

Closing the gap in academic readiness and achievement: the role of early childcare

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Background: Socially disadvantaged children with academic difficulties at school entry are at increased risk for poor health and psychosocial outcomes. Our objective is to test the possibility that participation in childcare – at the population level – could attenuate the gap in academic readiness and achievement between children with and without a social disadvantage (indexed by low levels of maternal education). **Methods:** A cohort of infants born in the Canadian province of Quebec in 1997/1998 was selected through birth registries and followed annually until 7 years of age ($n = 1,863$). Children receiving formal childcare (i.e., center-based or non-relative out-of-home) were distinguished from those receiving informal childcare (i.e., relative or nanny). Measures from 4 standardized tests that assessed cognitive school readiness (Lollipop Test for School Readiness), receptive vocabulary (Peabody Picture Vocabulary Test Revised), mathematics (Number Knowledge Test), and reading performance (Kaufman Assessment Battery for children) were administered at 6 and 7 years. **Results:** Children of mothers with low levels of education showed a consistent pattern of lower scores on academic readiness and achievement tests at 6 and 7 years than those of highly educated mothers, unless they received formal childcare. Specifically, among children of mothers with low levels of education, those who received formal childcare obtained higher school readiness ($d = 0.87$), receptive vocabulary ($d = 0.36$), reading ($d = 0.48$) and math achievement scores ($d = 0.38$; although not significant at 5%) in comparison with those who were cared for by their parents. Childcare participation was not associated with cognitive outcomes among children of mothers with higher levels of education. **Conclusions:** Public investments in early childcare are increasing in many countries with the intention of reducing cognitive inequalities between disadvantaged and advantaged children. Our findings provide further evidence suggesting that formal childcare could represent a preventative means of attenuating effects of disadvantage on children's early academic trajectory. **Keywords:** Cognition, prevention, social class, day care.

It is well known that children who experience socio-economic disadvantages in their home are more likely to enter in the formal school system with limitations in their readiness to learn and to follow a trajectory of poor academic achievement (Duncan et al., 2007; Hertzman & Power, 2006). Academic readiness and achievement are mostly determined by modifiable environmental factors with a negligible contribution of genetic factors (Lemelin et al., 2007). Thus, poor school readiness likely reflects the 'poor quality' of accumulated early learning experiences (Duncan et al., 2007; Hertzman & Power, 2006). Such disadvantage is well indexed by low maternal education. Children of mothers with low levels of education may not receive adequate amounts of cognitive stimulation (Hart & Risley, 1995; Hoff, 2003) and are more likely to enter kindergarten less

prepared to learn than their more advantaged counterparts (Magnuson, Meyers, Ruhm, & Waldfogel, 2004).

Decades of research have shown that the provision of higher-quality post-natal environment could attenuate the negative impact of disadvantage on children's cognitive trajectory. For instance, cross-fostering studies have shown that children born to low-socioeconomic (SES) parents and adopted by high-SES parents obtained higher IQ scores than non-adopted children born to low-SES parents (Capron & Duyme, 1989). Similarly, intervention studies conducted in the United States (e.g., Carolina Abecedarian Project, High Scope Perry Preschool, Early Head Start) and in the United Kingdom (e.g., Effective Provision of Preschool Education, Sure Start) have found that disadvantaged children who were exposed to educational childcare during the preschool years enjoyed better cognitive

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competences over the life course than those who did not receive such intervention (for a literature review see Melhuish, 2004).

Many observational studies of early childcare have reported comparable effects (although their magnitude may be smaller in some instances) to those of interventional childcare studies, designed to be of the highest quality (Côté et al., 2007; Dearing, McCartney, & Taylor, 2009; Magnuson et al., 2004). For example, using a representative sample of Canadian children born between 1994 and 1996, we have shown that socioeconomically disadvantaged children were more at risk for poor receptive language at 4 years of age unless they received full-time childcare in their first year of life (Geoffroy et al., 2007). There were no effects of childcare for advantaged children.

Research questions

Based on our previous work, we test whether participation in childcare could be particularly beneficial to the cognitive development of socially disadvantaged children, therefore proving to be a means of attenuating the detrimental effects of disadvantage. In addition, we examined whether the extent to which childcare may be protective depended on the nature of the childcare arrangement (e.g., formal versus informal). Typically, informal childcare included care by a relative (grandparent, sister/brother) or, less frequently, care by a nanny, while formal childcare included center-based and non-relative out-of-home childcare (i.e., family childcare) arrangements. This distinction is important because distinct patterns of childcare use may have different implications for child development. A significant proportion of children are receiving informal childcare arrangements, especially disadvantaged ones (Riley & Glass, 2002), and the effect of informal childcare is not well documented in the literature (Bradley & Vandell, 2007).

Method

Participants

This research is part of the Quebec Longitudinal Study of Child Development (QLSCD), a large, ongoing epidemiological cohort of infants born between October 1997 and July 1998 in the province of Quebec (Canada) (Jetté & Des Groseilliers, 2000). The target population of the QLSCD was singleton infants who were 59 or 60 weeks of gestational age born to mothers residing in each geographic area of the Canadian province of Quebec in Canada, with the exception of Northern Quebec, Cree Territory, Inuit Territory and Aboriginal reserves (2.2% of all births).

The Quebec Master Birth Registry of the Ministry of Health and Social Services was used to select a representative sample of 2,917 infants. Within this, 689 families were considered non-respondent (e.g., unreachable, refused to participate for various reasons)

and 8 families did not meet the inclusion criteria of the target population (e.g., twins, deaths). At its inception, 2,120 families participated in the first assessment. Ethics approval and informed parental consent were obtained at each assessment.

Children were excluded from the target sample because they were not Caucasian ($n = 187$) or did not speak French or English at home ($n = 136$) to reduce cultural biases to tests, leaving an initial study sample size of 1,883 participants. From those, 1,605 had complete information on childcare. Sample sizes vary thereafter for specific outcomes ($n = 965$ for receptive vocabulary test; $n = 941$ for academic school readiness; $n = 1,132$ for mathematics performance; and $n = 1,096$ for reading skills).

In this study sample, 14% of children were living in a family with insufficient income and 15% had mothers with low education levels (i.e., no high-school diploma). The mean age of the mothers at first childbearing was 26.17 ($SD = 4.79$).

Outcome measures

Kindergarten measures. Kindergarten measures were obtained during the spring of 2004 when the child was 6 years of age (Mean age = 6.24 years \pm 0.26). The Lollipop Test, a well-validated diagnostic test of school readiness, is composed of four subtests: identification of colors and shapes and copying shapes; picture description, position, and spatial recognition; identification of numbers and counting; identification of letters and writing (Chew, 1989). Kindergarten scores predict academic achievement up to grade four (Chew & Morris, 1989). Receptive vocabulary was assessed using the Peabody Picture Vocabulary Test-Revised (PPVT-R) in either of Canada's two official languages: French and English (Dunn & Dunn, 1981; Dunn, Theriault-Whalen, & Dunn, 1993).

First-grade measures. First-grade achievement tests were administered during the spring of 2005 when the child was 7 years of age (Mean age = 7.15 years \pm 0.26). The Number Knowledge Test [NKT] measures basic knowledge and understanding of number concepts (e.g., which number comes after 7?) (Okamoto & Case, 1996). The reading test was composed of the reading comprehension and decoding subtests from the Kaufman Assessment Battery for children [K-ABC] (Kaufman & Kaufman, 1983). Because reading and decoding subtests were highly correlated ($r = .78$), we created a reading score by averaging the standard scores of the two K-ABC subscales.

For all measures, raw scores were converted into IQ-type scale (i.e., $M = 100.0$, $SD = 15.0$) and we controlled for the children's age in months at the time of testing in analyses. The language of test administration was controlled for tests with a language component (i.e., K-ABC and the PPVT-R). Pearson correlations between outcomes ranged from .38 to .55; all P s < .001.

Predictors

Childcare. Childcare information was obtained at each data collection (5 months, 1.5, 2.5, 3.5, and 4

years) occurring during the preschool years. Mothers were asked about types of childcare arrangements their child was currently receiving and for how many hours per week. Childcare arrangements were classified into three broad categories: (1) 'formal childcare' is by non-relative(s) that takes place in either residential or non-residential 'school-like' settings; (2) 'informal childcare' is by relatives such as by a grandparent/brother/sister, taking place in a residential home; or less frequently by a non-relative in children's own home (e.g., nanny); and (3) 'parental care', i.e., children not in childcare, was used here as the reference category. We calculated the total hours spent in each childcare arrangement (for children who spent ≥ 10 hours of childcare per week) by summing the weekly number of hours per week from 5 months to 4 years. The 'primary childcare arrangement' reflects the type of childcare attended for the most hours during the whole preschool period. Weekly average for formal childcare was 21.3 hours (SD = 9.78; range = 2 to 46) and it was 16.5 hours (SD = 9.09, range = 2 to 42) for informal childcare. Finally, *Maternal level of education* was represented by a variable indicating if the mothers have high levels of education (e.g., high-school diploma or more) or low levels of education (e.g., no high-school diploma).

Confounding factors. All confounding variables were obtained 5 months after birth, unless otherwise indicated. *Birth weight* was collected from medical records and was coded as low or ≤ 2500 grams or normal. *Data on length of breastfeeding* was obtained about 17 months after birth (range from 0 to 18), and was dichotomized (no breastfeeding or any breastfeeding). *Maternal age at childbearing* was represented by a continuous variable ranging from 14 to 41 years. The *birth order* of the child was indicated by a categorical variable coded as 1st or ≥ 2 nd. *Insufficient income* was computed from the before-taxes low-income cut-off set by Statistics Canada (Statistics Canada, 2008). This index takes into account the size of the household and the region where it is located (e.g., urban versus rural, population density). The low-income cut-off is an income level from which, on average, a person (or family) spends 20% more of their total income on food, shelter and clothing than is spent by similar persons or families in similar locations. Income was coded as insufficient or adequate. *Maternal verbal capacity* was estimated 60 months after birth, using a multiple choice test administered to the mothers (Veroff, McClelland, & Marquis, 1971). Mothers had to complete 14 sentences by filling in blanks (e.g., lemons are sour but sugar is (a. bitter; b. sweet; c. fattening; d. white; $\alpha = 0.53$). Correct answers were summed and standardized to obtain a score that ranged from 0 to 10. *Home stimulation levels* were obtained by summing two standardized subscales of the Home Observation for Measurement of the Environment Inventory Short-Form (Bradley & Caldwell, 1984) (cognitive stimulation: $\alpha = 0.85$, and emotional relationship between the mother and the child: $\alpha = 0.87$; total scores ranged from 0 to 20). *Maternal depressive symptoms* were assessed with a short version of the Center for Epidemiologic Studies Depression Scale (Radloff, 1977) and included 13 items scored as 0 (never) to 3 (often) (ranging from 0 to

39). *Parenting* was measured with two scales from the Parental Cognitions and Conduct Toward the Infant Scale completed by the mothers. The mothers had to indicate on a scale ranging from 0 to 10 to what extent each statement accurately described their actions, thoughts or feelings in the context of their interactions with their 5-month-old infants: (1) *perceived parental impact* (e.g., my behavior has little effect on the intellectual development of my infant; scores ranged from 0 to 10; $\alpha = 0.69$); (2) *overprotection* (e.g., I can never bring myself to leave my infant with a baby-sitter; scores ranged from 0 to 10; $\alpha = 0.58$). Higher values reflect poor parenting.

Statistical analyses

Sample weighting. We used weighting in order to make our study sample comparable to the targeted population in term of demographic characteristics. The principle behind estimation in a probability sample such as the QLSCD is that each person in the sample is given a weight which is inversely proportional to the probability of being drawn from the population given some demographic characteristics. Those characteristics are known in the population because the participants were drawn from an administrative list. For example, if the participants with a lower SES are under-represented in the selected sample a weight above 1 will be assigned to them, giving them more importance than the participants with higher SES. The weighting procedure was done in order to take into account selective non-response on each set of cognitive tasks.

Data imputation. We imputed missing values on the potential confounding factors using Multivariate Imputation by Chained Equations (i.e., R statistical software/library MICE) (Yu, Burton, & Rivero-Arias, 2007). This was done to avoid the loss of further participants due to listwise deletion. Fewer than 10% of the observations were missing on each covariate, except for maternal verbal skill where about 20% of the observations were missing. This procedure allowed us to keep a confidence level close to 95% even with 20% of missing observations, as long as the degree of skewness is not too high, which is not the case here (Yu et al., 2007).

Selection of confounders. A limitation of research evaluating the putative preventive impact of childcare with a correlational design is that children are not randomly assigned to various forms of childcare. Research shows that utilization of childcare is far more common among children of highly educated mothers than among children of low-educated mothers (Côté et al., 2007; Geoffroy et al., 2007; Singer, Fuller, Keiley, & Wolf, 1998). In turn, children of highly educated mothers are more likely to obtain higher scores on cognitive assessments than children's of low-educated mothers (Melhuish et al., 2008). Therefore, a simple comparison of means between children who receive childcare and those who do not could lead to the conclusion that childcare is beneficial for cognitive outcomes when, in fact, the difference may likely reflect the effect of an unmeasured factor on the outcome. The likelihood of producing valid estimates of

the 'real' childcare effect in correlational studies is increased when factors that have the potential to affect directly or indirectly the selection of children into childcare are controlled. We followed the recommendations made by Duncan and Gibson-Davis (2006) and controlled for all theoretically relevant factors available in our dataset that could potentially bias our conclusions. This strategy reduces the effect of social selection bias.

Table 1 presents bivariate associations between potential confounders, maternal levels of education and childcare groups. These confounders have been controlled in all models.

Moderation analyses. We tested the modifying role of low maternal education in the association between outcomes and childcare groups by computing two-way interactions, consistent with our previous work (Côté et al., 2007; Geoffroy et al., 2007). The general postulate was that childcare would be more likely to be positively associated with academic outcomes among children who are from socioeconomically disadvantaged backgrounds than among those from advantaged backgrounds.

Cohen's *d* was used to obtain effect size statistics of mean differences to help interpret interactions (Cohen, 1988). We used the following effect size formula:

$$d = \frac{|\hat{\mu}_{\text{estimated marginal childcare groups}} - \hat{\mu}_{\text{estimated marginal parental care}}|}{\sqrt{MS_{\text{Error}}}}$$

Verifying statistical assumptions. The *p*-value of Levene's test was significant for academic readiness and mathematics achievement, indicating that the null

hypothesis of equal variances was rejected. We therefore transformed variables to meet the assumption of equal variance. Because the results did not differ using the transformed or the non-transformed variables we reported results for non-transformed variables.

Results

Table 2 presents the results of analyses of covariance (ANCOVAs) with type III sum of squares predicting cognitive outcomes by maternal education and childcare, while controlling for confounders. We present the final models only, owing to space limitation.

Modifying role of maternal education in the association between childcare and cognitive outcomes

The interactions between maternal education and childcare were significant for three of the four outcome measures (see Table 2). For academic readiness, the interaction for the Lollipop scores ($F(2, 965) = 10.68, p < .001$), revealed that scores were higher in either formal ($d = .87$) or informal ($d = 0.80$) childcare for children of mothers with low education levels. For receptive vocabulary, the interaction for PPVT-R scores ($F(2, 941) = 3.53, p = .03$), revealed that scores were higher in formal childcare ($d = .36$) for children of mothers with low education levels. For reading achievement, the interaction for K-ABC

Table 1 Bivariate associations between potential confounders, maternal levels of education and childcare groups

	Mothers with low levels of education						Mothers with high levels of education					
	Formal childcare		Informal childcare		Parental care		Formal childcare		Informal childcare		Parental care	
	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>
Sex of the child												
Girl	56	50	62	21	52	30	53	384	56	85	51	78
Boy	44	39	38	13	48	28	47	339	44	66	49	74
Birth weight												
Birth weight, ≥ 2500 g	99	88	97	33	97	56	97	703	99	149	97	147
Birth weight, < 2500 g	1	1	3	1	3	2	3	20	1	2	3	5
Any breastfeeding												
Yes	52	46	53	18	69	40	75	543	73	110	76	115
No	48	43	47	16	31	18	25	180	27	41	24	37
Income levels of sufficiency												
Sufficient	64	57	74	25	55	32	92	666	93	141	77	117
Insufficient	36	32	26	9	45	26	8	57	7	10	23	35
Birth order												
Birth order, 1st	36	32	44	15	33	19	48	350	50	75	31	47
Birth order, ≥ 2nd rank	64	57	56	19	67	39	52	373	50	76	69	105
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Maternal age at childbearing	22.9	4.7	22.2	5.1	21.8	4.1	26.9	4.4	27.0	4.4	26.5	5.2
Maternal verbal skills	7.6	1.0	7.6	0.8	7.7	1.2	8.3	0.9	8.3	1.0	8.1	1.2
Depressive symptoms	6.3	4.8	5.1	3.8	6.1	5.2	4.7	4.7	4.1	4.1	5.5	4.8
Home levels of stimulation	5.6	1.8	5.5	1.8	5.4	1.8	6.0	1.7	5.8	1.8	5.5	2.0
Maternal overprotection	5.3	2.0	4.6	1.7	5.3	2.1	4.1	2.0	4.3	1.9	5.0	2.2
Perceived parental impact	7.7	1.9	8.0	1.9	7.7	2.2	8.8	1.4	8.7	1.7	8.7	1.5

Note: Data courtesy of the Institut de la Statistique du Québec.

Table 2 ANCOVAs Predicting Academic Readiness and Achievement with Maternal Levels of Education and Childcare Groups

	Kindergarten						First-Grade					
	Academic Readiness (Lollipop)			Receptive Vocabulary (PPVT-R)			Mathematics Achievement (NKT)			Reading Achievement (K-ABC)		
	n = 965			n = 941			n = 1,132			n = 1,096		
	B	SE	p	B	SE	p	B	SE	p	B	SE	p
COVARIABLES												
Sex of the child, boy	-5.06	.91	<.001	-0.24	0.93	.79	1.42	0.85	.10	-0.71	0.86	.41
Birth weight, < 2500 g	-7.42	2.57	.004	-3.11	2.63	.24	-4.53	2.63	.09	-2.79	2.42	.25
Any breastfeeding, no	-0.99	1.08	.36	-0.48	1.09	.66	-0.62	0.98	.52	1.14	0.99	.25
Birth order, ≥ 2	-1.59	.97	.10	-2.81	0.98	.004	-0.59	0.90	.51	-1.88	0.91	.04
Insufficient income	-2.41	1.36	.08	-1.48	1.39	.29	-5.25	1.32	<.001	-1.53	1.32	.25
Maternal age	1.30	.51	.01	1.06	0.53	.04	1.14	0.48	.02	0.82	0.49	.09
Maternal verbal skills	0.56	.47	.23	1.33	0.48	.01	1.91	0.46	<.001	1.41	0.46	.002
Depressive symptoms	0.00	.48	.99	-0.64	0.49	.19	0.37	0.44	.40	0.11	0.44	.81
Home levels of stimulation	0.97	.46	.04	0.99	0.47	.03	1.09	0.43	.01	1.16	0.44	.01
Maternal overprotection	-0.39	.48	.42	-1.36	0.49	.01	-0.31	0.45	.49	-0.08	0.45	.86
Perceived parental impact	1.42	.46	.002	1.82	0.47	<.001	1.10	0.43	.01	1.76	0.43	<.001
PREDICTORS												
Low levels of maternal education	-12.75	2.37	<.001	-5.65	2.41	.02	-6.53	2.23	.003	-9.88	2.22	<.001
Formal childcare	-1.45	1.42	.31	-2.31	1.45	.11	0.19	1.34	.89	0.19	1.37	.89
Informal childcare	-1.97	1.87	.29	-1.88	1.89	.32	1.40	1.72	.42	1.06	1.74	.54
INTERACTIONS												
Formal childcare*Low education	12.88	2.91	<.001	7.02	2.93	.02	5.08	2.71	.06	6.31	2.71	.02
Informal childcare*Low education	12.58	3.72	.001	0.82	3.82	.83	0.97	3.49	.78	1.98	3.44	.56

Note: Adjusted R² were .13 for academic readiness; .14 for receptive vocabulary; .11 for mathematics achievement and .13 for reading achievement.

The reference category for childcare was parental care.

Data courtesy of the Institut de la Statistique du Québec.

scores ($F(2, 1096) = 2.95, p = .05$), revealed that scores were higher in formal childcare ($d = .48$) for children of mothers with low education levels. Finally, for mathematics achievement, although the interaction for NKT scores was marginally significant ($F(2, 1,132) = 2.05, p = .129$), it was otherwise consistent with the previous three outcomes, also indicating higher scores in formal childcare ($d = .38$) for children of mothers with low education levels.

Figure 1 presents adjusted means according to maternal education and childcare groups for (a) academic readiness (Lollipop), (b) receptive vocabulary (PPVT-R), (c) mathematics achievement (NKT), and (d) reading achievement (K-ABC).

Additional analyses were conducted in order to examine whether the observed difference between formal and informal childcare was explained by the higher number of hours in formal childcare. This was done by adding a variable reflecting total number of hours in childcare prior to entering the maternal education*childcare group interaction term. The introduction of number of hours in the model did not alter the significance of our previous results.

Discussion

The first aim of the study was to examine the potentially preventive role of childcare with regard to

disadvantaged children's risk for poor academic readiness and achievement. The results suggest that childcare participation, particularly in formal childcare arrangements, could attenuate discrepancies in several cognitive outcomes in kindergarten and first grade between children of mothers with low levels of education and those without such low levels. The putative preventive impact of childcare for disadvantaged children was not explained by confounders, including maternal verbal competencies, a proxy for cognitive heredity.

In a previous study, we found that utilization of early childcare was associated with higher receptive vocabulary at 4 years among children from low socioeconomic status families ($d = .58$), but not among children from adequate socioeconomic status families (Geoffroy et al., 2007). In the present study using data from the QLSCD in Quebec, we extend these findings by documenting the longer-term association of formal childcare with receptive vocabulary skills measured at 6 years of age among children of mothers with low levels of education. However, the effect size here was smaller, suggesting that such an effect could attenuate over time as children enter formal schooling. We also documented similar longer-term associations on a wider range of key outcomes including cognitive academic readiness in kindergarten, and mathematics and reading achievement in first grade. Although these

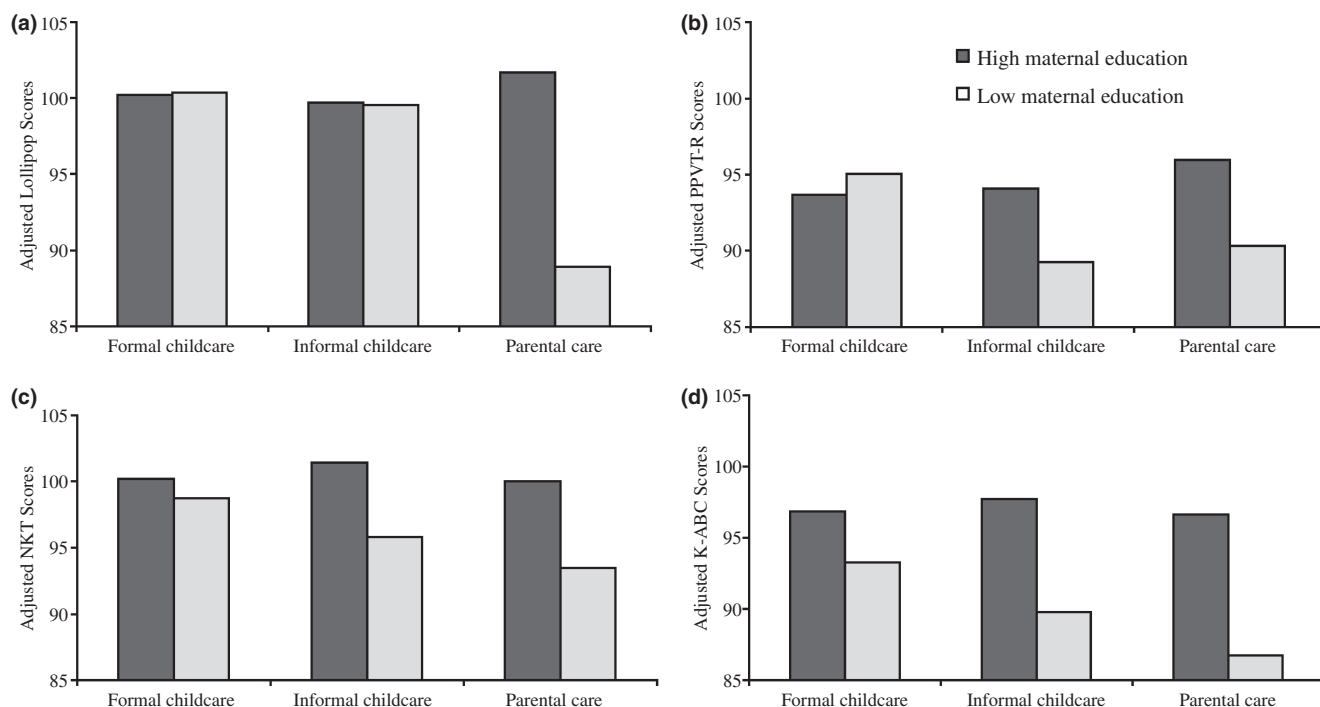


Figure 1 Academic readiness and achievement outcomes according to maternal education and childcare groups

findings are consistent with numerous studies which have shown that childcare could be specifically beneficial to cognitive outcomes for disadvantaged children (Caughy, DiPietro, & Strobino, 1994; Dearing et al., 2009; McCartney, Dearing, Taylor, & Bub, 2007), this study extends these previous studies by clarifying which form of childcare is likely to be better.

We did not detect any association between childcare groups and cognitive outcomes for children of mothers with high levels of education. Although this finding is consistent with our prior research (Geoffroy et al., 2007), and that of the NICHD Study of Early Childcare and Youth Development (SECCYD), which also included a comparison group for children in parental care (Dearing et al., 2009; McCartney et al., 2007), it may seem at odds with studies that show benefits of interventions across the range of socioeconomic levels (Melhuish et al., 2008). It is possible that the average levels of childcare quality provided in our sample was not sufficient to influence the academic skills of children from more advantaged backgrounds. Recent findings from Vandell, Belsky, Burchinal, Steinberg, and Vandergrift (2010), using the latest data collection of the NICHD SECCYD, suggest that only childcare services in the moderate- to high- quality ranges influence cognitive outcomes at 15 years across the range of socioeconomic status, although effect sizes remained moderate.

Among children of mothers with low levels of education, we found large effect sizes of formal childcare for academic readiness ($d = 0.87$); and moderate effect sizes for reading ($d = 0.48$), receptive

vocabulary ($d = 0.36$) and mathematical skills ($d = 0.38$). These effects are comparable to those reported in a systematic meta-analytic review of early childhood development programs for disadvantaged children (median $d = 0.38$ for school readiness and median $d = 0.35$ for academic achievement) (Anderson et al., 2003). However, our effect sizes should be interpreted with caution because the study design is correlational and may produce more liberal estimates of childcare services than could be found in a randomized controlled trial.

The second aim of this study was to determine whether the extent to which childcare could be protective may also depend on the nature of the arrangement, i.e., formal or informal. Although we failed (except for academic readiness) to document any effects of informal childcare arrangements on cognitive outcomes for children of mothers with low levels of education, our findings for reading and mathematics clearly suggest a dose-response curve where informal childcare fell in between parental care and formal childcare arrangements for the children of low-educated mothers.

Variations across childcare settings may reflect differences in aspects of childcare quality which in turn are associated with cognition in children. For example, it was shown in the NICHD SECCYD that caretakers in informal relative settings were generally less educated and offered lower levels of stimulation than ones in formal childcare (Dowsett, Huston, Imes, & Gennetian, 2008). Whereas we have no information on levels of quality in informal childcare for the QLSCD, the quality of formal

childcare (that is, non-relative center-based and non-relative out-of-home) in Quebec, Canada has been rated as moderate (Japel, Côté, & Tremblay, 2005), and similar to that of several other industrialized countries (i.e., United States, Germany, Portugal, and Spain) (Egeland & Hiester, 1995).

Strengths and limitations

The strengths of the present study are: (a) a large sample that included children of low-educated mothers to detect moderation effects; (b) measures of language and academic achievement obtained during kindergarten and the first year of elementary school from validated tests; (c) inclusion of extensive child and family factors assessed very soon after the child's birth (at 5 months of age) to reduce selection bias; (d) distinction between formal and informal childcare. However, some limitations should be noted: (a) Many studies have documented effects of quality childcare for cognitive outcomes in samples with various socioeconomic backgrounds (Belsky et al., 2007; NICHD ECCRN, 2006), and in samples of disadvantaged children (Loeb, Fuller, Kagan, & Carrol, 2004). Therefore we could expect cognitive measures in children to be more sensitive to childcare quality than to type of childcare arrangement. (b) Although we were careful in controlling for confounding factors, the design of the study remains correlational, and this limits our capacity to make causal inferences. Indeed, we could not rule out the possibility that the difference in cognitive outcomes between childcare groups could be explained by unmeasured social selection factors. (c) Caution is required in generalizing the findings to populations where childcare services differ substantially and to immigrant families and other cultural groups not part of this sample. (d) Although type of childcare arrangement appears to be a factor sensitive to cognitive outcomes, more needs to be known about the mechanisms through which childcare may protect against poor academic readiness.

Despite these limitations, and until we understand better the causal mechanisms, the best evidence that can be provided to guide policy and practice to date supports the hypothesis that formal childcare may help attenuate cognitive gaps related to disadvantaged backgrounds.

Implications for policy and prevention

Although the evidence is accruing for the potential role of childcare participation in the prevention of children's academic underachievement, recent evidence, especially that drawn from samples outside

the US, is valuable given the global implications such findings may have. In the province of Quebec, it was shown that children exposed to a disadvantaged home environment are less likely to receive childcare than those from better-off families (Kohen, Dahinten, Khan, & Hertzman, 2008). Given the documented associations between childcare and academic outcomes, special societal and individual measures could be taken to facilitate the use of childcare among disadvantaged children. At the societal level, public investments in early childcare are increasing in many countries with the intention of reducing cognitive inequalities between disadvantaged and advantaged children (UNICEF Innocenti Research Centre, 2008). At the individual level, we suggest that health professionals recommend evidence-based interventions that could promote school readiness and academic achievement to at-risk families (High, 2008), because these professionals are in a privileged position to encourage the use of childcare among families, and particularly vulnerable ones (Silverstein, Grossman, Koepsell, & Rivara, 2003). In summary, this study suggests that the preferential use of formal childcare could prevent academic underachievement among disadvantaged children.

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Key points

- Poor academic achievement could be attenuated by the provision of childcare to disadvantaged children.
- The putative protective effect of childcare on academic achievement at 6–7 years may vary by type of childcare (formal vs. informal) and as a function of mothers' level of education.
- Children of mothers with low levels of education (i.e., no high-school diploma) are at an increased risk for poor academic readiness and achievement, unless they have been exposed to formal childcare (i.e., childcare center or family childcare) in comparison with those who have been cared by their mothers at home.

References

- Anderson, L.M., Shinn, C., Fullilove, M.T., Scrimshaw, S.C., Fielding, J.E., Normand, J., et al. (2003). The effectiveness of early childhood development programs: A systematic review. *American Journal of Preventive Medicine*, 24(Suppl. 1), 32–46. doi: 10.1016/S0749-3797(02)00655-4
- Belsky, J., Vandell, D.L., Burchinal, M., Clarke-Stewart, K.A., McCartney, K., Owen, M.T., et al. (2007). Are there long-term effects of early child care? *Child Development*, 78, 681–701. doi: 10.1111/j.1467-8624.2007.01021.x
- Bradley, R.H., & Caldwell, B.M. (1984). The HOME Inventory and family demographics. *Developmental Psychology*, 20, 315–320.
- Bradley, R.H., & Vandell, D.L. (2007). Child Care and the well-being of children. *Archives of Pediatrics and Adolescent Medicine*, 161, 669–676. doi: 10.1001/archpedi.161.7.669
- Capron, C., & Duyme, M. (1989). Assessment of effects of socio-economic status on IQ in a full cross-fostering study. *Nature*, 340, 552–554. doi: 10.1038/340552a0
- Caughy, M.O.B., DiPietro, J.A., & Strobino, D.M. (1994). Day-care participation as a protective factor in the cognitive development of low-income children. *Child Development*, 65, 457–471. doi: 10.1111/j.1467-8624.1994.tb00763.x
- Chew, A.L. (1989). *The Lollipop test: A diagnostic training test of school readiness*. Atlanta, GA, USA: Humanics Psychological Test Corporation.
- Chew, A.L., & Morris, J.D. (1989). Predicting later academic achievement from kindergarten scores on the Metropolitan Readiness Tests and the Lollipop Test. *Educational and Psychological Measurement*, 49, 461–465. doi: 10.1177/0013164489492019
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd edn). Hillsdale, NJ: Erlbaum.
- Côté, S.M., Boivin, M., Nagin, D.S., Japel, C., Xu, Q., Zoccolillo, M., et al. (2007). The role of maternal education and nonmaternal care services in the prevention of children's physical aggression problems. *Archives of General Psychiatry*, 64, 1305–1312. doi: 10.1001/archpsyc.64.11.1305
- Dearing, E., McCartney, K., & Taylor, B.A. (2009). Does higher quality early child care promote low-income children's math and reading achievement in middle childhood? *Child Development*, 80, 1329–1349. doi: 10.1111/j.1467-8624.2009.01336.x
- Dowsett, C.J., Huston, A.C., Imes, A.E., & Gennetian, L. (2008). Structural and process features in three types of child care for children from high and low income families. *Early Childhood Research Quarterly*, 23, 69–93.
- Duncan, G.J., Dowsett, C.J., Claessens, A., Magnuson, K., Huston, A.C., Klebanov, P., et al. (2007). School readiness and later achievement. *Developmental Psychology*, 43, 1428–1446. doi: 10.1037/0012-1649.43.6.1428
- Duncan, G.J., & Gibson-Davis, C.M. (2006). Connecting child care quality to child outcomes: Drawing policy lessons from nonexperimental data. *Evaluation Review*, 30, 611–630. doi: 10.1177/0193841x06291530
- Dunn, L.M., & Dunn, L.M. (1981). *Peabody Picture Vocabulary Test-Revised (PPVT-R)*. Circle Pines, MN: American Guidance Services.
- Dunn, L.M., Theriault-Whalen, C.M., & Dunn, L.M. (1993). *Échelle de Vocabulaire en Images Peabody. Adaptation française du Peabody Picture Vocabulary Test-Revised. Manuel pour les formes A et B*. Toronto, ON: Psycan.
- Egeland, B., & Hiester, M. (1995). The long-term consequences of infant day-care and mother-infant attachment. *Child Development*, 66, 474–485.
- Geoffroy, M.C., Côté, S.M., Borge, A.I., Larouche, F., Séguin, J.R., & Rutter, M. (2007). Association between nonmaternal care in the first year of life and children's receptive language skills prior to school entry: The moderating role of socioeconomic status. *Journal of Child Psychology and Psychiatry*, 48, 490–497. doi: 10.1111/j.1469-7610.2006.01704.x
- Hart, B., & Risley, T.R. (1995). *Meaningful differences in the everyday experience of young American children*. Baltimore, MD: Paul H. Brookes.
- Hertzman, C., & Power, C. (2006). A life course approach to health, and human development In J. Heymann, C. Hertzman, L. Barer, & R. Evans (Eds.), *Healthier societies: From analysis to action* (pp. 83–106). Oxford: Oxford University Press.
- High, P.C., & The Committee on Early Childhood Adoption, and Dependent Care and Council on School Health. (2008). School readiness. *Pediatrics*, 121, e1008–1015. doi: 10.1542/peds.2008-0079
- Hoff, E. (2003). The specificity of environmental influence: Socioeconomic status affects early vocabulary development via maternal speech. *Child Development*, 74, 1368–1378. doi: 10.1111/1467-8624.00612
- Japel, C., Côté, S., & Tremblay, R. (2005). Quality counts! Assessing the quality of daycare services based on the Quebec Longitudinal Study of Child Development. *Choice Institute for Research on Public Policy*, 11. Retrieved from <http://www.irpp.org/fr/choices/archive/vol11no4.pdf>
- Jetté, M., & Des Groseilliers, L. (2000). Survey Description and Methodology. In *Longitudinal Study of Child Development in Québec (ELDEQ 1998–2002)* (Vol. 1). Québec: Institut de la Statistique du Québec.
- Kaufman, N., & Kaufman, A. (1983). *Kaufman Assessment Battery for Children*: Circle Pines, MN: American Guidance Service.
- Kohen, D., Dahinten, V.S., Khan, S., & Hertzman, C. (2008). Child care in Québec: Access to a universal

- program. *Canadian Journal of Public Health*, 99, 451–455.
- Lemelin, J.-P., Boivin, M., Forget-Dubois, N., Dionne, G., Seguin, J.R., Brendgen, M., et al. (2007). The genetic-environmental etiology of cognitive school readiness and later academic achievement in early childhood. *Child Development*, 78, 1855–1869. doi:10.1111/j.1467-8624.2007.01103.x
- Loeb, S., Fuller, B., Kagan, S.L., & Carrol, B. (2004). Child care in poor communities: Early learning effects of type, quality, and stability. *Child Development*, 75, 47–65. doi: 10.1111/j.1467-8624.2004.00653.x
- Magnuson, K.A., Meyers, M.K., Ruhm, C.J., & Waldfogel, J. (2004). Inequality in preschool education and school readiness. *American Educational Research Journal*, 41, 115–157. doi: 10.3102/00028312041001115
- McCartney, K., Dearing, E., Taylor, B.A., & Bub, K.L. (2007). Quality child care supports the achievement of low-income children: Direct and indirect pathways through caregiving and the home environment. *Journal of Applied Developmental Psychology*, 28, 411–426. doi: 10.1016/j.appdev.2007.06.010
- Melhuish, E.C. (2004). *A literature review of the impact of early years provision upon young children, with emphasis given to children from disadvantaged backgrounds: Report to the Comptroller and Auditor General*. London: National Audit Office.
- Melhuish, E.C., Sylva, K., Sammons, P., Siraj-Blatchford, I., Taggart, B., Phan, M.B., et al. (2008). The early years: Preschool influences on mathematics achievement. *Science*, 321, 1161–1162. doi: 10.1126/science.1158808
- NICHD ECCRN. (2006). Child-care effect sizes for the NICHD study of early child care and youth development. *American Psychologist*, 61, 99–116. doi: 10.1037/0003-066x.61.2.99
- Okamoto, Y., & Case, R. (1996). Exploring the microstructure of children's central conceptual structures in the domain of number. In R. Case, & Y. Okamoto (Eds.), *The role of central conceptual structures in the development of children's thought* (vol. 60, pp. 27–28). Monographs of Society for Research in Child Development.
- Radloff, L.S. (1977). The CES-D Scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement*, 1, 385–401.
- Riley, L.A., & Glass, J.L. (2002). You can't always get what you want. Infant care preferences and use among employed mothers. *Journal of Marriage and Family*, 64, 2–15. doi: 10.1111/j.1741-3737.2002.00002.x
- Silverstein, M., Grossman, D.C., Koepsell, T.D., & Rivara, F.P. (2003). Pediatricians' reported practices regarding early education and Head Start referral. *Pediatrics*, 111, 1351–1357. doi: 10.1542/peds.111.6.1351
- Singer, J.D., Fuller, B., Keiley, M.K., & Wolf, A. (1998). Early child-care selection: Variation by geographic location, maternal characteristics, and family structure. *Developmental Psychology*, 34, 1129–1144. doi: 10.1037/0012-1649.34.5.1129
- Statistics Canada. (2008). *Income trends in Canada: 1976–2006*. Ottawa, ON: Minister of Industry.
- UNICEF Innocenti Research Centre. (2008). *The child care transition, Innocenti Report Card 8*. Retrieved from http://www.unicef.ca/portal/Secure/Community/502/WCM/HELP/take_action/Advocacy/rc8.pdf
- 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, 737–756. doi: 10.1111/j.1467-8624.2010.01431.x
- Veroff, J., McClelland, L., & Marquis, K. (1971). *Measuring intelligence and achievement motivation in surveys: Final report to the U.S. Department of Health, Education, and Welfare*. Washington, DC: Office of Economic Opportunity.
- Yu, L.M., Burton, A., & Rivero-Arias, O. (2007). Evaluation of software for multiple imputation of semi-continuous data. *Statistical Methods in Medical Research*, 16, 243–258. doi: 10.1177/0962280206074464

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