
	Other combinations vs center	-0.144	-0.425	0.136	0.313	0.006	-0.063	0.075	0.867
Social withdrawal									
	Family-based only vs no	-0.563	-0.932	-0.194	0.003	0.051	-0.048	0.150	0.310
	Center only vs no	-0.564	-0.940	-0.187	0.003	0.095	-0.007	0.197	0.068
	Individual only vs no	-0.736	-1.152	-0.320	0.001	0.144	0.032	0.256	0.011

	Family-based/Center vs no	-0.734	-1.105	-0.363	0.000	0.064	-0.036	0.164	0.210
	Other combinations vs no	-0.523	-0.887	-0.159	0.005	0.060	-0.038	0.157	0.232
	Family-based only vs center	0.000	-0.268	0.269	0.997	-0.044	-0.115	0.027	0.225
	Individual only vs center	-0.172	-0.500	0.155	0.303	0.049	-0.039	0.137	0.276
	Family-based/Center vs center	-0.171	-0.435	0.094	0.205	-0.031	-0.103	0.040	0.392
	Other combinations vs center	0.040	-0.215	0.296	0.756	-0.036	-0.104	0.033	0.309
Prosocialit y									
	Family-based only vs no	0.085	-0.261	0.431	0.631	-0.016	-0.121	0.090	0.772
	Center only vs no	0.195	-0.158	0.549	0.279	-0.032	-0.141	0.077	0.566
	Individual only vs no	0.258	-0.135	0.651	0.199	-0.047	-0.168	0.075	0.452
	Family-based/Center vs no	0.155	-0.192	0.503	0.381	-0.027	-0.134	0.079	0.616
	Other combinations vs no	0.039	-0.302	0.381	0.821	0.014	-0.090	0.117	0.799
	Family-based only vs center	-0.110	-0.369	0.148	0.403	0.016	-0.064	0.097	0.690
	Individual only vs center	0.063	-0.255	0.380	0.698	-0.015	-0.115	0.086	0.775
	Family-based/Center vs center	-0.040	-0.295	0.216	0.760	0.005	-0.076	0.086	0.911
	Other combinations vs center	-0.156	-0.404	0.092	0.218	0.045	-0.033	0.124	0.254
Opposition									
	Family-based only vs no	0.549	0.104	0.995	0.016	-0.259	-0.492	-0.027	0.029
	Center only vs no	1.006	0.552	1.459	0.000	-0.386	-0.629	-0.142	0.002
	Individual only vs no	0.254	-0.248	0.756	0.321	-0.206	-0.470	0.058	0.126
	Family-based/Center vs no	0.855	0.409	1.300	0.000	-0.325	-0.559	-0.091	0.006
	Other combinations vs no	0.656	0.217	1.095	0.003	-0.282	-0.516	-0.047	0.019
	Family-based only vs center	-0.456	-0.784	-0.129	0.006	0.127	-0.047	0.300	0.152
	Individual only vs center	-0.752	-1.149	-0.354	0.000	0.180	-0.029	0.389	0.092
	Family-based/Center vs center	-0.151	-0.471	0.169	0.355	0.061	-0.109	0.231	0.482
	Other combinations vs center	-0.350	-0.661	-0.039	0.027	0.104	-0.059	0.268	0.212

Aggression								
	Family-based only vs no	1.278	0.517	2.038	0.001	-0.546	-1.054	-0.037	0.035
	Center only vs no	2.299	1.417	3.181	0.000	-0.742	-1.288	-0.196	0.008
	Individual only vs no	0.587	-0.253	1.426	0.171	-0.327	-0.896	0.243	0.261
	Family-based/Center vs no	1.792	0.986	2.597	0.000	-0.641	-1.182	-0.100	0.020
	Other combinations vs no	1.763	0.966	2.561	0.000	-0.668	-1.203	-0.133	0.014
	Family-based only vs center	-1.021	-1.727	-0.314	0.005	0.196	-0.181	0.574	0.307
	Individual only vs center	-1.712	-2.508	-0.916	0.000	0.416	-0.030	0.861	0.068
	Family-based/Center vs center	-0.507	-1.240	0.226	0.175	0.101	-0.310	0.513	0.630
	Other combinations vs center	-0.535	-1.282	0.211	0.160	0.074	-0.336	0.484	0.723

Table e9: Complementary analyses with multiple child care variables

For opposition and aggression, both type of child care and intensity of child care made a significant contribution. The table presents a complementary analysis including both variables in the same model to check whether the two variables still make a significant contribution. The reference categories for these analyses are: Center only group for type of care; and the low trajectory of hours in child care for intensity of care. The type of child care variable and the Ns for behavioral analyses are the same than in Table e8. Children not using child care (N=103) were excluded from this analyses as type or intensity of child care do not make sense for these children.

		Intercept				Slope			
Behavior		Estimate	95%CI Lower	95%CI Upper	p-value	Estimate	95%CI Lower	95%CI Upper	p-value
Opposition									
	Family-based only vs Center only	-0.472	-0.802	-0.142	0.005	0.130	-0.046	0.306	0.149
	Individual only vs Center only	-0.688	-1.091	-0.285	0.001	0.167	-0.046	0.381	0.125
	Family-based/Center vs Center only	-0.212	-0.539	0.115	0.204	0.065	-0.110	0.240	0.466
	Other combinations vs Center only	-0.404	-0.720	-0.089	0.012	0.110	-0.057	0.277	0.196
	Hours: Rising vs low	0.207	-0.066	0.480	0.138	-0.035	-0.179	0.110	0.639
	Hours: High vs low	0.334	0.056	0.611	0.018	-0.063	-0.209	0.082	0.394
Aggression									
	Family-based only vs Center only	-1.053	-1.761	-0.345	0.004	0.210	-0.167	0.587	0.275
	Individual only vs Center only	-1.640	-2.435	-0.845	0.000	0.437	-0.019	0.894	0.060
	Family-based/Center vs Center only	-0.624	-1.376	0.129	0.104	0.094	-0.322	0.510	0.657
	Other combinations vs Center only	-0.649	-1.405	0.107	0.093	0.082	-0.331	0.495	0.696
	Hours: Rising vs low	0.435	-0.143	1.013	0.140	0.021	-0.305	0.347	0.900
	Hours: High vs low	0.460	-0.096	1.015	0.105	0.060	-0.252	0.372	0.708

Complementary analyses: details on propensity score matching analyses

The complementary analyses with propensity score matching included three main steps:

1. *Imputation.* We used multiple imputation because: 1/ the matching procedure does not deal with missing data on covariates; 2/ given the large number of covariates in the model, using only complete cases would have seriously reduced the sample size and biased the sample estimates. We used multivariate imputation by chained equation implemented in package *Mice 2.22* in R and imputed 50 data sets (van Buuren & Groothuis-Oudshoorn, 2011).
2. *Propensity score matching.* The propensity score matching was then conducted for each data set using the package *MatchIt 2.4-21 (Ho, Imai, King, & Stuart, 2011)*. In this section, we adopt the vocabulary "treatment" and "control" group that is often use in the propensity score matching literature. The aim of the matching procedure is, for all covariates, to reduce the difference in means between treated and controls, thereby reducing the confounding influence of these variables. The package *MatchIt* generates the propensity score, implements the matching procedure, computes the corresponding weights and, finally, offers a summary of the balance between groups before and after matching. We selected full matching, a flexible matching algorithm implemented in the package. Matching methods, including full matching, have been described in details elsewhere (Stuart, 2010; Stuart & Green, 2008). Full matching has several options. We used the "discard" option to discard controls who were outside the range of the propensity score of the other group (enabling a better matching). An issue with full matching is that it can generate a wide range of weights, which can lead to inflated standard errors and a loss of power (Stuart & Green, 2008). To deal with this issue, *MatchIt* offers the possibility to limit the ratio between treated in controls, thereby limiting the range of weights. For instance, if the observed ratio is 1 treated for 5 controls in the data set, full matching can be constrained to have treated:controls ratios ranging from 2:5 to 1:10, i.e. no less than half and no more than double what was in the original data set. In this case, for instance, a maximum of 10 controls can be matched to 1 treated individuals. There is a compromise between: 1/ strict constraints leading to a restricted range of weights but poorer resulting balance between the groups and; 2/ more flexible constraints resulting in a better balance but a larger range of weights (and thus inflated standard errors). In the present analyses, we used a ratio no less than a quarter and no more than quadruple the observed ratio, which resulted in an excellent balance between groups whilst limiting the variability in weights. To assess the resulting balance between the treated and the controls, we report 5 values for each covariate: 1/ the mean in the treatment group (i.e. observed mean); 2/ the mean in the control group *before* matching (i.e. observed mean); 2/ the mean in the control group *after* matching; 4/ the standardized mean difference *before* matching (i.e. observed difference); 5/ the standardized mean difference *after* matching (i.e. remaining difference after applying the weights). The matching procedure is successful when the standardized mean differences are greatly reduced after matching for most confounding variables. There is no consensus regarding how to assess that an adequate balance was achieved. Some authors suggested using standardized mean differences smaller than 0.05 after matching (Caliendo & Kopeinig, 2008). Other authors suggested to analyze standardized mean differences as effect sizes (i.e. 0.2 considered small, 0.5 medium and 0.8 large) and compare them before and after matching for all covariates in order to assess the success of the matching procedure (McCaffrey, Ridgeway, & Morral, 2004). The balance achieved in the present study was adequate whatever solution was retained.
3. *Final estimation.* To estimate the final models, with used the *lavaan.survey 1.1.1* package (Oberski, 2014), which enables the re-estimation of the growth models estimated in *lavaan* (see manuscript) but with weights. The weights obtained from the propensity score matching procedure for each data set were thus used to compute estimates and standard errors. A MLM estimator with robust standard errors

is used to account for the use of weights. In addition, *lavaan.survey* accepts multiple imputed data sets and return the estimates and standard errors of the weighted analyses combined across multiple data sets.

The results regarding each complementary analyses for use, trajectories of hours in child care and type of child care are reported below.

Propensity score matching analysis of use of child care services

For this analysis, we estimated the effect of use by comparing non-using children to using children. Children who had never used child care were a minority and were coded as the treatment variable (= 1) whereas children in child care were coded as the control group (= 0) in order to facilitate the matching procedure (i.e. a large group of potential controls to find adequate matching children for the treated). Total N for this analysis was 1544, corresponding to the children having relevant child care data as well as behavioral data (see manuscript). A total of 93 children were in the non-using group and 1451 in the using group. Note that among the 103 non-using children with relevant data on child care (see manuscript), 93 had also behavioral data and were included in the analyses. As mentioned above, participants in the control group whose propensity scores were too distant from those in the treated group were discarded (Stuart & Green, 2008). An average of 1156 participants in the control group (using) were kept in the analyses. The table below presents the balance in covariates from the propensity score matching analysis. For instance, the socioeconomic status score was quite lower in the non-using group compared to the using group before matching, leading to a standardized mean difference of -0.628. After matching, this difference was largely reduced (-0.048). The same was true for all variables with standardized mean differences close to 0 after matching. If standardized mean differences are interpreted as effect sizes, as suggested by McCaffrey et al. (2004), we can conclude that there were a few large to moderate differences between the two groups before matching, and that not even a small difference remained after matching.

Table e10: Balance between using and non-using children

	Means			Standardized Mean Differences	
	Non-using	Using	Using *After Matching*	Before Matching	*After Matching*
Sex (% males)	0.45	0.49	0.45	-0.073	0.005
CSNR	1.16	0.90	1.09	0.180	0.051
Difficult Temperament	2.51	2.73	2.54	-0.143	-0.017
Socioeconomic status	-0.56	0.05	-0.52	-0.628	-0.048
Work Status (% working)	0.04	0.21	0.03	-0.801	0.044
Immigrant Status (% immigrant)	0.07	0.08	0.07	-0.040	-0.008
Family structure (% of non-intact families)	0.26	0.17	0.25	0.198	0.033
Sibling(s) (% 1 or more)	0.78	0.56	0.78	0.535	0.018
Neighborhood: unsafe	1.82	1.74	1.82	0.136	0.000
Neighborhood: Little Social Problems	2.76	2.79	2.76	-0.074	-0.004
Family Functioning	1.85	1.69	1.86	0.114	-0.007
Efficacy	8.89	8.77	8.88	0.102	0.008
Impact	8.04	8.45	8.04	-0.183	0.003
Hostile-reactive	1.12	1.09	1.14	0.020	-0.016
Overprotection	6.16	5.20	6.14	0.404	0.007
Verbalization	6.44	6.74	6.42	-0.185	0.015
Involvement	4.51	4.85	4.46	-0.140	0.021

Maternal Depression	1.58	1.37	1.58	0.168	0.002
Shyness (17 months)	3.49	3.25	3.47	0.101	0.010
Prosociality (17 months)	2.97	2.65	2.91	0.120	0.024
Opposition (17 months)	3.30	3.50	3.31	-0.113	-0.007
Physical aggression (17 months)	1.25	1.36	1.25	-0.090	-0.003

The following table presents the final growth model estimates of the contribution of child care use, after matching. The estimates are very similar to the ones obtained from the regression with covariates. A difference is that the contributions of use to the slope of shyness and social withdrawal were significant in propensity score matching analyses whereas they fell short of significance in the regressions with covariates. This is consistent with the overall conclusion that initial differences between using and non-using children tend to fade away with time.

Table e11: Contribution of child care use based on propensity score matching

	Intercept				Slope			
Behavior	Estimate	95%CI Lower	95%CI Upper	p-value	Estimate	95%CI Lower	95%CI Upper	p-value
Shyness	-0.826	-1.287	-0.366	0.000	0.085	0.002	0.169	0.046
Social withdrawal	-0.628	-0.993	-0.263	0.001	0.095	0.016	0.174	0.018
Opposition	0.580	0.224	0.937	0.001	-0.241	-0.420	-0.062	0.008
Aggression	1.407	0.746	2.069	0.000	-0.562	-0.980	-0.145	0.008

Propensity score matching analysis of trajectories of hours in child care

Next, we compared the results between the low trajectory of hours in child care on the one hand and the rising and high trajectories on the other hand. The rising and high trajectories were grouped in these analyses given the very similar pattern of results observed for these two trajectories in the main analyses (see manuscript Table 2). A total of 393 children were classified in the low trajectory (coded as 1) and a total of 1058 were classified either in the rising and high trajectory (recoded as 0). An average of 1035 out of 1058 participants in the latter group were used in the matching analyses (i.e. not discarded). The table below presents the balance before and after matching between these two groups. The table shows that, after matching, the differences between the two groups are very close to 0 for all variables.

Table e12: Balance between low trajectory and rising/high trajectories

	Means			Standardized Mean Differences	
	Low trajectory	Rising/High	Rising/High *After Matching*	Before Matching	*After Matching*
Sex (% males)	0.48	0.49	0.48	-0.019	0.006
CSNR	0.89	0.91	0.86	-0.019	0.023
Difficult Temperament	2.78	2.71	2.77	0.041	0.005
Socioeconomic status	-0.23	0.16	-0.24	-0.421	0.010
Work Status (% working)	0.16	0.22	0.17	-0.163	-0.007
Immigrant Status (% immigrant)	0.07	0.08	0.07	-0.016	-0.003
Family structure (% of non-intact families)	0.17	0.18	0.17	-0.025	0.008
Sibling(s) (% 1 or more)	0.61	0.55	0.61	0.132	0.011
Neighborhood: unsafe	1.79	1.73	1.79	0.122	-0.006
Neighborhood: Little Social Problems	2.76	2.80	2.76	-0.110	-0.019
Family Functioning	1.70	1.68	1.69	0.013	0.009
Efficacy	8.83	8.74	8.83	0.082	-0.001
Impact	8.28	8.52	8.26	-0.123	0.011
Hostile-reactive	1.02	1.11	1.04	-0.070	-0.016
Overprotection	5.68	5.02	5.63	0.271	0.019
Verbalization	6.58	6.81	6.61	-0.133	-0.017
Involvement	4.70	4.90	4.73	-0.085	-0.013
Maternal Depression	1.47	1.33	1.47	0.097	-0.005
Shyness (17 months)	3.52	3.16	3.51	0.154	0.005
Prosociality (17 months)	2.57	2.68	2.56	-0.042	0.004
Opposition (17 months)	3.49	3.51	3.48	-0.012	0.000
Physical aggression (17 months)	1.36	1.36	1.33	0.003	0.022

The final estimates showed in the following table are very similar to the ones obtained from regression analyses (see Table 2 in the manuscript: high and rising trajectories compared to low trajectory). The effects for the intercepts of opposition and aggression were somewhat smaller in the propensity score analysis compared to the regression analyses, resulting in marginally significant p-values.

Table e13: Contribution of trajectories of hours in child care based on propensity score matching

	Intercept				Slope			
Behavior	Estimate	95%CI Lower	95%CI Upper	p-value	Estimate	95%CI Lower	95%CI Upper	p-value
Shyness	-0.346	-0.575	-0.116	0.003	0.036	-0.01	0.082	0.128
Social withdrawal	-0.224	-0.427	-0.022	0.003	0.032	-0.016	0.079	0.191
Opposition	0.233	-0.009	0.474	0.059	-0.025	-0.136	0.086	0.656
Aggression	0.457	-0.069	0.983	0.088	0.039	-0.229	0.307	0.776

Propensity score matching analysis of type of child care

Finally, we tested whether the reported effects of type of child care would be maintained when using propensity score matching. Namely, we tested whether initial levels of opposition and aggression were higher in center care children compared to individual care children, as observed in regression analyses. In order to maximize the number of children for this analysis, we retained the "pure" types presented in Table e8 in this online material. A total of 143 children in individual child care (coded 1) were compared to a total of 272 children in center care (coded 0); these numbers correspond to the children with adequate data on child care as explained in Table e8 *and* data on behaviors in elementary school. Out of the 272 children in center care, an average of 263 were retained in the propensity score matching procedure (i.e. not discarded). The table below presents the balance before and after matching. Once again, the standardized mean differences after matching were close to 0.

Table e14: Balance between individual and center care

	Means			Standardized Mean Differences	
	Individual	Center	Center *After Matching*	Before Matching	*After Matching*
Sex (% males)	0.46	0.51	0.48	-0.106	-0.043
CSNR	0.82	0.73	0.82	0.072	0.005
Difficult Temperament	2.77	2.81	2.82	-0.026	-0.031
Socioeconomic status	0.06	-0.07	0.12	0.119	-0.052
Work Status (% working)	0.19	0.10	0.19	0.241	0.015
Immigrant Status (% immigrant)	0.05	0.17	0.05	-0.546	0.003
Family structure (% of non-intact families)	0.15	0.24	0.15	-0.253	0.003
Sibling(s) (% 1 or more)	0.60	0.67	0.57	-0.130	0.064
Neighborhood: unsafe	1.73	1.83	1.72	-0.185	0.024
Neighborhood: Little Social Problems	2.75	2.73	2.75	0.055	0.002
Family Functioning	1.69	1.98	1.68	-0.188	0.008
Efficacy	8.85	8.60	8.87	0.221	-0.018
Impact	8.44	8.16	8.49	0.147	-0.029
Hostile-reactive	1.08	1.04	1.11	0.022	-0.024
Overprotection	5.12	5.53	5.07	-0.186	0.023
Verbalization	6.64	6.42	6.59	0.122	0.026
Involvement	4.96	4.44	4.89	0.208	0.027
Maternal Depression	1.24	1.53	1.24	-0.233	-0.001
Shyness (17 months)	3.03	3.64	3.04	-0.274	-0.001
Prosociality (17 months)	2.89	2.77	2.92	0.042	-0.011
Opposition (17 months)	3.60	3.24	3.64	0.158	-0.016
Physical aggression (17 months)	1.32	1.38	1.38	-0.049	-0.049

The following table shows the final results for opposition and aggression. The estimates were very closed to those comparing individual child care to center care in regressions with covariates (see Table e8 in this online material).

Table e15: Contribution of individual child care versus center child care based on propensity score matching

	Intercept				Slope			
Behavior	Estimate	95%CI Lower	95%CI Upper	p-value	Estimate	95%CI Lower	95%CI Upper	p-value
Opposition	-0.691	-1.113	-0.27	0.001	0.145	-0.043	0.332	0.13
Aggression	-1.504	-2.413	-0.595	0.001	0.279	-0.169	0.726	0.222

Overall, the results were remarkably similar when using either: 1) Full Imputation 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. For regression adjustment to be trustworthy, the absolute standardized differences of means should be less than 0.25 (Stuart, 2010). As can be seen in the tables above, the absolute standardized differences were above that threshold only for a few covariates. The biggest differences before matching were observed when comparing non-using with using children. However, even in this case, the average of the absolute standardize mean differences was below 0.21 (i.e. the average of absolute values in column 4 in Table e10). As such, the comparability of the results obtained from the two procedures is understandable.

References online material

Caliendo, M., & Kopeinig, S. (2008). Some practical guidance for the implementation of propensity score matching. *Journal of Economic Surveys*, *22*(1), 31–72. doi:10.1111/j.1467-6419.2007.00527.x

Ho, D. E., Imai, K., King, G., & Stuart, E. A. (2011). MatchIt: Nonparametric preprocessing for parametric causal inference. *Journal of Statistical Software*, *42*(8), 1–28.

McCaffrey, D. F., Ridgeway, G., & Morral, A. R. (2004). Propensity score estimation with boosted regression for evaluating causal effects in observational studies. *Psychological Methods*, *9*(4), 403–425. doi:10.1037/1082-989X.9.4.403

Oberski, D. (2014). lavaan.survey: An R Package for complex survey analysis of Structural Equation Models. *Journal of Statistical Software*, *57*(1), 1–27.

Stuart, E. A. (2010). Matching methods for causal inference: A review and a look forward. *Statistical Science : A Review Journal of the Institute of Mathematical Statistics*, *25*(1), 1–21. doi:10.1214/09-STS313

Stuart, E. A., & Green, K. M. (2008). Using full matching to estimate causal effects in nonexperimental studies: Examining the relationship between adolescent marijuana use and adult outcomes. *Developmental Psychology*, *44*(2), 395–406. doi:10.1037/0012-1649.44.2.395

Van Buuren, S., & Groothuis-Oudshoorn, K. (2011). mice: Multivariate Imputation by Chained Equations in R. *Journal of Statistical Software*, *45*(3), 1–67.

Willms, J., & Shields, M. (1996). *A measure of socioeconomic status for the National Longitudinal Survey of Children.* Atlantic Center for Policy Research in Education: University of New Brunswick and Satistics Canada.