Incidence and Persistence of Early Literacy Problems: Evidence from the NLSCY, 1994-2000

Final Report

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Strategic Policy and Planning
Human Resources and Skills Development Canada

April 2006

SP-617-04-06E
(également disponible en français)

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This paper is available in French under the title *Incidence et persistance des problèmes d'alphabétisme en bas âge : Preuves tirées de l'ELNEJ, 1994 à 2000.*

La version française du présent document est disponible sous le titre *Incidence et persistance des problèmes d'alphabétisme en bas âge : Preuves tirées de l'ELNEJ, 1994 à 2000.*

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Paper
ISBN: 0-662-41848-4
Cat. No.: HS28-36/2005E

PDF
ISBN: 0-662-41849-2
Cat. No.: HS28-36/2005E-PDF

HTML
ISBN: 0-662-41850-6
Cat. No.: HS28-36/2005E-HTML

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Acknowledgements

** The author is indebted to Karen MacLeod for assistance with the literature review. The author has also benefited from conversations with Anne-Marie Shaker. Finally, the author has benefited from the comments of members of the LPD as well as comments from two anonymous reviewers.*

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Abstract

The analysis of this paper employs data from the first three Cycles of the National Longitudinal Survey of Children and Youth to analyze: 1) the factors associated with early literacy problems and 2) the persistence of early literacy problems. Children with more highly educated mothers were less likely to score in the bottom third of the vocabulary test score distribution administered to children age five. Children with immigrant mothers whose mother tongue was neither English nor French were also more likely to score in the bottom third of the vocabulary distribution. In addition, a weak relationship between expected scores on the PPVT and family income was found. Children age seven with more highly educated fathers were found to have higher expected math scores than other children. Also, children in families with high annual income were found to have higher expected mathematics scores. The results of the longitudinal analysis support the view that early literacy problems persist to a certain extent into older ages. However, there is also evidence that early literacy problems are temporary for many children.

1. Introduction

This report contains an analysis of the incidence and persistence of early literacy problems for children in Canada as well as an analysis of the factors associated with early literacy problems. The data employed are taken from the first four cycles of the National Longitudinal Survey of Children and Youth (NLSCY). Descriptive statistics are presented that shed light on the possible associations between family characteristics and the child scoring in each third of vocabulary and mathematics test score distributions. Next, regression and logistic models of test score outcomes are presented that allow for an evaluation of the relative importance of individual and family characteristics in explaining test score outcomes. Finally, the longitudinal nature of the NLSCY data is employed to analyze whether poor outcomes in test scores at early ages are associated with a higher likelihood of poor test score outcomes at older ages.

2. The Relevant literature

Before describing the data and empirical results, the literature on factors associated with early literacy problems is reviewed. Rather than try to cover all papers on the topic, a subset has been selected and discussed in order to guide the interpretation of the empirical findings. However, there are few studies based on surveys where actual performance was measured directly on a national sample (e.g. TIMSS, NLSCY).

A number of studies exist in the education literature on the success of English as a Second Language (ESL) programs in terms of raising the English language proficiency of children from non-English language backgrounds in English-based schools. Cummins (1992) reviews this literature and concludes that five to seven years of school experience are needed before second language students achieve as well as native speakers in academic aspects of English. This literature is typically based on data sets particular to specific school boards and therefore does not allow for a generalisation to the broader population of children in Canada. The NLSCY data allows for longitudinal analysis on a representative sample of children at the start of the survey. The importance of immigrant status in terms of its association with literacy problems will be a focus of the analysis.

A related paper by Sweetman (1998) compares the school performance of immigrant children to other children in terms of performance in mathematics and science using data for Australia, Canada, Great Britain and the United States taken from the Third International Math and Science Survey (TIMSS) – carried out in 1995. He finds that immigrant children's test scores in mathematics and science are typically lower than those of native-born children in Canada and the United States but are higher than those of the native-born children in Australia. He also finds evidence of a convergence towards the native-born mean performance with more years in the school system for the cases of Canada and the United States.

A number of other studies are worth reviewing. Currie and Thomas (1990) analyze the impact of Head Start (a government sponsored pre-school program) on test scores of Hispanic children in the United States. They find large and significant benefits from the program; however, they find that the benefits from the program vary across sub-groups of the Hispanic population.

Richmond and Mendoza (1990) describe difficulties experienced by the children of immigrants from Caribbean countries in both Canada and Britain. They argue that in both countries, there has been a great deal of concern regarding the 'under-achievement' of West Indian children in schools. They report results from surveys of immigrant families and teachers of the children of immigrants from the Caribbean. The data support the view that discrimination is a problem for these children. They also report that researchers in the field have identified social and home circumstances of the children as major factors that determine the academic performance of these students.

Finally, an important paper is the study of Carliner (1995) who looks at the language ability of U.S. immigrants and their children. Using the 1980 and 1990 U.S. Census data, Carliner finds that a substantial fraction of the native-born children of ethnic groups who have come to the U.S. in the past 30 years, were not fluent in English when they entered primary school.

Worswick (2001) compares the school performance of the children of immigrant parents to the school performance of the children of Canadian-born parents. The study employed test scores in reading and mathematics for children in grade 2 and higher as well as the PPVT test scores for vocabulary of children in kindergarten and grade one. The analysis also employed the qualitative measures of school performance provided by the Person-Most Knowledgeable (PMK) about the child (the child's mother in roughly 90 percent of the cases) as well as the qualitative measures of school performance provided by the child's teacher. The children of immigrant parents whose first language is neither English nor French are found to be at a disadvantage in the early years at school in the area of vocabulary and to a lesser extent reading in the grade 2 through grade 5 range. However, by age 14 these children's average performance is equal to or better than that of the children of Canadian-born parents and the children of immigrant parents whose first language is neither English nor French.

In a second paper in the area, Worswick (2004) analyzes the entire test score distribution of the children of immigrants. The goal of the study is to see whether the average performances found in Worswick (2001) hid important differences in the distribution of test score performance. This is especially relevant for the proposed research since one of the main goals is to identify children at risk of low literacy. Therefore, it is important to realize that the average test score of a particular demographic group of children may be close to an acceptable level while a significant percentage of the children may have very low test scores. Worswick (2004) finds that the 10^{th} percentile of the vocabulary (PPVT) distribution is lower for children of immigrant parents whose mother tongue is neither English nor French than for children of Canadian-born parents. However, this difference is present primarily in the kindergarten years, is not present at higher grades in terms of reading and mathematics test scores.

Economic models of resources devoted to the education of children such as the one developed and tested by Burton, Phipps and Curtis (2002) are important in that they provide a theoretical context in which to interpret the empirical findings. Also, studies of the importance of literacy in terms of labour market outcomes (see for example, Finnie and Meng, 2002, and Green and Riddell, 2001 and 2003). These papers are also relevant since it is important to have good estimates of the interactions between literacy and the labour market outcomes in order to understand the incentives that children and their parents have to invest in the acquisition of literacy skills.

Sweetman and Dicks (1999) look at the different educational outcomes within ethnic groups in Canada. For men, they find a positive correlation between ethnic group average years of education and its return. They also find a negative correlation between ethnic group average educational outcomes and the previous generation's fertility for both males and females.

Kerchkhoff, Raudenbush and Glennie (2001) explore the extent to which educational attainment and cognitive skills can explain labor force outcomes of men and women in three groups (whites, blacks and Hispanics) in the United States. Both are shown to be influenced by social origins, and are found to contribute to the explanation of male and female labor force outcomes for the three ethnic groups. However, the relative contribution of each differs for ethnic and gender groups.

Schmid (2001) reviews the major factors that contribute to the unequal educational achievement of the new second generation looking at Asians and Latin Americans. These factors can be broken into external and internal factors. Economic opportunities, racial and gender stratification and group reception can be counted among the most important external factors, while intrinsic factors include human and social capital, family structure, community organization, and cultural and linguistic patterns.

The reviewed studies conclude that social class influences the academic success of the children of immigrants. Children from poor and minority backgrounds are the ones most at risk of lagging behind. They come from families (Mexican and other Latino backgrounds) who view schooling as providing unequal opportunities and eroding their identities and languages. Asians on the other hand fair much better.

Zhou (1997) reviews several studies that analyze immigrant children's experiences and outcomes. Several factors play significant roles in the progress of second generation immigrants such as the human and financial capital attained by families as well as the social conditions of their families prior to immigration. Other important influences are cultural patterns, including values, family relations, as well as social ties. Another issue is the fact that the host countries may offer different groups different possibilities, which may limit their opportunities. It is found that if immigrants enter the middle class directly or after a short period of time, this proves to be to their advantage.

A recent study that by Hoddinott, Lethbridge and Phipps (2002) has important insights for the current research. They employed the first three cycles of the NLSCY to analyze the role of resources in transitions for children's education in Canada. They find that the mother's characteristics (especially education) are strongly associated with child attainments. They also find household income to be correlated with outcomes, but the magnitude of this effect is small. Using the longitudinal nature of the data they find clear evidence of persistence in child attainments over time. They argue that these findings mean that past disadvantage can 'snowball' into educational disadvantage in the future (p. ii, Hoddinott, Lethbridge and Phipps, 2002).

3. NLSCY Sample and Summary Statistics

Data from the master files of the National Longitudinal Survey of Children and Youth (NLSCY) from Statistics Canada are employed in the analysis. The survey is carried out every second year and the data employed in the analysis are taken from the 1994/95, 1996/97, 1998/99 and 2000/01 cycles of the survey.

The NLSCY data sets contain weights to allow for generalizations of the results to the underlying population of Canadian children. Since the analysis employs the longitudinal nature of the NLSCY data, the longitudinal sample from Cycle 1 (and their observations from subsequent Cycles) is employed in the analysis of this paper. Therefore, it is the longitudinal weights that are used throughout. In addition, the NLSCY has a complex survey design that can lead to incorrect statistical inference if not accounted for properly. In the analysis of this paper, the inference is based on standard errors derived using the bootstrap replicate weights provided by Statistics Canada.

The analysis focuses on two groups of children: 1) five year-olds in Cycle 1 and 2) seven year-olds in Cycle 1.[1] In each case, tests administered to these two groups of children as part of Cycle 1 are used to classify whether they are in the bottom, middle or top third of the respective test score distributions. Next, using test score data on these same children in subsequent cycles of the NLSCY, it is possible to identify whether poor performance on the relevant test (scoring in the bottom third) was associated with poor performance on subsequent tests at older ages. The first group was chosen since they were administered the Peabody Picture Vocabulary Test – Revised (PPVT) and they were also old enough to be administered the reading and mathematics test in Cycle 2.

The second group of children was chosen in order to analyze the factors associated with problems at older ages and the degree of persistence of those problems. Ideally, one would use a reading test for seven year-olds. Unfortunately, the reading test was only administered in Cycles 2 and 3. Therefore, the measure used to classify whether the seven year-olds in Cycle 1 experienced early literacy problems, is the mathematics test administered to children in grade 2 and above.

In Table 1, sample means are presented for the case of five year-olds in Cycle 1. In the first column of Table 1, sample means of the key variables used in the analysis are presented for all children age five in Cycle 1 with a PPVT score. The controls include indicator variables for mother and father present. It is important to note that the information on the parents is taken from the answers to questions related to the "Person-Most-Knowledgeable" (PMK) about the child and the PMK's spouse. The approach followed is that used in Worswick (2004). If the PMK is female then she is considered to be the child's mother.[2] In this case, if the spouse is present and is male, then the spouse is considered to be the child's father. Alternatively, if the PMK is male, then the PMK is considered to be the

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[1] Initially, both seven and eight year-olds were employed in the analysis. However, due to a significant problem with eight (and ten) year-olds scoring at the top of the Cycle 1 Math test, it was decided to focus the analysis only on seven-year olds. This problem with the Cycle 1 data was identified by Hoddinott, Lethbridge and Phipps (2002).

[2] In over 90 percent of the cases, the PMK is the child's biological mother.

child's father. In this case, if the spouse is present and is female, then the spouse is considered to be the child's mother. As can be seen in Table 1, the mother is present in 99 percent of the cases and the father is present in 86 percent of the cases of children with a PPVT score in Cycle 1. Other family controls included in Table 1 are controls for family income, size of place of residence and region of residence. The income information used in the analysis has three broad categories – annual family income under 20,000, between 20,000 and 400,000 and over 40,000, all in 1994 dollars. The income information in Cycle 1 of the NLSCY is grouped and so it was not possible to break up the over 40,000 group further to allow for finer groupings.

Table 1
Means of Child and Family Characteristics by Third of the PPVT Distribution
Five Year-Olds in Cycle 1

	Children with PPVT score	Bottom Third PPVT Dist.	Middle Third PPVT Dist.	Top Third PPVT Dist.
	(1)	(2)	(3)	(4)
Mother present	0.985 (0.005)	0.974 (0.013)	0.988 (0.073)	0.992 (0.006)
Father present	0.863 (0.015)	0.838 (0.026)	0.866 (0.027)	0.886 (0.026)
Single Parent	0.153 (0.016)	0.188 (0.028)	0.145 (0.027)	0.121 (0.026)
Female child	0.497 (0.007)	0.484 (0.036)	0.537 (0.037)	0.475 (0.035)
Family Income				
Less than 20,000	0.141 (0.015)	0.213 (0.033)	0.131 (0.025)	0.075 (0.016)
20,000 to 40,000	0.283 (0.021)	0.289 (0.037)	0.241 (0.035)	0.316 (0.039)
Over 40,000	0.576 (0.023)	0.498 (0.042)	0.628 (0.041)	0.610 (0.040)
Population Size				
Urban 500,000 or more	0.421 (0.024)	0.487 (0.045)	0.374 (0.050)	0.395 (0.044)
Urban 100,000 to 499,000	0.190 (0.014)	0.146 (0.024)	0.195 (0.027)	0.233 (0.026)
Urban less than 100,000	0.198 (0.014)	0.168 (0.024)	0.213 (0.028)	0.215 (0.027)
Rural	0.191 (0.014)	0.199 (0.028)	0.071 (0.027)	0.157 (0.023)

Table 1 (continued) Means of Child and Family Characteristics by Third of the PPVT Distribution Five Year-Olds in Cycle 1				
	Children with PPVT score	**Bottom Third PPVT Dist.**	**Middle Third PPVT Dist.**	**Top Third PPVT Dist.**
	(1)	**(2)**	**(3)**	**(4)**
Region of Residence				
Atlantic Provinces	0.084 (0.002)	0.076 (0.009)	0.081 (0.011)	0.095 (0.011)
Quebec	0.248 (0.005)	0.244 (0.033)	0.239 (0.031)	0.261 (0.032)
Ontario	0.394 (0.007)	0.369 (0.037)	0.456 (0.038)	0.361 (0.037)
Manitoba or Saskatchewan	0.073 (0.003)	0.062 (0.011)	0.072 (0.012)	0.084 (0.011)
Alberta	0.093 (0.007)	0.092 (0.020)	0.095 (0.018)	0.092 (0.019)
British Columbia	0.109 (0.008)	0.156 (0.026)	0.057 (0.014)	0.107 (0.020)

Note:

1. The PPVT is a vocabulary test.
2. Each variable takes on a value of either 0 or 1.
3. The survey weights are employed in the analysis. The complex survey design was taken into account in the calculation of the bootstrap-generated standard errors which are presented in parentheses.

Columns (2) through (4) of Table 1 provide mean characteristics according to whether the child is in the bottom third (33^{rd} percentile or lower), middle third (34^{th} percentile to the 66^{th} percentile) and top third (67^{th} percentile and higher) of the PPVT distribution in Cycle 1. The fraction of children with a father present rises as we look across the row starting with the children in the bottom third of the vocabulary distribution (84 percent) and ending with those in the top third of vocabulary distribution (89 percent); however, the differences are not large. Large differences are present when we look at the income variables. For children scoring in the bottom third of the PPVT, 21 percent are in households with income below 20,000 while 50 percent are in households with income over 40,000. In contrast, for children scoring in the top third of the PPVT, only eight percent are in households with less than 20,000 in income and 61 percent are in households with income over 40,000.

The gender differences in the mean PPVT performance across the three thirds of the distribution are reported in the fourth row. While the fraction of children who are girls is similar across the three thirds of the PPVT distribution, a slightly higher fraction of girls have PPVT scores in the middle of the distribution while boys are more likely to have scores in the bottom and top thirds of the PPVT distribution.

In terms of size of place of residence, an especially high fraction of children with low PPVT scores reside in large urban centres of 500,000 people or more (49 percent for the bottom third of the PPVT compared with 40 percent for the top third of the PPVT). This may be driven by the high rate of residence in large cities by new immigrants whose children may struggle early in school.

The remaining variables of Table 1 relate to the geographic distribution of children according to their placement in the PPVT distribution. By comparing across rows, it is possible to see if children from a particular part of the country are more likely to be in one third of the PPVT distribution compared to the other two thirds. Children in Ontario appear to be over-represented in the middle third of the PPVT distribution. In contrast, children in British Columbia are under-represented in the middle third of the distribution with a particularly high fraction in the bottom third of the distribution. For the other regions of the country, the fractions in each third of the distribution are similar.

In Table 2, equivalent sample means are presented as those in Table 1 but for the mother's and father's characteristics. In each case, the mean is presented only if the relevant parent is present in the household in Cycle 1. This preliminary evidence indicates that mother's education is correlated with the child's performance on the PPVT. A higher fraction of children scoring in the bottom third of the PPVT have mothers who did not graduate from high school (25 percent compared to 17 percent for the middle third and 11 percent for the top third). A similar pattern exists at high levels of education with 12 percent of children scoring in the bottom third of the PPVT having a mother with a university degree compared to 20 percent of the children in the top third of the PPVT distribution.

Table 2
Means of Parental Characteristics Third of the PPVT Distribution
Five Year-Olds in Cycle 1

	Child with PPVT score	Bottom Third PPVT Dist.	Middle Third PPVT Dist.	Top Third PPVT Dist.
	(1)	(2)	(3)	(4)
Mother's characteristics (if mother present)				
Did not graduate from high school	0.177 (0.020)	0.248 (0.038)	0.173 (0.036)	0.106 (0.021)
Graduated from high school (no post-sec.)	0.182 (0.018)	0.198 (0.034)	0.171 (0.035)	0.176 (0.027)
Post-secondary (no university degree)	0.502 (0.026)	0.432 (0.004)	0.564 (0.047)	0.519 (0.041)
University degree	0.140 (0.019)	0.122 (0.034)	0.092 (0.027)	0.202 (0.038)
Age (years)	33.5 (0.305)	33.3 (0.574)	33.6 (0.556)	33.6 (0.42)
Immigrant, mother tongue English or French	0.064 (0.017)	0.026 (0.014)	0.062 (0.034)	0.106 (0.034)
Immigrant mother tongue other	0.106 (0.019)	0.230 (0.044)	0.060 (0.027)	0.022 (0.010)

Table 2 (continued) **Means of Parental Characteristics Third of the PPVT Distribution** **Five Year-Olds in Cycle 1**				
	Child with PPVT score	**Bottom Third PPVT Dist.**	**Middle Third PPVT Dist.**	**Top Third PPVT Dist.**
	(1)	**(2)**	**(3)**	**(4)**
Mother tongue English	0.606 (0.019)	0.501 (0.042)	0.674 (0.039)	0.651 (0.035)
Mother tongue French	0.254 (0.014)	0.228 (0.032)	0.252 (0.032)	0.282 (0.033)
Father's characteristics (if father present)				
Did not graduate from high school	0.148 (0.021)	0.240 (0.041)	0.179 (0.041)	0.131 (0.030)
Graduated from high school (no post-sec.)	0.181 (0.021)	0.190 (0.036)	0.197 (0.048)	0.156 (0.027)
Post-secondary (no university degree)	0.423 (0.026)	0.373 (0.047)	0.413 (0.048)	0.482 (0.040)
University degree	0.213 (0.023)	0.197 (0.045)	0.211 (0.043)	0.231 (0.042)
Age (years)	35.9 (0.268)	35.6 (0.53)	36.2 (0.468)	36.0 (0.521)

Note:

1. The PPVT is a vocabulary test.
2. Each variable (other than age) takes on a value of either 0 or 1.
3. The survey weights are employed in the analysis. The complex survey design was taken into account in the calculation of the bootstrap-generated standard errors which are presented in parentheses.

Children with immigrant mothers whose mother-tongue is either English or French are over-represented in the group of children with PPVT scores in the top third of the distribution (11 percent compared with 6 percent for the middle third and 3 percent for the bottom third). However, the opposite pattern is found for other children of immigrant mothers. For children in the bottom third of the PPVT, 23 percent have immigrant mothers whose mother tongue is neither English nor French compared with only two percent for children in the top third of the PPVT distribution.

As was the case for mother's education, lowest education for the father is associated with lowest third PPVT scores for the child. Twenty-four percent of children in the bottom third of the PPVT distribution had a father who did not graduate from high school compared with only 13 percent for children in the top third of the PPVT distribution. Interestingly, differences at the top end of the father's education distribution are less clear.

In Table 3, equivalent sample means to those in Table 1 are presented for the case of seven year-olds in Cycle 1 with a mathematics test score. It should be noted that the sample size is not as large for the sample of seven year-olds with math scores in Cycle 1 compared with the sample of five year-olds with PPVT scores in Cycle 1. This means that in some cases the number of observations used to generate the statistics of Table 3 is small. Therefore, it is important to take into account the size of the standard errors reported below each statistic.

Table 3
Means of Child and Family Characteristics by Third of the Math Distribution
Seven Year-Olds in Cycle 1

	Children with Math Score	Bottom Third of Math Dist.	Middle Third of Math Dist.	Top Third of Math Dist.
	(1)	**(2)**	**(3)**	**(4)**
Mother present	0.993 (0.005)	0.986 (0.013)	1.00 (0.00)	0.993 (0.006)
Father present	0.895 (0.021)	0.877 (0.035)	0.843 (0.051)	0.945 (0.021)
Single Parent	0.113 (0.021)	0.137 (0.037)	0.157 (0.051)	0.062 (0.022)
Female child	0.514 (0.029)	0.533 (0.056)	0.639 (0.056)	0.410 (0.047)
Family Income				
Less than 20,000	0.112 (0.025)	0.121 (0.032)	0.107 (0.045)	0.109 (0.049)
20,000 to 40,000	0.192 (0.024)	0.204 (0.042)	0.228 (0.051)	0.158 (0.031)
Over 40,000	0.696 (0.032)	0.675 (0.052)	0.665 (0.060)	0.734 (0.053)
Population Size				
Urban 500,000 or more	0.371 (0.040)	0.437 (0.066)	0.324 (0.077)	0.350 (0.061)
Urban 100,000 to 499,000	0.216 (0.023)	0.171 (0.040)	0.244 (0.048)	0.234 (0.042)
Urban less than 100,000	0.217 (0.022)	0.175 (0.036)	0.190 (0.040)	0.272 (0.040)
Rural	0.195 (0.022)	0.217 (0.045)	0.243 (0.058)	0.144 (0.030)
Region of Residence				
Atlantic Provinces	0.100 (0.009)	0.098 (0.019)	0.115 (0.025)	0.091 (0.018)
Quebec	0.103 (0.020)	0.056 (0.021)	0.123 (0.045)	0.128 (0.037)
Ontario	0.438 (0.030)	0.599 (0.054)	0.467 (0.067)	0.285 (0.048)
Manitoba or Saskatchewan	0.079 (0.012)	0.069 (0.022)	0.078 (0.031)	0.089 (0.023)

Table 3 (continued) **Means of Child and Family Characteristics by Third of the Math Distribution** **Seven Year-Olds in Cycle 1**				
	Children with Math Score	**Bottom Third of Math Dist.**	**Middle Third of Math Dist.**	**Top Third of Math Dist.**
	(1)	**(2)**	**(3)**	**(4)**
Alberta	0.135 (0.019)	0.135 (0.037)	0.133 (0.042)	0.138 (0.029)
British Columbia	0.144 (0.021)	0.044 (0.017)	0.085 (0.030)	0.269 (0.046)

Note:

1. Each variable takes on a value of either 0 or 1.
2. The survey weights are employed in the analysis. The complex survey design was taken into account in the calculation of the bootstrap-generated standard errors which are presented in parentheses.

There are a number of similarities to what was found in Table 1. For example, children with math scores in the top third of the distribution are more likely to have a father present than is the case for children in the bottom third of the distribution.

It is important to note that there are some important differences in the patterns found in Table 1 and Table 3. Residence in Ontario is associated with the lowest third performance on the mathematics test with 60 percent of children in the bottom third residing in Ontario but only 29 percent of children in the top third residing in Ontario. The opposite is true for the case of British Columbia since children in BC are over-represented in the top third of the math distribution (27 percent) and under-represented in the bottom third of the math distribution (4 percent).

In Table 4, the sample means for the mother's characteristics and father's characteristics are presented for seven year-olds in Cycle 1 with mathematics test scores. There appears to be a weak relationship between parental education and the child's math test score. Generally speaking, higher education of the parents is associated with being in the top part of the math test distribution. However, in some cases the standard errors are large and the estimates do not necessarily follow a clear pattern (for example, the variable for the father having a university degree). This is likely due to the small sample sizes underlying some of these cases.

Table 4 **Means of Parental Characteristics Third of the Math Distribution** **Seven Year-Olds in Cycle 1**				
	Child with Math Score	**Bottom Third of Math Dist.**	**Middle Third of Math Dist.**	**Top Third of Math Dist.**
	(1)	**(2)**	**(3)**	**(4)**
Mother's characteristics (if mother present)				
Did not graduate from high school	0.149 (0.026)	0.192 (0.053)	0.157 (0.051)	0.107 (0.032)

Table 4 (continued) Means of Parental Characteristics Third of the Math Distribution Seven Year-Olds in Cycle 1				
	Child with Math Score	**Bottom Third of Math Dist.**	**Middle Third of Math Dist.**	**Top Third of Math Dist.**
	(1)	**(2)**	**(3)**	**(4)**
Graduated from high school (no post-sec.)	0.199 (0.023)	0.226 (0.050)	0.158 (0.041)	0.204 (0.038)
Post-secondary (no university degree)	0.481 (0.036)	0.426 (0.061)	0.503 (0.066)	0.512 (0.054)
University degree	0.171 (0.028)	0.155 (0.056)	0.183 (0.072)	0.176 (0.039)
Age (years)	35.3 (0.416)	36.0 (0.790)	34.8 (0.486)	35.1 (0.696)
Immigrant, mother tongue English or French	0.074 (0.021)	0.045 (0.026)	0.043 (0.025)	0.119 (0.043)
Immigrant mother tongue other	0.077 (0.024)	0.123 (0.059)	*	0.051 (0.024)
Mother tongue English	0.739 (0.033)	0.714 (0.064)	0.795 (0.050)	0.721 (0.049)
Mother tongue French	0.145 (0.021)	0.116 (0.035)	0.134 (0.034)	0.176 (0.040)
Father's characteristics (if father present)				
Did not graduate from high school	0.167 (0.026)	0.163 (0.039)	0.190 (0.050)	0.156 (0.039)
Graduated from high school (no post-sec.)	0.189 (0.028)	0.268 (0.070)	0.168 (0.047)	0.139 (0.029)
Post-secondary (no university degree)	0.503 (0.038)	0.364 (0.068)	0.504 (0.071)	0.546 (0.054)
University degree	0.141 (0.028)	0.206 (0.062)	0.034 (0.017)	0.159 (0.039)
Age (years)	37.9 (0.433)	38.7 (0.80)	37.6 (0.504)	37.5 (0.752)

Note:

1. Each variable (other than age) takes on a value of either 0 or 1.
2. The survey weights are employed in the analysis. The complex survey design was taken into account in the calculation of the bootstrap-generated standard errors which are presented in parentheses.
3. * denotes case where the sample size is too small to report the statistic.

The immigrant status and mother tongue of the child's mother appears to be correlated with the child's math performance but not to the same extent as was found for the PPVT. For example, 12 percent of children in the bottom third of the math distribution have a mother who is an immigrant and whose mother tongue is neither English nor French compared with only five percent for children in the top third of the math distribution. In contrast, these differences were much larger in Table 2 at 23 percent and two percent, respectively.

4. Factors Associated with Poor Vocabulary Test Performance

The descriptive evidence indicates that family characteristics are correlated with test score outcomes at different ages. In order to further explore the relative importance of these different characteristics as predictors of test performance, multivariate models are employed. Both regression models and logistic model are used in the analysis of the PPVT and mathematics test score data. The regression models are used to estimate expected differences in performance in vocabulary for the five year-olds and in mathematics for seven year-olds. The logit models are used to analyze differences in the probability of having a test score in the bottom third of the relevant test score distribution (which can be interpreted as the probability of experiencing early literacy problems).

In Table 5, the results from the regression and logit models of test score performance are presented. In column (1), the logit estimates of a Binary Choice Model is presented where the dependent variable equals one if the child scored in the bottom third of the PPVT in Cycle 1 and equals zero otherwise. The model was estimated over the sample of five year-olds in Cycle 1. In the second column, the results from a regression model are reported where the dependent variable is the PPVT score. This model relates the same set of characteristics to the child's score rather than the indicator variable for whether the child is in the bottom third of the distribution or not. The coefficients across the two models cannot be directly compared. However, one would expect that a negative coefficient in the logit analysis to be broadly consistent with a positive coefficient in the regression analysis since a factor that is positively associated with being in the bottom third of the distribution would likely also be associated with having a bottom score on the PPVT. An important difference between the two models is that the Logit approach ignores much of the variation in the PPVT score.

Table 5
Estimates from Models of School Performance

	Logit Estimates for Low PPVT Score Model	Regression Estimates for PPVT Score Model	Logit Estimates for Low Math Score Model	Regression Estimates for Math Score Model
	(1)	(2)	(3)	(4)
Father not present	0.171 [0.041] (0.464)	1.04 (2.59)	0.274 [0.066] (0.604)	-10.9 (9.24)
Female Child	-0.010 [-0.002] (0.141)	-1.21 (1.25)	-0.073 [-0.018] (0.335)	-12.2** (6.12)
Immigrant Child	0.607 [0.145] (3.74)	-7.27 (9.13)	n.a.	n.a.

Table 5 (continued) **Estimates from Models of School Performance**				
	Logit Estimates for Low PPVT Score Model	**Regression Estimates for PPVT Score Model**	**Logit Estimates for Low Math Score Model**	**Regression Estimates for Math Score Model**
	(1)	**(2)**	**(3)**	**(4)**
Mother's characteristics				
Did not graduate from high school	0.040 [0.010] (0.377)	-0.870 (2.45)	0.064 [0.015] (0.573)	-3.36 (11.6)
Post-secondary (no university degree)	-0.587* [-0.140] (0.300)	2.63 (1.75)	-0.323 [-0.078] (0.400)	5.74 (7.37)
University degree	-0.337 [-0.080] (0.502)	5.58** (2.64)	-0.514 [-0.124] (0.710)	19.9* (10.6)
Immigrant, mother tongue English or French	-1.32 [-0.315] (0.974)	6.11* (3.43)	-0.447 [-0.108] (4.34)	10.0 (11.7)
Immigrant mother tongue other	1.875** [0.449] (0.604)	-13.2** (2.97)	0.536 [0.130] (1.41)	-13.6 (21.3)
Mother tongue French	0.334 [0.080] (0.453)	-4.59 (3.06)	n.a.	n.a.
Father's characteristics (=0 if father not present)				
Did not graduate from high school	0.175 [0.042] (0.416)	0.117 (2.64)	n.a.	n.a.
Post-secondary (no university degree)	-0.076 [-0.018] (0.345)	2.38 (2.07)	n.a.	n.a.
University degree	-0.409 [-0.098] (0.481)	2.01 (2.52)	n.a.	n.a.
Family Income				
Less than 20,000	0.455 [0.109] (0.367)	-6.91** (2.17)	0.044 [0.066] (0.660)	0.461 (10.1)
Over 40,000	0.455 [0.109] (0.367)	-0.585 (1.57)	-0.098 [-0.024] (0.445)	11.0** (5.35)

Table 5 (continued) Estimates from Models of School Performance				
	Logit Estimates for Low PPVT Score Model	Regression Estimates for PPVT Score Model	Logit Estimates for Low Math Score Model	Regression Estimates for Math Score Model
	(1)	(2)	(3)	(4)
Population Size				
Urban 100,000 to 499,000	-0.556 [-0.133] (0.354)	2.04 (1.90)	-0.693 [-0.168] (0.504)	4.99 (9.60)
Urban less than 100,000	-0.373 [-0.089] (0.331)	0.64 (1.81)	-0.450 [-0.109] (0.459)	0.461 (10.1)
Rural	0.093 [0.022] (0.356)	-3.32* (1.91)	-0.011 [-0.003] (0.531)	-3.56 (9.75)
Region of Residence				
Atlantic Provinces	0.118 [0.028] (0.289)	1.46 (1.57)	-0.467 [-0.113] (0.431)	17.8** (8.05)
Quebec	-0.272 [-0.065] (0.502)	6.27** (3.20)	-1.60** [-0.387] (0.670)	40.0** (11.6)
Manitoba or Saskatchewan	-0.054 [-0.013] (0.366)	1.43 (1.80)	-0.908 [-0.220] (0.601)	25.4** (11.1)
Alberta	0.078 [0.019] (0.449)	1.11 (2.11)	-0.729 [-0.176] (0.629)	11.9 (10.6)
British Columbia	0.723* [0.173] (0.422)	-2.64 (3.00)	-1.93** [-0.467] (0.672)	35.2** (9.43)
Constant	2.78 (4.17)	72.7** (22.2)	0.359 (0.643)	291.5** (12.2)
Pseudo R^2 / R^2	0.12	0.19	0.10	0.18

Note:

1. The specification employed in the PPVT analysis also contains controls for the mother's age and age-squared.
2. In the Logit analysis, the dependent variable takes on a value of 1 if the child scores in the bottom third of the Mathematics Test in Cycle 1 and 0 otherwise.
3. * denotes significance at 10 percent level, ** at 5 percent level.
4. For the Logit models, marginal probabilities are presented in square brackets. These are calculated at the default values of the explanatory variables.
5. The sample weights are employed in the analysis. The bootstrap-generated standard errors of the parameter estimates (presented in parentheses) take into account the complex survey design.

In the Logit analysis of column (1), many of the coefficients on the controls are not individually statistically significant.[3] Therefore, the discussion is focused primarily on the significant variables. The mother having a post-secondary education (but no university degree) is associated with a lowest probability of the child having a PPVT score in the bottom third of the distribution relative to the default category of the mother having graduated from high school but without any post-secondary education. However, it is somewhat surprising that a similar relationship is not found for children whose mothers have a university degree.

Children of immigrant mothers whose mother tongue is neither English nor French are found to have a higher probability of having a PPVT score in the bottom third of the distribution relative to the children of mothers who were born in Canada.[4]

Some variation is found in the coefficient estimates on the region variables is found but only the coefficient on the British Columbia indicator variable is significant implying a higher probability of children in that province being in the bottom third of the PPVT distribution relative to the default group (children residing in Ontario).

In column (2), the PPVT regression estimates are presented. As was the case in column (1), many of the coefficient estimates are not individually significant. However, a number of relationships can be seen. Children with university educated mothers have close to 6 points higher scores on the PPVT relative to the children in the default group (those whose mothers have graduated from high school but have no post-secondary education).[5] As was found in column (1), children of immigrant mothers whose mother tongue is neither English nor French are at a disadvantage in the PPVT (of 13 points) relative to children of Canadian-born mothers. One difference from column (1) is the fact that the coefficient on the other immigrant status variable is statistically significant implying a six points higher score on the PPVT for the children of immigrant mothers whose first language is either English or French relative to the children of Canadian-born mothers. Another difference relative to the results for column (1), is the fact that the coefficient on the indicator variable for family income being less than $20,000 is statistically significant implying seven points lowest third performance on the PPVT for children in these families relative to children in the default category (income between 20,000 and 40,000).

In columns (3) and (4), equivalent results are presented but for the case of seven year-olds in Cycle 1 with a mathematics score. Due to the smaller sample for this group relative to the group of five year-olds with a PPVT score, a more parsimonious specification is employed for both the Logit and regression models. In particular, controls for the immigrant status of the child, the mother having French as a mother tongue, the mother's age and the father's education are not included.

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[3] For the Logit analyses, the estimated coefficients are presented along with the imputed marginal probabilities which are presented in square brackets. The marginal probability is calculated for the case of the default values of each variable.

[4] This is consistent with the findings in Worswick (2001, 2004).

[5] The PPVT is designed to have a mean of 100 and a standard deviation of 15.

In the Logit model results of column (3), very few of the family and parental characteristics variables are individually significant. The coefficients on the region variables for Quebec and British Columbia are the only ones statistically significant indicating a low probability of being in the bottom third of the math distribution relative to children in the default category (those residing in Ontario). Most coefficients on the variables related to the mother's and father's characteristics are not individually significant. However, the child's expected math score is found to be 20 points higher for children with a mother who has a university degree, relative to children whose mother graduated from high school only. Also, unlike in the Logit estimation, the coefficient on family income over $40,000 is significant indicating 11 points higher on the math score for children in these high income families relative to children whose family income was between 20,000 and 40,000.

The coefficients on the region variables are generally significant (with the exception of Alberta) and imply higher expected math scores for children outside of Ontario relative to those inside Ontario with the differences being largest for children in Quebec and British Columbia.

5. Longitudinal Analysis of Persistence of Early Literacy Problems

In the previous section, evidence on the factors associated with early problems in school was documented. Parental education, family income, immigrant status and mother tongue of the mother, as well as region and size of place of residence were all identified as determinants of success at school. In this section, the longitudinal nature of the data are employed in order to investigate the performance of these same children in terms of reading and mathematics on tests administered in later cycles of the NLSCY.

In Table 6, sample means are presented of the test scores in Cycles 2 through 4 calculated separately according to the different thirds of the PPVT test score distribution from Cycle 1. The goal of this part of the analysis is to see whether the PPVT scores are persistent in the sense of a low score in the past being associated with a low score on future measures of academic ability. In column (1) of Table 6, the mean PPVT score for each of the three thirds of the PPVT distribution are reported to facilitate comparisons. Below these means are the sample means for reading and mathematics tests carried out by the same children in the subsequent cycles of the survey.

Table 6
Means of Test Scores in all Four Cycles by Part of the PPVT Distribution of Five Year-Olds in Cycle 1

	Bottom Third of PPVT Distribution (less than 94)	Middle Third of PPVT Distribution (between 94 and 105)	Top Third of PPVT Distribution (greater than 105)
	(1)	(2)	(3)
Cycle 1			
PPVT	83.2 (9.51)	99.72 (3.65)	115.5 (7.64)
Cycle 2			
Reading	179.4 (6.08)	192.9 (7.02)	207.5 (2.66)
Mathematics	314.9 (6.77)	318.6 (5.43)	323.5 (48.8)
Cycle 3			
Reading	208.1 (6.71)	230.4 (3.11)	241.8 (2.53)
Mathematics	390.0 (8.06)	388.6 (5.32)	414.2 (6.92)

Table 6 (continued) Means of Test Scores in all Four Cycles by Part of the PPVT Distribution of Five Year-Olds in Cycle 1			
	Bottom Third of PPVT Distribution (less than 94)	**Middle Third of PPVT Distribution (between 94 and 105)**	**Top Third of PPVT Distribution (greater than 105)**
	(1)	**(2)**	**(3)**
Cycle 4			
Mathematics	441.2 (6.64)	442.4 (6.82)	465.7 (5.49)

Note:

1. The data are based on observations on five year-olds in Cycle 1 (and their longitudinal records in the subsequent Cycles).
2. The PPVT is a vocabulary test.
3. The sample weights are employed in the analysis. The bootstrap-generated standard errors (in parentheses) take into account the complex survey design.

The results for the reading tests performed in Cycles 2 and 3 indicate that the children who had scores in the bottom third of the PPVT distribution have bottom third mean reading scores in Cycles 2 (179.4) and 3 (208.1) than did the children who scored in the middle of the PPVT distribution (192.9 in Cycle 2 and 230.4 in Cycle 3). The children who scored in the top third of the PPVT distribution in Cycle 1 had the highest mean reading scores (207.5 in Cycle 2 and 241.8 in Cycle 3). It is difficult to compare across different tests partly because they measure different skills but also because they have different metrics. However, there is evidence of a narrowing of the test performance across the three groups of children.

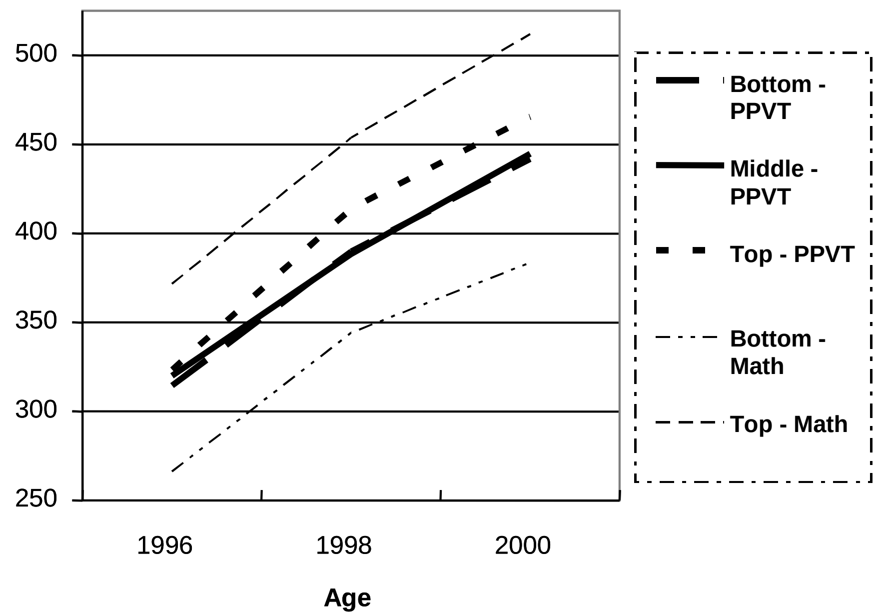
In terms of the mathematics tests, the differences across the groups of children are much smaller. In Cycle 2, the middle group of children (in terms of the Cycle 1 PPVT scores) had only a four point higher mean than the bottom group of children and the top group had only a five point higher mean math score than the middle group of children. Therefore, it does not seem that either a poor or a strong performance on the PPVT at age five is a very good predictor of the math score performance two years later. The results for Cycles 3 and 4 are very similar. In both cases, the mean math score of the children in the bottom group from the PPVT in Cycle 1 have mean math scores that are very similar to those of the children in the middle group.[6] The PPVT ranking is better at explaining the top part of the mathematics test score distribution since the children who had scores in the top third of the PPVT distribution have higher mean math scores relative to the middle group of children (a 25 point difference in Cycle 3 and a 24 point difference in Cycle 4).

In Figure 1, the sample means for the mathematics tests from Table 6 are presented graphically. To demonstrate the fact that the differences across the three groups of children in the mean test scores are small, the mean math test scores of the top third and the bottom third of the mathematics test score distribution are also presented. These are defined analogously to the mean math scores of Table 6 except the bottom and top designations relate to the mathematics test distribution (in Cycles 2, 3 and 4) rather than

[6] The mean math score is slightly higher for the bottom group compared with the middle group in the Cycle 3 data.

the PPVT test score distribution (in Cycle 1).[7] As can be seen, the mean math scores for the Top and Bottom groups based on the mathematics test score distribution lie above and below the outside of the Top and Bottom groups defined off of the PPVT. This is consistent with the idea that either poor or strong performance on the PPVT is not a good predictor of performance on the subsequent mathematics tests.

Figure 1
Mean Math Scores by Thirds of the PPVT distribution in Cycle 1 and by Thirds of the Math Distribution in Subsequent Cycles



Note:
1. Author's calculations based on estimates from Table 6.
2. The PPVT is a vocabulary test. The Cycle 1 PPVT data were employed in this part of the analysis.
3. The scaled mathematics test scores were employed from all three Cycles 2 through 4.
4. In each case, the mean mathematics test score is calculated for each third of the relevant test score distribution (bottom, middle and top).

This may imply that the difficulties that children experience on the PPVT are temporary and do not imply problems later in school. However, it is also possible that those vocabulary-related problems do persist but are not measured well by a mathematics test. In order to investigate this possibility the equivalent exercise is carried out for the reading test and presented in Figure 2 for the two cycles in which a reading test is available, Cycles 2 and 3.

[7] For example, the 'Bottom – Math' line is the mean mathematics score in each year of children whose mathematics score in that cycle was at or below the 33rd percentile of the mathematics test score distribution in that cycle.

Figure 2
Mean Reading Scores by Thirds of the PPVT distribution in Cycle 1 and by Thirds of the Reading Distribution in Subsequent Cycles

Note:

1. Author's calculations based on estimates from Table 6.
2. The PPVT is a vocabulary test. The Cycle 1 PPVT data were employed in this part of the analysis.
3. The scaled reading test scores were employed from Cycles 2 and 3. A reading test was not administered in Cycle 4.
4. In each case, the mean reading test score is calculated for each third of the relevant test score distribution (bottom, middle and top).

As was done in Figure 1 for the mathematics tests, the mean reading scores for the bottom and top thirds of the reading test score distribution in each cycle were calculated and plotted. The wide difference between the Top-Reading line and the Bottom – Reading line demonstrate the high degree of variation in the test score performance. The fact that the Bottom – PPVT and Top – PPVT lines lie well within these curves indicates that poor (strong) performance on the PPVT does not necessarily imply poor (strong) performance on the subsequent reading tests.

However, it is interesting to note that the Bottom-PPVT curve and the Top –PPVT curves appear to be closer to the Bottom-Reading and Top-Reading curves (respectively) than was the case for the equivalent curves in Figure 1. This indicates that poor performance on the PPVT may be more closely correlated with poor performance on the subsequent reading scores than is the case for subsequent mathematics scores. This would not be surprising given that vocabulary skills are more closely related to reading skills than to mathematics skills. However, the fact that the mean reading scores for the children in the bottom third of the PPVT distribution lie above the mean reading scores for children in the bottom third of the reading distribution is an important finding. This indicates that either there are important differences in the vocabulary and reading tests or the difficulties experienced by the children on the PPVT are often temporary in nature and do not imply long run problems in reading.

In Table 7, the equivalent analysis to Table 6 is carried out based on data on the seven year-olds in Cycle 1 with mathematics test scores. In the first row of Table 7, the mean math scores in Cycle 1 are presented separately for the three thirds of the mathematics test score distribution. In the bottom rows of the table, the mean scores on the reading and mathematics tests administered in later cycles are presented. Focusing first on the mathematic scores, we see some persistence in the mathematics scores in the sense that in Cycles 2 through 4, mean performance of those with math scores in Cycle 1 in the top third of the distribution are higher than those with Cycle 1 math scores in the middle third of the distribution. A similar ranking also persists in that the mean math scores of children who in Cycle 1 had math scores in the middle third of the distribution are higher than the mean math scores of children with Cycle 1 test scores in the bottom third of the math distribution. However, there is also evidence of a narrowing of these differences in math scores over time. For example, in the first row, the mean math score of the top third is 42 percent higher than the mean math score of the bottom third of the Cycle 1 math distribution. In contrast, the equivalent percentage differences in the later cycles are 14 percent in Cycle 2, 7 percent in Cycle 3 and 12 percent in Cycle 4.

Table 7
Means of Test Scores in all Four Cycles by Part of the Mathematics Distribution of Seven Year-Olds in Cycle 1

	Bottom Third of Math Distribution (less than 283)	Middle Third of Math Distribution (between 283 and 317)	Top Third of Math Distribution (greater than 317)
	(1)	(2)	(3)
Cycle 1			
Mathematics	258.34 (3.28)	307.64 (1.37)	367.0 (2.79)
Cycle 2			
Reading	216.0 (5.69)	241.1 (5.06)	252.3 (3.25)
Mathematics	392.1 (5.89)	422.1 (7.77)	446.3 (5.00)
Cycle 3			
Reading	254.7 (4.32)	258.8 (6.30)	269.4 (4.37)
Mathematics	451.6 (14.5)	481.1 (5.32)	482.9 (8.72)
Cycle 4			
Mathematics	496.6 (8.40)	526.2 (10.5)	556.3 (7.35)

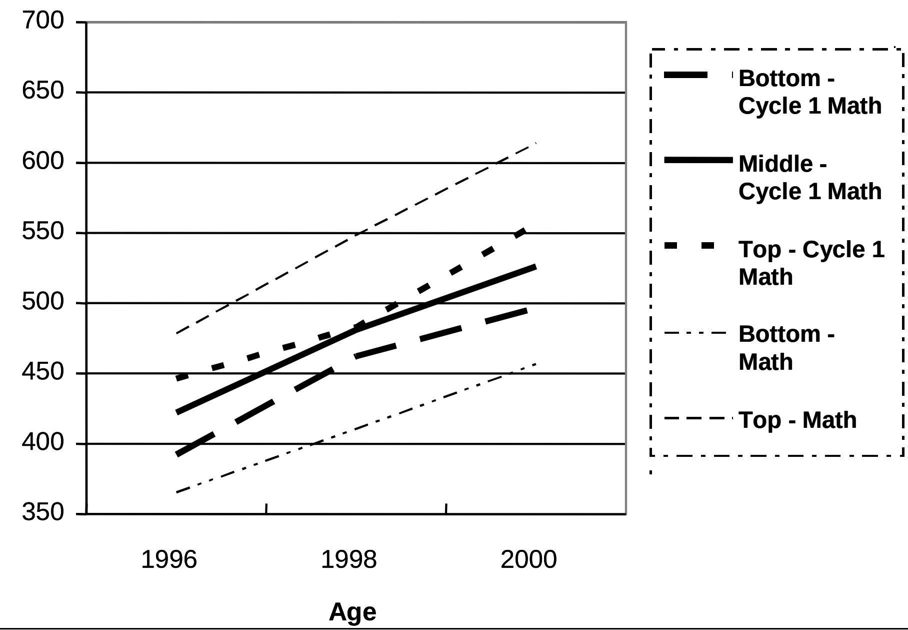
Note:
1. The data are based on observations on seven year-olds in Cycle 1 (and their longitudinal records in the subsequent Cycles).
2. The sample weights are employed in the analysis. The bootstrap-generated standard errors (in parentheses) take into account the complex survey design.

When the focus is instead on reading performance in later cycles, a similar pattern emerges. For each of the subsequent cycles, the mean reading score of children who scored in the top third of the math distribution in Cycle 1 is higher than the mean reading score of children scoring in the middle third of the Cycle 1 math score distribution which is higher than the mean reading score of children who scored in the bottom third of the math score distribution in Cycle 1. However, the differences are not large. The percentage difference in the mean reading test scores of the children scoring in the top third of the math distribution in Cycle 1 and the children scoring in the bottom third of the math test score distribution in Cycle 1 is 17 percent for the case of Cycle 2 and 6 percent for the case of Cycle 3.

In order to explore this further, Figures 3 and 4 are presented which closely mirror Figures 1 and 2. Figures 3 and 4 present mean math and reading scores for Cycles 2 through 4 for the seven year-olds in Cycle 1 according to which part of the Cycle 1 math distribution they belong. So as to show that the differences across the three groups of children in the mean test scores are relatively small, the mean math test scores of the top third and the bottom third of the mathematics test score distribution are also presented in Figure 3.[8] The mean math scores for the Top and Bottom groups based on the mathematics test score distribution lie above and below the relevant Top and Bottom groups defined off of the mathematics test in Cycle 1. This is consistent with the idea that either poor or strong performance on the mathematics test in Cycle 1 is not a perfect predictor of performance on the subsequent mathematics tests.

[8] To be clear, "Bottom – Cycle 1 Math" refers to the mean mathematics score in Cycles 2 through 4 for children with a Cycle 1 mathematics score that was in the bottom third of the Cycle 1 distribution. "Middle – Cycle 1 Math" refers to the mean mathematics score in Cycles 2 through 4 for children with a Cycle 1 mathematics score that was in the middle third of the Cycle 1 distribution. "Top – Cycle 1 Math" refers to the mean mathematics score in Cycles 2 through 4 for children with a Cycle 1 mathematics score that was in the top third of the Cycle 1 distribution. "Bottom – Math" refers to the mean mathematics score in each cycle for children with a mathematics score in that cycle that was in the bottom third of its distribution. "Top – Math" refers to the mean mathematics score in each Cycle for children with a mathematics score in that cycle that was in the top third of its distribution.

Figure 3
Mean Math Scores by Thirds of the Math distribution in Cycle 1 and by Thirds of the Math Distribution in Subsequent Cycles



Note:

1. Author's calculations based on estimates from Table 7.
2. The scaled mathematics test scores were employed from all three Cycles 2 through 4.
3. In each case, the mean mathematics test score is calculated for each third of the relevant test score distribution (bottom, middle and top).

In Figure 4, the mean reading scores for the bottom and top thirds of the reading test score distribution in each cycle are plotted. To provide a benchmark, the mean reading scores for children in the top third and bottom third of the reading test score distributions are also plotted for each of the two cycles in which a reading test was administered (Cycle 2 and Cycle 3). The fact that the Bottom – Cycle 1 Math and Top – Cycle 1 Math lines lie well within these curves indicates that poor (strong) performance on the mathematics test at age seven does not imply poor (strong) performance on the subsequent reading tests.

Figure 4
Mean Reading Scores by Thirds of the Math distribution in Cycle 1 and by Thirds of the Reading Distribution in Subsequent Cycles

Note:

1. Author's calculations based on estimates from Table 7.
2. The scaled reading test scores were employed from Cycles 2 and 3. A reading test was not administered in Cycle 4.
3. In each case, the mean reading test score is calculated for each third of the relevant test score distribution (bottom, middle and top).

The final part of the analysis is an investigation of the probability of a child being in the bottom third of a distribution of academic test scores given that the child was in the bottom third of a test score distribution in a previous cycle. Specifically, we calculate the mean incidence of being in the bottom third of a reading or math test in Cycle 2, 3 or 4 conditional on having been: 1) in the bottom third of the PPVT distribution for the case of children who were five in Cycle 1 and 2) in the bottom third of the mathematics test distribution for the case of children who were seven in Cycle 1. The results of the analysis are presented in Table 8.

Table 8 Probability of a Test Score in the Lowest Third of the Distribution in a Future Cycle Given that Previous Test Score was in Bottom Third of Distribution in Cycle 1		
	Bottom Third of PPVT Distribution in Cycle 1, Five Year-Olds	**Bottom Third of Math Distribution in Cycle 1, Seven Year-Olds**
Cycle 2		
Bottom Third of Reading Distribution	50.0 (6.51)	60.6 (7.87)
Bottom Third of Mathematics Distribution	37.5 (5.92)	63.1 (7.85)
Cycle 3		
Bottom Third of Reading Distribution	52.8 (7.09)	52.8 (10.1)
Bottom Third of Mathematics Distribution	43.6 (7.45)	58.0 (10.7)
Cycle 4		
Bottom Third of Mathematics Distribution	41.2 (5.64)	50.7 (8.46)

Note:

1. The sample weights are employed in the analysis. The bootstrap-generated standard errors (in parentheses) take into account the complex survey design.

From column (1), we see that only 50 percent of the children in the bottom third of the PPVT distribution in Cycle 1 are in the bottom third of the reading distribution two years later in Cycle 2. By using the data from Cycle 3, we see that 53 percent of children in the bottom third of the PPVT in Cycle 1 are in the bottom third of the reading distribution four years later. This indicates that while some persistence exists in terms of the same children being at risk of literacy problems over these early years in school, the problems are not completely persistent since it is well below 100 percent. It also indicates that vocabulary problems may differ in important ways from reading problems at older ages.

The results from the analysis of the mathematics tests in Cycles 2 through 4 show even less persistence. In each of these cycles, the percentage of children who had a PPVT score in Cycle 1 in the bottom third of the distribution and who had a math score in the bottom third of the later mathematics test distribution varies form a low of 38 percent in Cycle 2 to a high of 44 percent in Cycle 3. The fact that these numbers are all above 33 percent indicates that there is some persistence in these early literacy/academic performance measures. However, these numbers indicate that a high fraction of children with vocabulary problems at age five do not experience reading and mathematic problems at ages seven, nine and eleven.

In the second column of Table 8, the equivalent figures are presented but for the case of the cohort of seven year-olds from Cycle 1 with mathematics scores. Of the children in Cycle 2 who had a Cycle 1 math score in the bottom third of the math distribution, 61 percent also had a Cycle 2 reading test score that was in the bottom third of the reading test distribution and 63 percent had a Cycle 2 mathematics score in the bottom third of the math distribution. Carrying out the same calculations for Cycle 3 yields 53 percent of the children with a Cycle 1 math score in the bottom third of the distribution having a Cycle 3 reading score in the bottom third of the reading distribution and 58 percent having a Cycle 3 math score in the bottom third of the distribution. Similarly, 51 percent of the children in Cycle 4 who had a Cycle 1 math score in the bottom third of the distribution also had a math score (at age 13 or 14) in Cycle 4 that was in the bottom third of the math distribution.

The results of the longitudinal analysis support the view that there is persistence in early literacy problems since children with low vocabulary scores at age five and those with low mathematics scores at age seven are more likely to be in the bottom third of the reading and mathematics test scores at older ages than are other children. However, the evidence also indicates that for many children the early problems experienced in vocabulary and mathematics are temporary.

These results differ somewhat with the findings of Hoddinott, Lethbridge and Phipps (2002) in that while some persistence is found, evidence of poor early outcomes ‘snowballing’ into larger problems at older ages is difficult to see. This is an important issue that deserves greater attention in the literature.

6. Remaining Issues

The longitudinal analysis was extended so as to carry out a multivariate analysis of the probability of remaining in the bottom third of a test score distribution (given a previous test score in the bottom third of a test score distribution). Unfortunately, once the analysis is restricted to a particular group (eg. five year-olds in Cycle 1) the sample sizes become sufficiently small to make it impossible to generate reliable estimates. Even for very simple models, it was impossible to generate statistically significant relationships from analyses in which child and family characteristics are included. Consequently, these results are not presented. In future work, it may be possible to pool more groups of children together in order to further explore this possibility. However, given the problems with the mathematics test score in Cycle 1 of the NLSCY (for eight year-olds and ten year-olds), it may be the case that a new source of data is needed before this type of analysis is possible.

7. Policy Implications

It is difficult to draw clear policy implications in the absence of experimental or quasi-experimental data. Ideally, one would be able to identify the "impact" of factors such as income, parental education and place of residence on the early literacy performance of children. However, in practice this is very difficult since it is virtually impossible to rule out the effects of unobserved heterogeneity – unobserved factors that may be correlated with the characteristics of interest and that are correlated with the early literacy outcomes. Since it is not possible to randomly assign children into households with high income while randomly assigning other children to households with low income (which is analogous to what a study might do in a random trial for a new medical treatment), one cannot know for certain the impact that family income has on early literacy problems.

Consequently, one must be cautious when interpreting the relationships found in a study of this kind in terms of developing policy prescriptions. The fact that evidence is found to indicate that children from lower income households are more likely to experience early literacy problems does not necessarily imply that a federal government program that raised the incomes of these households would necessarily lead to an improvement in the literacy outcomes of the children in these households. It may be that other unobserved factors may be relevant that are correlated with the household income but are the true factors that affect the literacy performance of these children.

In summary, the results shed light on groups of children who are at greater risk of early literacy problems than are other children. In terms of difficulty in vocabulary at age five, children with more highly educated mothers are less likely to have children with vocabulary scores in the bottom third of the test score distribution than are children with less educated mothers. In addition, children with an immigrant mother whose first language is neither English nor French are at a higher risk of having vocabulary test scores in the bottom third of the distribution. This result is consistent with other studies (see for example Worswick, 2003). Government programs intended to target groups of children who are at risk of early literacy problems would ideally include this sub-group of the child population. Further research using new sources of data is needed in order to further refine the groups of interest and gain a greater understanding of the appropriate program interventions that could be used to aid children in these families in terms of avoiding early literacy problems. The NLSCY is a very useful data set for studying many groups of children but the sample size for children of immigrant families makes detailed analyses of the children of immigrants difficult. A special survey targeting this group may be needed.

In terms of the analysis of math scores for seven year-olds, children with mothers who have a high level of education are found to have higher expected mathematics scores. This is consistent with a large literature in the social sciences that finds that children with more educated parents are likely to have higher levels of success in elementary school. In terms of shedding light on policy option, the result does indicate that children with less educated fathers may be at a greater risk of problems in mathematics at a young age.

The high degree of variation in mathematics test scores across regions of Canada is also a cause for concern. These differences across provinces could be related to differences in the programs offered in the different school systems and could be out of the realm of policy of the federal government. However, they may also be driven in part by unobserved characteristics that differ on average across provinces. An evaluation of these issues is an important area for future research. A detailed analysis of whether these differences can be explained by school related factors such as funding per student and the degree of emphasis placed on training in mathematics at different ages would be important starting points in terms of gaining a better understanding of what are the underlying causes of these regional differences in math score outcomes.

Finally, the longitudinal analysis indicates considerable persistence in early literacy problems; however, it also indicates that for many children, these early vocabulary problems are not associated with problems in mathematics at school. There is a pressing need for more detailed data allowing for a more in depth analysis of the persistence of early literacy problems. The small sample sizes of the longitudinal sample from the NLSCY make it impossible to investigate these issues fully. A special survey targeting children in groups likely to have early literacy problems should be considered. By targeting the children whom we know are likely to be at risk, it may be possible to carry out a feasible longitudinal study with a large enough sample size to fully explore the factors associated with the persistence of early literacy problems.

8. Conclusions

The analysis of this paper can be divided into two parts: 1) an investigation into the factors associated with early literacy problems and 2) an investigation of the persistence of early literacy problems. In each part of the analysis there were two groups studied: 1) children age five in Cycle 1 with a vocabulary (PPVT) test score and 2) children age seven in Cycle 1 with a mathematics test score.

In the analysis of the PPVT scores, children with more highly educated mothers were less likely to score in the bottom third of the PPVT distribution. Children with immigrant mothers whose mother tongue was neither English nor French were more likely to score in the bottom third of the PPVT distribution. In addition, a weak relationship between expected scores on the PPVT and family income was found. This may be due to the fact that the income variable available in Cycle 1 of the NLSCY is categorical and does not allow for a detailed analysis.

In the analysis of the math scores for children age seven in Cycle 1, children with more highly educated mothers were found to have higher expected math scores. Also, children in families with annual income over $40,000 in 1994 dollars were found to have higher expected mathematics scores. Regional variation in mathematics test scores was found with especially high expected scores for children in British Columbia and Quebec and lower scores for children in Ontario.

The results of the longitudinal analysis support the view that early literacy problems persist to a certain extent into older ages. Forty to fifty percent of the children who scored in the bottom third of the PPVT distribution at age five also scored in the bottom third of a reading or mathematics test taken as part of a later cycle of the survey. For the case of seven year-old children who scored in the bottom third of the math test distribution in Cycle 1, 50 to 60 percent of them scored in the bottom third of the distribution of tests taken at later cycles of the NLSCY. However, the fact that these numbers are considerably below 100 percent indicates that early literacy problems are often temporary or they are multi-dimensional making a comparison of the incidence of these problems both across time and across test instruments problematic.

Taken in total, the results help in the process of identifying children at risk of early literacy problems. They also give an indication of the likelihood that these problems persist into older age groups. A shortcoming of the analysis is that the small sample sizes made it impossible to carry out a multivariate analysis of the family characteristics that are correlated with the persistence of early literacy problems. This should be studied in future work, perhaps using new sources of data. In terms of guiding policy, it would be beneficial to know which of the groups at risk of early literacy problems are also at risk of persistent early literacy problems.

References

Burton, Peter, Shelley Phipps and Lori Curtis (2002). "All in the Family: A Simultaneous Model of Parenting Style and Child Conduct," *American Economic Review*, 92(2): 368-72

Carliner (1995). *The Language Ability of U.S. Immigrants: Assimilation and Cohort Effects*, National Bureau of Economic Research Working Paper 5222.

Carneiro, Pedro, James J. Heckman. 2003. "Human Capital Policy." *Inequality in America*. The MIT Press, Cambridge, Massachusetts, pp. 77-239.

Cummins, Jim (1992). "Knowledge, power, and identity in teaching English as a second language," Chapter 2 of *Educating Second Language Children: The whole child, the whole curriculum, the whole community,* edited by Fred Genesee, Cambridge University Press.

Currie, Janet and Duncan Thomas (1999). "Does Head Start Help Hispanic Children?" *Journal of Public Economics*, 74(2): 235-62.

Desjardins, Richard (2003). "Determinants of Economic and Social Outcomes from a Life-Wide Learning Perspective in Canada," *Education Economics* 11(1): 11-38.

Finnie, Ross and Ronald Meng (2002). "Minorities, Cognitive Skills and Incomes of Canadians," *Canadian Public Policy*, 28(2): 257-73.

Green, David A. and W. Craig Riddell (2001). "Literacy Skills, Non-cognitive Skills and Earnings: An Economist's Perspective," in *Towards evidence-based policy for Canadian education/Vers des politiques canadiennes d'éducation fondées sur la recherche*, edited by Patrice DeBroucker and Arthur Sweetman.

Green, David A. and W. Craig Riddell (2003). "Literacy and Earnings: An Investigation of the Interaction of Cognitive and Unobserved Skills in Earnings Generation," *Labour Economics*, 10(2): 165-84.

Hoddinott, John, Lynn Lethbridge and Shelley Phipps (2002). *Is History Destiny? Resources, Transitions and Child Education Attainments in Canada*, Research Paper, Strategic Policy, Human Resources Development Canada, December.

Richmond, Anthony H. and Aloma Mendoza (1990). "Education and Qualifications of Caribbean Immigrants and Their Children in Britain and Canada." In Ransford W. Palmer, ed. In *Search of a Better Life: Perspectives on Migration from the Caribbean*, pp. 73-90.

Schmid, Carol S. (2001). “Educational Achievement, Language Minority Students and the New Second Generation.” *Sociology of Education*, 74, Extra Issue. Current of Thought, Sociology of Education at the Dawn of the 21 Century, 71-87.

Sweetman, Arthur (2002). *Immigrant Children in Grade School: An International Perspective*, paper presented at the American Economics Association Meetings in Atlanta.

Sweetman, Arthur and Gordon Dicks (1999). “Education and Ethnicity in Canada: An Intergenerational Perspective.” *The Journal of Human Resources*, 34(4): 668-696.

Worswick, Christopher (2001). *School Performance of the Children of Immigrants in Canada*, 1994-98, Research Paper No. 178, Statistics Canada, 11F0019MIE, November.

Worswick, Christopher (2003). *School Program Choice and Streaming: Evidence from Canada’s French Immersion Program*, paper presented at the June Meetings of the Canadian Employment Research Forum, Ottawa.

Worswick, Christopher (2004). “Adaptation and Inequality: Children of Immigrants in Canadian Schools,” *Canadian Journal of Economics*, 37(1): 53-77.

Zhou, Min (1997). “Growing Up American: The Challenge Confronting Immigrant Children and Children of Immigrants.” *Annual Review of Sociology*, Vol 23, 1997, 63-95.