EARLY ARITHMETIC SKILLS IN CHILDREN WITH ENGLISH AS A SECOND LANGUAGE

by

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Abstract

The goal of the present longitudinal study was to compare the mathematical achievement of primary school students from recent immigrant families who had English as a Second Language (ESL) to the mathematical achievement of native English-speaking students. Of 97 children participating in this study, 32 were ESL speakers with first generation immigrant parents, and 65 were English speakers. The children participated over four years, from Kindergarten to Grade 3. In each grade, children completed standardized and experimental measures of numeracy and memory skills. Also, in grade 3, parents of these students were given a questionnaire addressing their attitudes towards mathematics, and home support (e.g., tutoring, help with homework) which they provide to their children in mathematics. In addition, immigrant parents received a questionnaire addressing their children's language home environment. It was found that ESL children did not differ significantly from native English speakers on any of the measures. A significantly larger proportion of ESL than native English speaking parents indicated that they tutor their children in mathematics at home. A significantly larger proportion of English speaking children were enrolled in extra-curricular activities, such as sports. There does not appear to be any significant difference in performance between the two language groups, suggesting that an ESL/immigrant background is not a strong determinant of success in early mathematics education. However, the greater investment of tutoring time by immigrant parents in their children's mathematical education may be one of the reasons why ESL children performed as well as native English speaking children.

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Introduction

The purpose of the present study was to compare early arithmetic skills of children who had English as a second language (ESL) to native-English speaking children, from Kindergarten to grade 3. In addition, in grade 3, parents of these children filled out a questionnaire addressing their attitudes towards mathematics, and home support (e.g., tutoring, help with homework) which they provide to their children in mathematics. The responses of ESL speaking parents and native-English speaking parents were compared.

Canada has a truly multicultural society. Every year, many newcomers from all around the world enter Canada. Eighteen percent of Canada's population is foreign born (Statistics Canada, 2003). The number of students with English as a second language (ESL) in public schools is increasing. In some Canadian schools, more than half the pupils have English as a second language (UBC Community Asset Mapping Project, 2003). Besides the foreign born students, there are children who are born in Canada, but still have English as a second language. How much and how ESL students from recent immigrant families differ from English speaking students in terms of their school achievement has not been clearly determined. In the present study, an attempt has been made to investigate some of these issues related to students of immigrant backgrounds and their mathematical achievement.

Nature versus Nurture in Mathematics

In the *Meno*, Plato argued that mathematical and other knowledge is not so much taught to students as it is exposed in them. Socrates demonstrates this by "revealing" knowledge of a geometric proof within a slave boy who had no formal education. "[*Socrates*] So the man who does not know has within himself true opinions about the things that he does not know? [*Meno*] So it appears." (Plato). Humans are born predisposed to acquire knowledge; but in order to know, they must be exposed to the knowledge. Some children lack certain predispositions necessary for understanding mathematics, and need more exposure. The mathematical achievement of children is determined by both their cognitive skills and their educational opportunities.

How Much of Mathematical Knowledge is Genetic?

Mathematical disability also called arithmetical disability, or dyscalculia is a learning disability characterized by severe deficits in the processing of numerical and arithmetical information (Geary, 1993; Geary, & Hoard, 2001; Haskell, 2000; Neumarker, 2000; Shalev etc., 2000). When parents and siblings of children with arithmetic disability were assessed for arithmetic, reading and attention disorders, using both cognitive and achievement tests, it was found that 66% of mothers, 40% of fathers, 53 % of siblings, and 44% of second-degree relatives had mathematical disability, which suggests that the familial prevalence of mathematical disability is much higher than expected for the general population (Shalev, 2001). Considering the fact that heredity plays a role in most specific cognitive abilities, it is not surprising that academic achievement shows substantial genetic influence (Plomin, 1990). There is evidence for heritability of arithmetical abilities (Geary, 2000; Resnick, 1989), and mathematical learning disabilities have a significant familial aggregation (Shalev, 2001).

In their review, Geary and Hoard (2001) concluded that the defining features of mathematical disabilities are difficulties with the procedural features associated with the solving of complex arithmetic problems and difficulties in remembering basic arithmetic facts. Both of these aspects are associated with specific brain functions. According to Geary and Hoard (2001), "The procedural deficits and one form of retrieval deficit appear to be associated with functioning of the prefrontal cortex, while a second form of retrieval deficit appears to be associated with the functioning of the left parieto-occipito-temporal areas and several subcortical structures."

Dehaene and Cohen (1997) investigated case studies of patients with aphasia and acalculia. They also associated arithmetic problems with subcortical and parietal areas. They propose a model according to which storage and retrieval of rote verbal arithmetic facts is served by the left subcortical network, while the mental manipulation of numerical quantities is associated with the inferior parietal network. In relation to these findings, Neumarker (2000) discussed the brain of Albert Einstein. Examination of Einstein's brain showed neuronal density in the frontal and temporal cortex, and also extensive development of the posterior parietal lobes (Neumarker, 2000). The brain areas which are often affected in individuals with poor mathematical skills were those best developed in Einstein's case.

According to recent research, certain basic numerical abilities appear to be inherent. It was shown that five-month-old infants are able to detect change if an object is secretly added or removed from a set (Koechlin, 1997; Simon, Hespos, & Rochat, 1995; Wynn, 1992), and that six-month-old infants are able to distinguish the number of jumps made by a puppet (jumping two or three times) (Wynn, 1995), and enumeration of other actions (Wynn, 1996). Similarly, one-week-old infants were able to discriminate between arrays containing one to three objects (Starkey, 1992; Starkey, Spelke, Gelman, 1990), and one-day-old babies habituated to a card with two black dots, and they then start to pay attention to the same card with three dots and vice versa (Antell & Keating, 1983). Geary (1993) has argued that infants have "biologically primary abilities" specific to arithmetic reasoning, similar to the abilities to acquire language. Arithmetic competence in young children includes the capacity to estimate amount without counting, as well as understanding the concepts of more and less. Geary (2000) believes that secondary mathematical abilities are later built on these primary abilities through schooling, environmental learning, and social and cultural influences. Considering the inborn predisposition for learning mathematics, it is not surprising that there are aspects of mathematical knowledge which are present regardless of both culture and formal exposure (Ruthven, 2001).

How Much of Students' Mathematical Knowledge is Learned?

Students' mathematical knowledge is also formed by their educational opportunities, and by the quality and the amount of instruction. Mathematical knowledge is not only biologically based, but also consists of skills that are imparted through instruction or environmental influences. The amount and quality of mathematical education differ greatly cross-culturally, depending on the resources and educational tradition of each country. Cross-cultural studies show that diversity in instructional traditions and styles of teaching mathematical knowledge have an impact on the development of arithmetic skills in young children (Haskell, 2000).

Basic knowledge of math facts and operations are explicitly taught in the classroom; however, besides explicit math instruction and formal schooling, children are also influenced by opportunities within their culture and community. For example, when the mathematical skills of two groups of young African children from Ivory Coast were compared, Baoule children – whose society is predominantly farming – performed lower than Dioula children – whose society is commercial and therefore stresses computational activities. Children from both of these groups had lower performance than US peers, but only at early grades (2 and 3). The performance of all three groups was similar at later grades (5-6) (Ginsburg, Posner, Russell, 1981). It was found that, for complex arithmetic, Chinese university students educated in Asia performed better than Canadian students of both Chinese and non-Asian origin, and that both Canadian students of Chinese origin and Chinese students from Asia performed higher on simple arithmetic tasks than Canadian students of non-Asian origin, again suggesting culture-specific influence on mathematical achievement (Campbell & Xue, 2001).

Mathematical knowledge is acquired both in and out of school. In each society, there are specific cultural influences on the development of this knowledge. Even among three of the world's countries with leading economies (Japan, Germany and USA), when mathematical education was compared, there were differences in national standards, teacher training, and attitudes towards dealing with differences in ability (Stevenson, 1998). For example, people in the US viewed home factors, such as family stability and support, as the main influence on academic achievement, contrary to German respondents who believed that natural intelligence and talents are the most influential factors on achievement. Japanese respondents greatly valued effort, and attributed school success mainly to hard work (Stevenson, 1998).

There seem to be culture-specific styles of teaching mathematics. When the use of mathematics textbooks was examined cross-culturally in England, France and Germany, it was concluded that students in these countries are offered different mathematics and given different opportunities for learning (Haggarty & Pepin, 2002). In France, the emphasis was on discovery, and books contained unstructured activities designed to guide students to their own discovery of mathematics. In Germany, textbooks were very structured, language demands high, and the emphasis was on abstractness and theory. In England, the language used in mathematical textbooks was restricted, and the apparent purpose of the textbooks was repeated practice of learned skills by doing various exercises (Haggarty & Pepin, 2002). Interestingly, when 8^{th}-grade teaching of mathematics in Italy was investigated, it was found that there is relative homogeneity of teaching methods throughout Italy, but that they differ from mathematical lessons in other countries. In particular, a unique activity during Italian mathematical lessons was found which was not observed in other countries. In this activity, teachers and students interacted through the blackboard while the class was observing them (Santagata & Stiger, 2000). This suggests that methods of teaching mathematics are at least partially dependent upon culture.

Given the importance of educational and cultural elements in the acquisition of mathematical knowledge, it is not surprising that differences may exist across cultures. All of these factors indicate that an important component of mathematical knowledge is external to the learner. Both nature and nurture are important in human development and learning; therefore, both environmental and hereditary influences should be considered in mathematical achievement.

ESL Students Are an At-Risk Population

The complexity of the mathematics 'nature-and-nurture' discussion is evident in the cases of children who come from different cultural and educational backgrounds. There are multiple factors negatively influencing school achievement among recent immigrant students (Derwing, et. al., 1999). For example, ESL students cited that they long for more understanding and support from their teachers (Derwing, et. al., 1999). Adjusting to a new culture, language, school environment, and often to new family dynamics, is very challenging. It is natural that immigrant and ESL students often do not know how to "fit in" within their new environment.

When the mathematical achievement of eighth-grade students in English-speaking countries was compared, it was found that immigrant children have lower achievement in Canada, England, and the United States (Haung, 2000). This may be due to the limited English proficiency of many immigrant students. Mathematics is not a universal language; one might, therefore, assume that students with limited English proficiency would be struggling with mathematics. When the roles of opportunity to learn, language proficiency, and immigrant status were analyzed on 2443 middle school students in California, it was found that students with limited English proficiency had significantly lower mathematical achievement than native English-speaking students (Wang, 1999). In the same study, it was found that, when other relevant factors are controlled, immigrant students had similar achievement levels to their non-immigrant peers, suggesting that language proficiency is a more important factor in mathematics achievement than immigrant status *per se*.

It is natural that many students with ESL have learning difficulties due to their limited English proficiency or educational opportunities; however, there are also ESL children with learning disabilities. Their learning problems are internal to them and persistent. There is a tendency within schools to overlook learning disabilities in ESL children, and ESL children are often misdiagnosed (Langdon, Novak, & Quinatar, 2000). Language difficulties and different cultural backgrounds are often seen as the only cause of educational difficulties (Limbos & Geva, 2001).

In addition, there are challenges within the educational system itself, faced by ESL students. For example, the age cap, which is a regulation implemented in some provinces, stating that only students who are 19 or younger before September 1 receive high school funding, makes it difficult for some ESL students to learn a new language and to master the required curriculum within the available time (Derwing, et. al., 1999). Because of this, some ESL students are "pushed out" of school before they may graduate. Analysis of data from an urban Alberta school board – including 556 former and current ESL students – showed that the percentage of ESL students forced to leave school because of the age cap may be as high as 10 percent (Derwing, et. al., 1999). These students did not fulfill graduation requirements, and could not continue in any K-12 system in Alberta, unless they were able to pay the full cost of their continuing education (Derwing, et. al., 1999).

Considering these risk factors associated with ESL and immigrant students, it is not surprising that the general high-school drop-out rate of ESL students may be high. For example, in Alberta studies, drop-out rate of ESL students was 74%, compared to 30-35% among the general high school population (Watt & Roessingh, 1994a, 1994b, 1996, 2001). It is clear that immigrant students face various challenges in schools. In order for them to succeed, they need support from their teachers and peers, and their cultural and language differences needs to be taken into consideration.

Academic Success of ESL Students

Although students of immigrant backgrounds are often considered an at-risk population, they also may enjoy high achievement in school. Some immigrant students perform very well at school, sometimes even better than their native born peers (Caplan, Chen, & Whitmore, 1991; 1992; Fuligni, 1997; Kao, & Tienda, 1995, Lesaux & Siegel, 2003; Rodriquez, 2002; Zhang, 2001).

It was found that first and second generation students from immigrant families who have a working knowledge of English received higher grades in both mathematics and English than the students from non-immigrant families (Fuligni, 1997). Similarly, elementary school ESL students (grade 2) had a higher performance than native English speaking children on several achievement measures of reading, suggesting a positive effect of bilingualism on acquisition of some early reading skills (Lesaux & Siegel, 2003). Kao and Tienda (1995) found that Hispanic, black and Caucasian grade-eight students with immigrant parents had higher performance than native-born students when their grades and achievement test scores in mathematics and reading were analyzed. Children from Indochinese refugee families living in the United States had very high grade point averages in grades K to 12 (Caplan, Choy, & Whitemore, 1992). A positive effect of bilingualism was also found in a study of Vietnamese high school students in New Orleans, where students' literacy in Vietnamese was positively related to their academic achievement (Bankston, & Zhou, 1995). In addition, certain ethnic groups appear to have high mathematics achievement compared to other groups. For example, Asian-Canadian university students performed higher than students of non-Asian origin in simple arithmetic (Campbell & Xue, 2001), and Asian-American high-school students had higher mathematics scores than those of Caucasian-American students (Chen & Stevenson, 1995). However, the immigrant generational status appears to have an impact on performance of students of Asian origin. It was found that Asian-American students of the first or second generation have better academic achievement than those of third and later generations Zhang, 2001).

This research evidence suggests that ESL speaking students of immigrant backgrounds may perform well in school, and in some instances, even better than their native-born peers. It is important to consider various factors contributing to this phenomenon, including parental and community influences, immigrant generational status, and variability among immigrant groups.

Immigrant Parents

It is natural to assume that parents' behavior has a significant impact on children's school achievement. Students from immigrant families may perform as well or better than their native born counterparts at least partly because their families place a strong emphasis on school success. Many students from recent immigrant backgrounds come from families that greatly value academic achievement, and encourage school success in their children. This appears to be true for diverse immigrant populations, including parents from East Asia, Europe, Central America, the Philipines, the Caribbean, and India (Caplan, Choi, Whitmore, 1991;1992; Gibson, 1991; Fuligni, 1997, Waters, 1994).

Immigrant parents appear to be primarily concerned with the time their children devote to homework, imposing less household and work duties on them than native born parents require of their children (Kao & Tienda, 1995). Immigrant students often exhibit great academic motivation, study hard, and seek extra help (Caplan et al, 1991; Fulingni 1997; Waters, 1994). For example, adolescent students from immigrant families adjusted to school remarkably well, experienced great support in their education effort from their families and peers, and had strong motivation to succeed in school, whether they were immigrants from Asia, Europe, or Latin America (Fuligni, 1997). Fulingni (1997) concluded that, "whereas important variations do exist among these students, the adolescents from immigrant families seem to share their parent's belief that education is the most important route to their success in this country." It appears that the second generations of children from immigrant families (i.e., native-born children of foreign-born parents) are the ones who are most likely to strive academically, because they have good English skills, and their parents promote their achievement (Kao & Tienda, 1995). According to Kao and Tienda (1995), "immigrant status of parents rather than of children is key in determining educational outcomes." Differences in parental influence on children's school achievement between immigrant and native-born parents may at least partially explain why students from immigrant families often perform as well or even better than their native-born counterparts.

Present Research

This study was undertaken with a view to surveying some of the differences between children with English as a second language and those whose first language is English in their numeracy skills during the early years of their primary education. It was thought that, as the number of children of recent immigrant and ESL backgrounds is increasing in Canadian classrooms, such research will be of benefit in serving the needs of our school-aged population as it becomes ever more diverse.

The performance in arithmetic of ESL children from immigrant families and native English speaking children was compared. This research was intended to determine whether ESL speaking children develop their mathematical knowledge at a different rate than native English speaking students. This research may provide insight into the influence of ESL speaking children's linguistic and educational background on their early mathematical performance, and help to determine whether improving the English language skills of children with ESL would have an impact on their mathematical achievement.

Responses of ESL speaking and native-English speaking parents on a questionnaire investigating their attitudes towards mathematics, and their "mathematical home environment" were compared, in order to determine whether there is any difference between these recent immigrant parents and their Canadian born counterparts.

Method

Design

The present research is part of a longitudinal study investigating early numeracy skills in young children. The data have been collected over a number of years (Kindergarten to Grade 3). This study compares the numeracy skills of ESL children to those children whose native language is English. This study is based on a longitudinal investigation of the development of early numeracy skills in children from kindergarten through grade 3. Various measures of arithmetic, basic calculation skill, reading and memory were administered to both ESL and native-English speaking children. Children were tested individually, and in group settings. Trained graduate and undergraduate students administered the tests to all children.

In the third grade, parents of these children were asked to fill out a short questionnaire addressing their attitudes towards mathematics, the time which they devote to assisting their children with homework and the enrolment of their children in extra-curricular activities and tutoring. Parents who were identified by the school as being of a first generation immigrant background (parents who are themselves immigrants), were given an additional questionnaire addressing their language and cultural background.

Schools and SES

The study took place in five elementary schools in North Vancouver. The population in these schools was racially and ethnically diverse. This was especially true in three of the five schools, which were characterized by high immigrant population. Data from Statistics Canada's 1996 census gives some indication of the socio-economic status of households in the neighborhoods served by the five schools included in this study. The average household income in four of the five schools' neighborhoods falls in the "upper middle class" range, while the figure for the one remaining school's neighborhood falls just short of that mark. One must remember, though, that these are average figures and that the diverse populations of these neighborhoods may have incomes spread widely on either side of that figure. It also bears mentioning that housing costs in these neighborhoods tend to be well above Canadian averages.

Participants

Ninety seven families participated in the present study. Of 97 children, 32 had a primary language background other than English. Although all parents of the ESL children were first-generation immigrants, some children (25% of the ESL group) were Canadian born. The ESL children came from various language backgrounds. The largest language group was Persian speakers from Iran. Other languages included within the ESL sample were Cantonese, Mandarin, Japanese, Korean, Tagalog, Yugoslavian (Serbo-Croat), Chechen/Russian, Kurdish, Spanish, Estonian and Gujaradi.

The sample size changed throughout grades, as some children were missing during the testing, and some children came to these schools in later grades. The language distribution of the ESL sample is described in the Table 1.

Table 1

Language Distribution of the ESL Sample

Language	Number of students in each grade			
	Kindergarten	Grade 1	Grade 2	Grade 3
Persian	8	8	7	12
Cantonese	2	3	3	3
Mandarin	1	1	1	1
Japanese	3	3	3	4
Korean	1	1	1	1
Tagalog	2	2	2	4
Serbo-Croat	2	2	2	3
Chechen/Russian	0	0	0	1
Spanish	1	1	1	1
Estonian	1	1	1	1
Gujarati	0	0	1	1

In Kindergarten, there were 37 girls and 37 boys; in grade one, there were 38 girls and 37 boys; in grade two, there were 37 girls and 36 boys; and in grade three, the sample included 49 girls and 47 boys. The mean age was 70.32 (SD = 3.51) in the kindergarten sample, 82.92 (SD = 3.68) in grade one sample, 93.49 (SD = 4.30) in grade two sample, and 102.40 (SD = 3.70) in grade three sample. For the growth curve analysis, only data of children present in all four grades (K- Grade 3) were included. Within this sample there were 55 children, 19 were ESL and 36 native English speakers, 25 were girls and 30 boys.

Measures Used in Kindergarten

The following tests, from standardized and experimental measures, were administered in Kindergarten.

Numeracy.

1. Wide Range Achievement Test – 3 (WRAT3): Computational Arithmetic subtest (Wilkinson, 1993). This test requires children to count, perform basic calculations orally, and perform written calculations. It requires both oral and written responses.

2. Equivalence Concept Learning (Siegel, 1973). In this experimental task, the child is shown a picture of various geometric shapes randomly arranged on a page. The child is then shown a number of different sets, and must choose the one which has the same number of shapes as the item first presented.

3. Number Identification. In this experimental task, children are presented with a page of randomly arranged numbers ranging from 1 to 9, and are asked to identify all the numbers as fast as they can. This task is timed.

Visual-motor integration.

Beery-Buktenica Developmental Test of Visual Motor Integration (VMI) (Beery & Buktenica, 1989). The Berry-Buktenica Developmental Test of Visual-Motor Integration is an individually administered test. Children are required to copy various two-dimensional figures.

Memory.

1. Working Memory for Numbers (Siegel & Ryan, 1989). This experimental task is administered individually. A child is asked to count the number of yellow dots presented among blue dots on a 5 x 8 in. index card. There are sets of cards. In each set,

there are three trials, and the number of cards per set increases as the task progresses, starting with two cards and ending with five cards. For each trial, the child is asked to recall the number of yellow dots counted on each card in the order in which they were presented (e.g., recall numbers of yellow dots on two cards). If a child fails all the items of a given set, then the task is discontinued.

2. Wechsler Intelligence Scale for Children – III (WISC III): Digit Span subtest (Wechsler, 1991). It requires a child to repeat a sequence of numbers that an examiner reads aloud. It has two parts: repetition of numbers forward (sequences of numbers ranging in length from 2 to 9 numbers) and repetition of numbers backward (sequences ranging in length from 2 to 8).

Literacy.

1. SATZ Recognition-Discrimination (Satz & Fletcher, 1982). In this task, children are presented with a picture of a pattern and then are asked to identify the same pattern among others.

2. Letter Identification. In this experimental task, children are presented with a page on which 26 letters are randomly arranged, and are asked to identify as many as they can.

3. Phoneme Deletion. (Muter, Hulme & Snowling, 1997). Children are shown a picture representing word (e.g. bus) and then are asked to delete an initial or final phoneme from the word. For example, an examiner would say, "Bus without 'b' says _?" The correct response would be "us".

Measures Used in Grades 1 to 3

The following tests, from standardized and experimental measures, were administered in Grades 1 to 3.

Numeracy.

1. Wide Range Achievement Test – 3 (WRAT3): Computational Arithmetic subtest (Wilkinson, 1993). This test requires children to count, perform basic calculations orally, and perform written calculations. It requires both oral and written responses.

2. Woodcock-Johnson III Achievement (WJ-III ACH): Quantitative Concepts subtest (Woodcock, McGrew, Mather, 2001). In this individually administered measure, a child is asked to identify various math terms, number patterns, and formulae (e.g., "Point to the largest duck"; or, "What number belongs in this series: 12 _ 16 18)?"

3. Woodcock-Johnson III Achievement (WJ-III ACH): Calculation subtest (Woodcock, McGrew, Mather, 2001). This measure was administered in a group setting and it is timed. It requires a child to perform various mathematical calculations, ranging from simple addition to more complex equations (e.g., "2 + 4 = _ " or "3x + 3y = 15") (Mather & Jaffe, 2002). The Calculation subtest is a normed measure of computational skills.

4. Woodcock-Johnson III Achievement (WJ-III ACH): Applied Problems subtest (Woodcock, McGrew, Mather, 2001): In this task, a child is asked to analyze and solve orally-presented mathematical problems (e.g., Bill had $7.00. He bought a ball for $3.95 and a comb for $1.20. How much money did he have left?), which may be repeated if needed (Mather & Jaffe, 2002).

5. Woodcock-Johnson III Achievement (WJ-III ACH): Block Rotation subtest (Research Edition): (Woodcock, McGrew, Mather, 2001). In this task, a child is presented with a picture of a three-dimensional pattern of blocks followed by five sets of similar block patterns. Two of the five are identical to the target pattern but rotated. The child must then choose which two sets of blocks are rotated versions of the target pattern. This task requires the child to be able to mentally manipulate three-dimensional objects.

6. Woodcock-Johnson III Achievement (WJ-III ACH): Math Fluency subtest (Woodcock, McGrew, Mather, 2001). In this task, children are required to rapidly calculate simple (single digit) subtraction, multiplication and addition problems (e.g., 3 + 4) (Mather & Jaffe, 2002). This test was administered only in grades two and three.

Memory.

1. Wechsler Intelligence Scale for Children – III (WISC-III): Digit Span subtest (Wechsler, 1991). This task is a measure of short-term sequential auditory memory and attention. It requires a child to repeat a sequence of numbers that an examiner reads aloud. It has two parts: repetition of numbers forward (sequences of numbers ranging in length from 2 to 9 numbers) and repetition of numbers backward (sequences ranging in length from 2 to 8).

2. Working Memory for Numbers (Siegel & Ryan, 1989). This experimental task is administered individually. A child is asked to count the number of yellow dots presented among blue dots on a 5 x 8 in. index card. There are sets of cards. In each set, there are three trials, and the number of cards per set increases as the task progresses, starting with two cards and ending with five cards. For each trial, the child is asked to recall the number of yellow dots counted on each card in the order in which they were

presented (e.g., recall numbers of yellow dots on two cards). If a child fails all the items of a given set, then the task is discontinued.

3. Rapid Automatized Naming (RAN): This task is individually administered. The child is presented with the numbers 1 to 9 randomly placed on the page. The child is asked to name the numbers as fast as possible (the exact counting time is recorded). This task measures the efficiency of lexical retrieval.

Literacy.

1. Woodcock-Johnson III Achievement (WJ-III ACH): Word Attack subtest (Woodcock, McGrew, Mather, 2001): In this individually administered test, a child is asked to read orally non-words that conform English spelling rules (e.g. flib, bungic). It is a good measure of decoding skills.

2. Woodcock-Johnson III Achievement (WJ-III ACH): Letter-Word Identification subtest (Research Edition) (Woodcock, McGrew, Mather, 2001). An individually administered measure, in which a child identifies and pronounces isolated letters and words (g, r, cat, palm). It is a good measure of basic decoding skills.

3. Wide Range Achievement Test – 3 (WRAT3): Spelling subtest (Wilkinson, 1993). This task was administered in a group setting. Children were asked to spell orally-presented words.

4. Stanford Diagnostic Reading Test (SDRT): Reading Comprehension subtest (Karlsen & Gardnes, 1994). This test was administered in a group setting, and it was administered only to grades two and three. In this test, children are required to read short passages, and then answer multiple-choice questions targeting various forms of comprehension. There is a time limit on this test.

Parents' Questionnaire

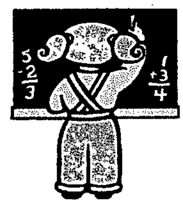
In grade 3, the parents of participating children were given a questionnaire in order to determine their children's involvement in extra-curricular activities, and the parents' attitude toward mathematical achievement. The questionnaire was designed by the authors of this study. The questionnaire was short (it took about 15 minutes to fill out) and parents were given the option of being interviewed instead of filling out the questionnaire. The purpose of this questionnaire/interview was to help researchers to better understand the relationships among the mathematical skills of children, their language backgrounds, and the attitudes of their parents towards mathematics and mathematics education. Special attention was given to immigrant families to determine the past and present language environment at home. The questionnaires are presented in Figures 1 and 2 below.

Of 97 parents, 85 filled out the questionnaire at home, 9 were interviewed, and three parents filled out the questionnaire only partially, and were interviewed on the remaining questions. For majority parents who have English as a second language, the questionnaire was given in their native language. The questionnaire was translated to Persian, Russian, Polish, Serbo-Croatian, Mandarin/Cantonese, Japanese, Korean, and Tagalog. The questions were predominantly answered by the children's mothers (87% of the time); however, in some instances fathers, grandparents, or both parents filled out the questionnaire.

Figure 1

Numeracy Questionnaire

The Development of Numeracy Skills
Parent Questionnaire



Your name:
Name of your child:
Your relationship to your child (e.g., mother, father):

1. Do you think that mathematics is an important subject at school? **(circle one)**
   Extremely Important 1 2 3 4 5 Not Important
2. Do you think that your child will need mathematical knowledge when she or he is an adult? (YES or NO)
3. Has your child ever had any tutoring or instruction in math outside of the classroom?(YES or NO)
4. If yes, please describe this tutoring or instruction.
5. Is your child enrolled in any extra-curricula activities? (YES or NO)
6. If yes, please describe these activities.
7. Does your child play games with the family (e.g., Monopoly, family games)? (YES or NO)
8. If yes, please describe these games.
9. Do you help your child with school assignments? (YES or NO)
10. Do you enjoy mathematics? (YES or NO)

Figure 2

Language Background Questionnaire

Your and Your Child's Language Background

1. What is your first language?
2. How long have you been in Canada?
3. Was your child born in Canada? (YES or NO)
4. Does anybody in your home have English as a first language? (YES or NO)
5. How much is your child exposed to a language other than English at home?
   (Not at all Moderately Extensively)
6. Does your child sometimes play with non-English speaking children? (YES or NO)
7. Does your child regularly participate in extra-curricula activities where English is not the language of instruction? (YES or NO)
8. If yes, please describe these activities.
9. Is mathematics an important subject in your country of origin? (YES or NO)
10. Is mathematics a popular subject in your country of origin? (YES or NO)
11. What language does your child speak with family members?

Mother__________ Father __________
Siblings __________ Grandparents __________
Aunts, Uncles __________ Cousins __________

12. When you do homework with your child, what language do you use?

Results

Performance of the Children

The results are presented in tables on the following pages. In order to answer the research question of whether there is a significant difference between the performance of the ESL/immigrant group and the native English speaking group, t-test analyses were used to test for differences between the two language groups in each measure. The results of this analysis of variance revealed almost no significant difference between the performance of the two language groups on any of the measures throughout the four grades.

Kindergarten.

Table 2

Kindergarten Performance of ESL and Native English Speaking Children

Measure	English (n = 53)		ESL (n = 21)			
	Mean	SD	Mean	SD	T-test	*p*
WRAT 3: Computational Arithmetic (percentile)	64.25	28.41	56.38	30.18	1.05	*ns*
Number Identification (raw score)	9.87	0.59	9.86	0.48	0.10	*ns*
SATZ Recognition-Discrimination (raw score)	12.51	2.29	12.33	2.96	0.28	*ns*
Equivalence Concept Learning (raw score)	10.47	2.44	10.14	0.66	0.61	*ns*
Beery-Buktenica Developmental Test of VMI (percentile)	57.68	30.05	66.43	29.72	1.13	*ns*
Working Memory for Numbers (raw score)	4.08	2.46	2.95	2.73	1.71	*ns*
WISC III: Digit Span Subtest (scaled score)	10.19	2.72	9.33	2.56	1.24	*ns*
WISC III: Digit Span Subtest Forward (raw score)	6.87	1.83	6.43	1.40	0.99	*ns*
WISC III: Digit Span Subtest Backward (raw score)	2.81	1.13	2.48	1.26	1.12	*ns*
Letter Identification (raw score)	8.3	6.05	6.71	5.93	0.60	*ns*
Phoneme Deletion (total score)	24.26	2.21	23.90	2.61	1.02	*ns*

Note. English = English as a first language (non-immigrant background); ESL = English as a second language (immigrant background)

Table 2 summarizes the overall performance of the ESL/immigrant group and the native English speaking group in Kindergarten. There were no significant differences between the two language groups on the WRAT 3: Computational Arithmetic subtest, $t(72) = 1.05$, *ns*, the Number Identification test $t(72) = 0.10$, *ns*, the SATZ Recognition-

Discrimination test $t(72) = 0.28$, *ns*, the Equivalence Concept Learning test, $t(72) = 0.61$, *ns*, the Beery-Buktenica Developmental Test of Visual Motor Integration, $t(72) = 1.13$, *ns*, the Working Memory for Numbers test , $t(72) = 1.71$, *ns*, the Digit Span Forward subtest, $t(72) = 0.99$, *ns*, the Digit Span Backward subtest , $t(72) = 1.12$, *ns*, the Letter Identification subtest , $t(72) = 0.60$, *ns, and* the Phoneme Deletion subtest , $t(72) = 1.02$, *ns*. The overall conclusion for Kindergarten performance is that the two language groups do not differ on any of the numeracy, memory or literacy measures.

Grade 1.

Table 3

Grade 1 Performance of ESL and Native English Speaking Children

Measure	English (n = 51)		ESL (n = 24)			
	Mean	SD	Mean	SD	T-test	*p*
WRAT 3: Computational Arithmetic (percentile)	56.98	28.98	59.17	27.76	0.32	*ns*
WJ-III Quantitative Concepts (percentile)	63.75	25.90	63.46	25.97	0.00	*ns*
WJ-III Calculation (percentile)	63.14	22.11	70.21	23.40	1.27	*ns*
WJ-III Applied Problems (percentile)	59.39	32.03	62.79	24.98	0.46	*ns*
WJ-III Block Rotation (percentile)	58.20	30.77	69.04	30.89	1.42	*ns*
Rapid Automatized Naming (time in seconds)	15.35	3.29	14.54	3.38	0.99	*ns*
Working Memory for Numbers (raw score)	4.00	2.21	4.92	2.18	1.68	*ns*
WISC III: Digit Span Subtest (scaled score)	11.08	2.70	11.50	3.51	0.57	*ns*
WISC III: Digit Span Subtest Forward (raw score)	7.61	1.77	7.38	12.37	0.48	*ns*
WISC III: Digit Span Subtest Backward (raw score)	3.29	1.17	3.92	1.41	2.00	<.*05*
WJ-III Word Attack (percentile)	81.10	16.24	82.29	19.31	0.28	*ns*
WJ-III Letter Word Identification (percentile)	75.18	23.78	84.50	15.05	1.76	*ns*
WRAT 3: Spelling (percentile)	70.50	22.97	66.48	22.31	0.70	*ns*

Note. English = English as a first language (non-immigrant background); ESL = English as a second language (immigrant background)

T-test analyses of Grade 1 numeracy and memory measures demonstrated no significant differences between the two language groups on the WRAT 3: Computational Arithmetic subtest, $t(73) = 0.32$, *ns*, the WJ-III Quantitative Concepts subtest, $t(73) =$

0.00, *ns*, the WJ-III Calculation subtest , $t(73) = 1.27$, *ns*, the WJ-III Applied Problems subtest, $t(73) = 0.46$, *ns*, the WJ-III Block Rotation subtest, $t(73) = 1.42$, *ns*, the Rapid Automatized Naming test, $t(73) = 0.99$, *ns*, the Working Memory for Numbers test, $t(73) = 1.68$, *ns*, the Digit Span Forward subtest, $t(73) = 0.48$, *ns*, the WJ-III Word Attack subtest, $t(73) = 0.28$, *ns*, the WJ-III Letter Identification subtest, $t(73) = 1.76$, *ns* and the WRAT 3: Spelling subtest, $t(73) = 0.70$, *ns*. As a group, the ESL children performed significantly better than native English speaking children on the Digit Span Backward subtest, $t(73) = 2.00$, $p < .05$. For results, see Table 3.

Grade 2.

Table 4

Grade 2 Performance of ESL and Native English Speaking Children

Measure	English (n = 50)		ESL (n = 23)			
	Mean	SD	Mean	SD	T-test	*p*
WRAT 3: Computational Arithmetic (percentile)	63.75	22.64	65.91	21.61	0.20	*ns*
WJ-III Quantitative Concepts (percentile)	66.28	28.37	66.09	23.58	0.00	*ns*
WJ-III Calculation (percentile)	69.42	25.86	66.10	24.79	0.48	*ns*
WJ-III Applied Problems (percentile)	65.74	31.02	68.13	28.95	0.32	*ns*
WJ-III Block Rotation (percentile)	54.72	35.29	53.70	32.27	0.10	*ns*
WJ-III Math Fluency (percentile)	58.15	23.62	63.70	26.38	0.89	*ns*
Rapid Automatized Naming (time in seconds)	12.62	3.36	12.22	3.28	0.48	*ns*
Working Memory for Numbers (raw score)	5.04	2.22	5.17	2.33	0.10	*ns*
WISC III: Digit Span Subtest (scaled score)	11.84	3.11	11.87	2.70	0.00	*ns*
WISC III: Digit Span Subtest Forward (raw score)	8.80	2.04	8.57	2.13	0.45	*ns*
WISC III: Digit Span Subtest Backward (raw score)	3.82	1.27	4.00	1.45	0.54	*ns*
WJ-III Word Attack (percentile)	75.26	19.77	73.17	19.96	0.41	*ns*
WJ-III Letter Word Identification (percentile)	72.44	24.35	76.26	19.25	0.66	*ns*
WRAT 3: Spelling (percentile)	67.40	22.90	68.09	20.85	0.45	*ns*
SDRT: Diagnostic Reading Comprehension (percentile)	51.23	26.87	53.48	24.67	0.35	*ns*

Note. English = English as a first language (non-immigrant background); ESL = English as a second language (immigrant background);

The results of the t-test analyses of Grade 2 measures are summarized in Table 4 above. No significant differences were observed between the two language groups on the WRAT 3: Computational Arithmetic subtest, $t(71) = 0.20$, *ns*, the WJ-III Quantitative Concepts subtest, $t(71) = 0.00$, *ns*, the WJ-III Calculation subtest , $t(71) = 0.48$, *ns*, the WJ-III Applied Problems subtest, $t(71) = 0.01$, *ns*, the WJ-III Block Rotation subtest, $t(71) = 0.00$, *ns*, the WJ-III Math Fluency, $t(71) = 0.89$, *ns*, the Rapid Automatized Naming test, $t(71) = 0.48$, *ns*, the Working Memory for Numbers test, $t(71) = 0.10$, *ns*, the Digit Span Forward subtest, $t(71) = 0.45$, *ns*, the Digit Span Backward subtest, $t(71) = 0.54$, *ns*, the WJ-III Word Attack subtest, $t(71) = 0.41$, *ns*, the WJ-III Letter Identification subtest, $t(71) = 0.66$, *ns*, the WRAT 3: Spelling subtest, $t(71) = 0.45$, *ns*, and the SDRT: Diagnostic Reading Comprehension subtest, $t(71) = 0.35$. The overall conclusion for grade 2 performance is that the two language groups do not differ on any of the numeracy, literacy or memory measures.

Grade 3.

Table 5

Grade 3 Performance of ESL and Native English Speaking Children

Measure	English (n = 64)		ESL (n = 32)			
	Mean	SD	Mean	SD	T-test	*p*
WRAT 3: Computational Arithmetic (percentile)	45.61	23.56	52.09	25.50	1.24	*ns*
WJ-III Quantitative Concepts (percentile)	57.53	24.65	63.59	22.46	1.17	*ns*
WJ-III Calculation (percentile)	52.84	25.33	56.56	21.86	0.70	*ns*
WJ-III Applied Problems (percentile)	66.80	29.04	65.38	30.83	0.22	*ns*
WJ-III Block Rotation (percentile)	65.89	29.97	63.75	34.50	0.32	*ns*
WJ-III Math Fluency (percentile)	45.00	28.35	53.84	27.65	1.45	*ns*
Rapid Automatized Naming (time in seconds)	11.64	2.67	11.72	3.02	0.14	*ns*
Working Memory for Numbers (raw score)	5.42	2.11	5.88	2.38	0.95	*ns*
WISC III: Digit Span Subtest (scaled score)	10.86	3.12	10.66	2.65	0.31	*ns*
WISC III: Digit Span Subtest Forward (raw score)	8.42	1.88	8.19	1.80	0.58	*ns*
WISC III: Digit Span Subtest Backward (raw score)	3.97	1.53	4.00	1.48	0.10	*ns*
WJ-III Word Attack (percentile)	67.34	20.02	65.66	19.92	0.39	*ns*
WJ-III Letter Word Identification (percentile)	64.98	24.99	65.25	19.70	0.00	*ns*
WRAT 3: Spelling (percentile)	58.94	26.43	65.41	22.93	1.18	*ns*
SDRT: Diagnostic Reading Comprehension (percentile)	43.38	24.79	45.06	27.05	0.30	*ns*

Note. English = English as a first language (non-immigrant background); ESL = English as a second language (immigrant background)

Table 5 summarizes the performance of the two language groups on the grade 3 tasks. There were no significant differences between the two language groups on the

WRAT 3: Computational Arithmetic subtest, $t(94) = 1.24$, *ns*, the WJ-III Quantitative Concepts subtest, $t(94) = 1.17$, *ns*, the WJ-III Calculation subtest, $t(94) = 0.70$, *ns*, the WJ-III Applied Problems subtest, $t(94) = 0.22$, *ns*, the WJ-III Block Rotation subtest, $t(94) = 0.32$, *ns*, the WJ-III Math Fluency, $t(94) = 1.45$, *ns*, the Rapid Automatized Naming test, $t(94) = 0.14$, *ns*, the Working Memory for Numbers test, $t(94) = 0.95$, *ns*, the Digit Span Forward subtest, $t(94) = 0.58$, *ns*, the Digit Span Backward subtest, $t(94) = 0.10$, *n* the WJ-III Word Attack subtest, $t(94) = 0.39$, *ns*, the WJ-III Letter Identification subtest, $t(94) = 0.00$, *ns*, the WRAT 3: Spelling subtest, $t(94) = 1.18$, *ns*, and the SDRT: Diagnostic Reading Comprehension subtest, $t(94) = 0.30$. In grade 3, the performance of the ESL speaking children did not significantly differ from the performance of the native English speaking children.

Developmental curve.

Children who were present for testing in all four grades were included in the sample for the developmental curve analysis of selected measures. Of 55 children, 19 were ESL and 36 native English speakers. There were 25 girls and 30 boys within this sample. Growth curves of the WRAT 3: Computational Arithmetic subtest, the WJ-III Quantitative Concepts subtest, the WJ-III Calculation subtest, the WJ-III Applied Problems subtest, the WJ-III Block Rotation subtest, and the Working Memory for Numbers test were created. The growth curve graphical representations of the two language groups' performances across grades on these measures showed very similar patterns of performance in both language groups. See Figures 3 to 10 below.

Figure 3

Mean Raw Scores of WRAT 3: Computational Arithmetic Subtest

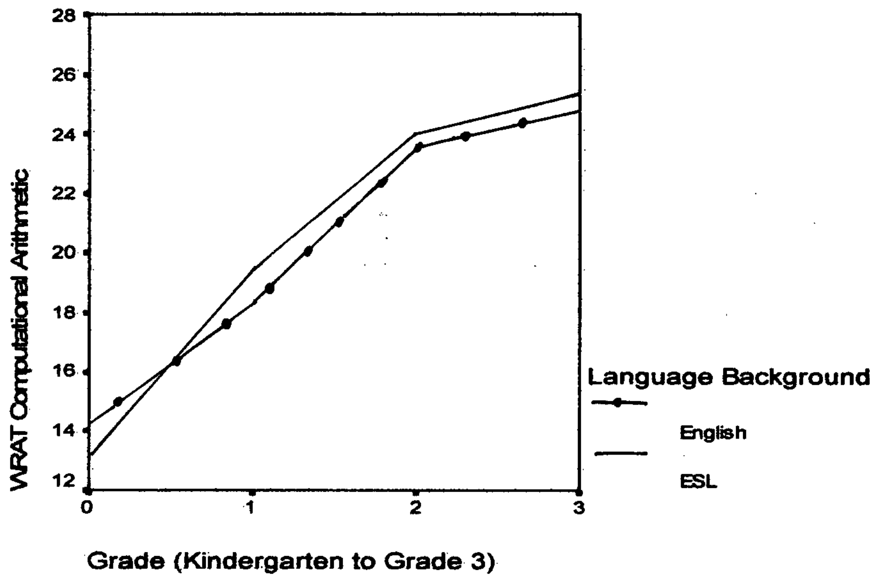


Figure 4

Mean Raw Scores of the WJ-III Applied Problems Subtest

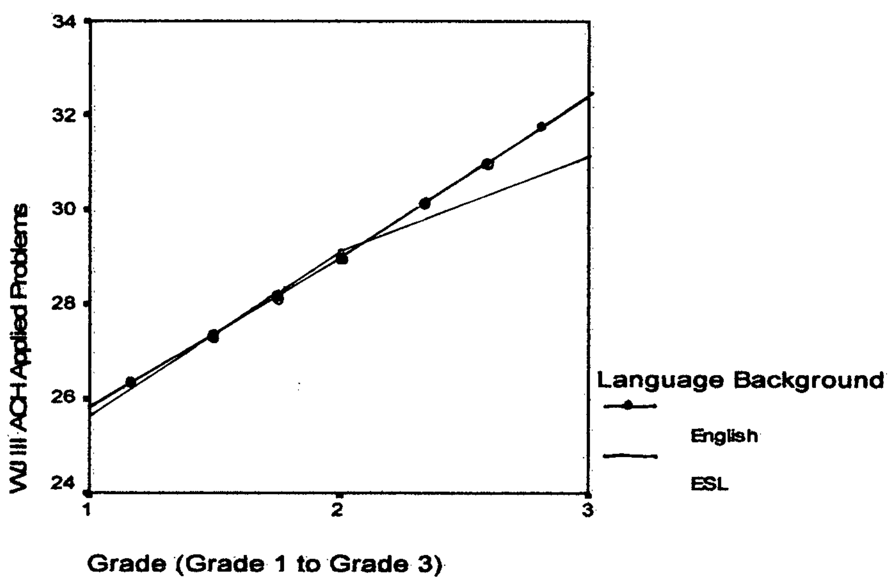


Figure 5

Mean Raw Scores of WJ-III Quantitative Concepts: Number Series subtest

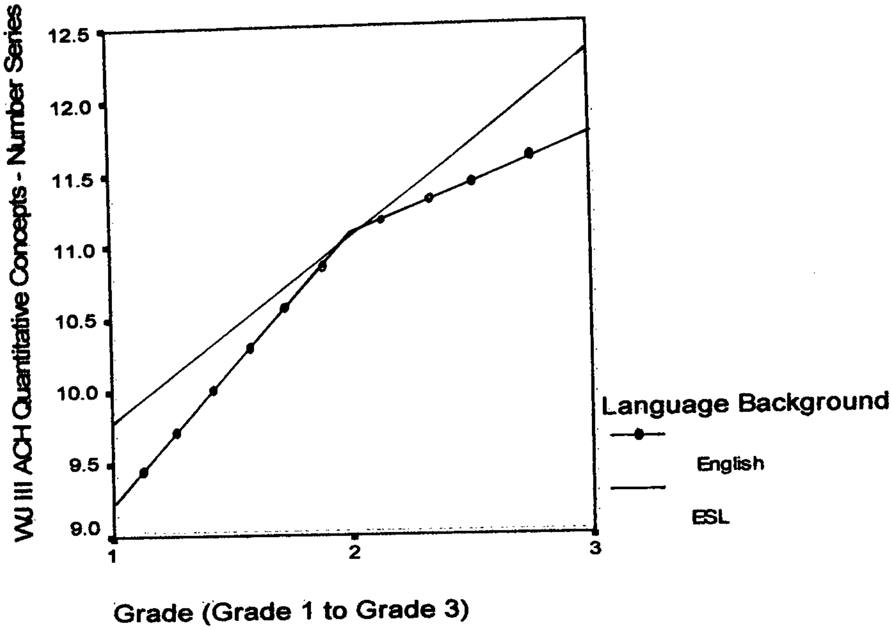


Figure 6

Mean Raw Scores of WJ-III Quantitative Concepts: Concepts

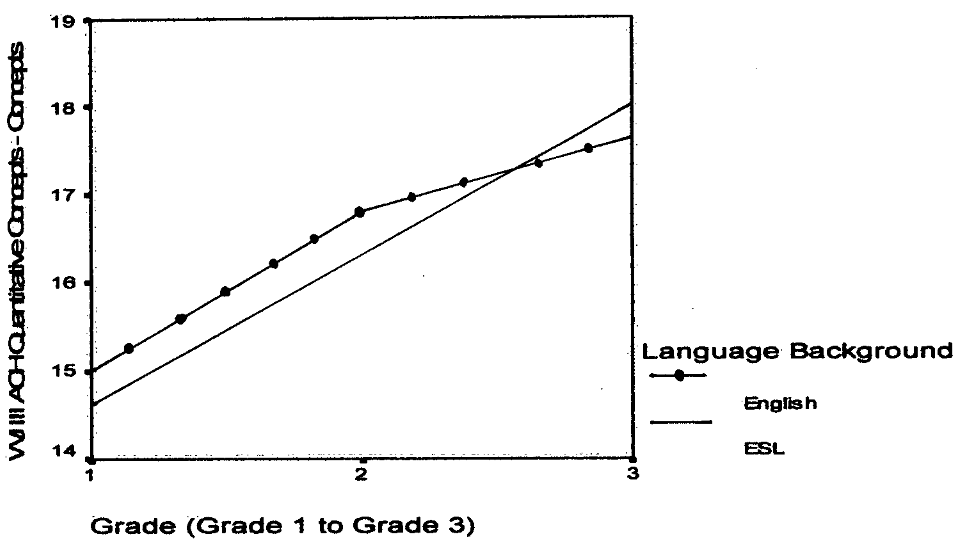


Figure 7

Mean Raw Scores of WJ-III Calculation Subtest

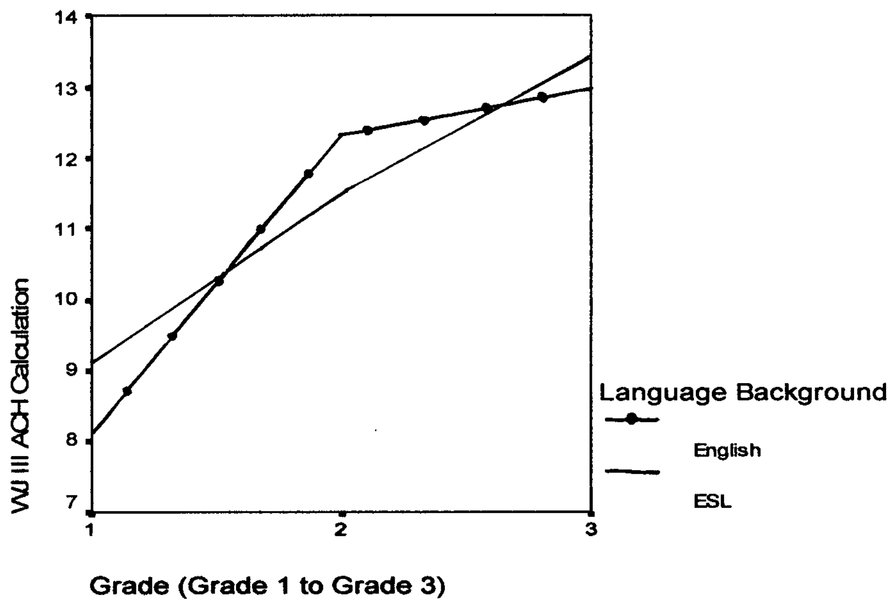


Figure 8

Mean Score of the Working Memory for Numbers Test

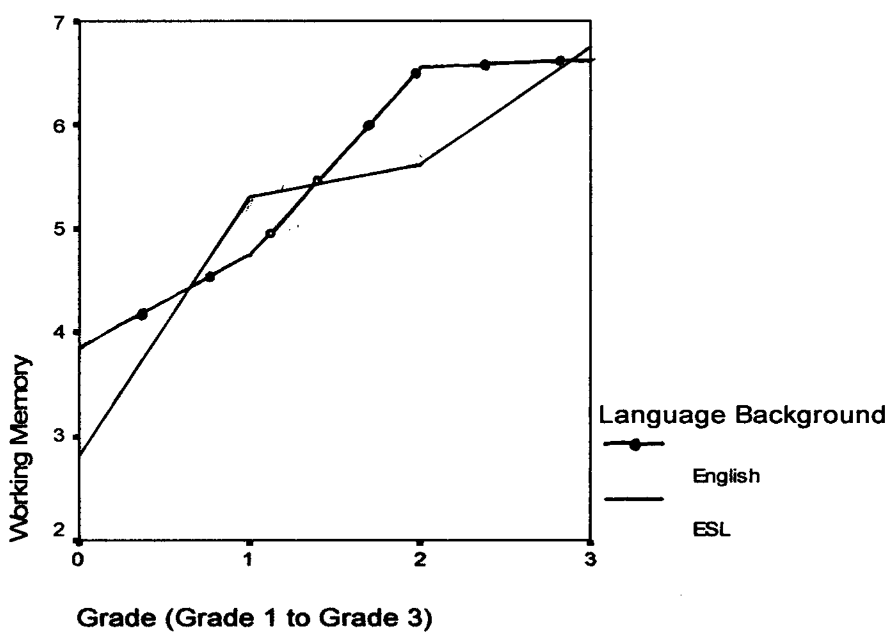


Figure 9

Mean Raw Scores of the WISC III. Digit Span - Forward Test

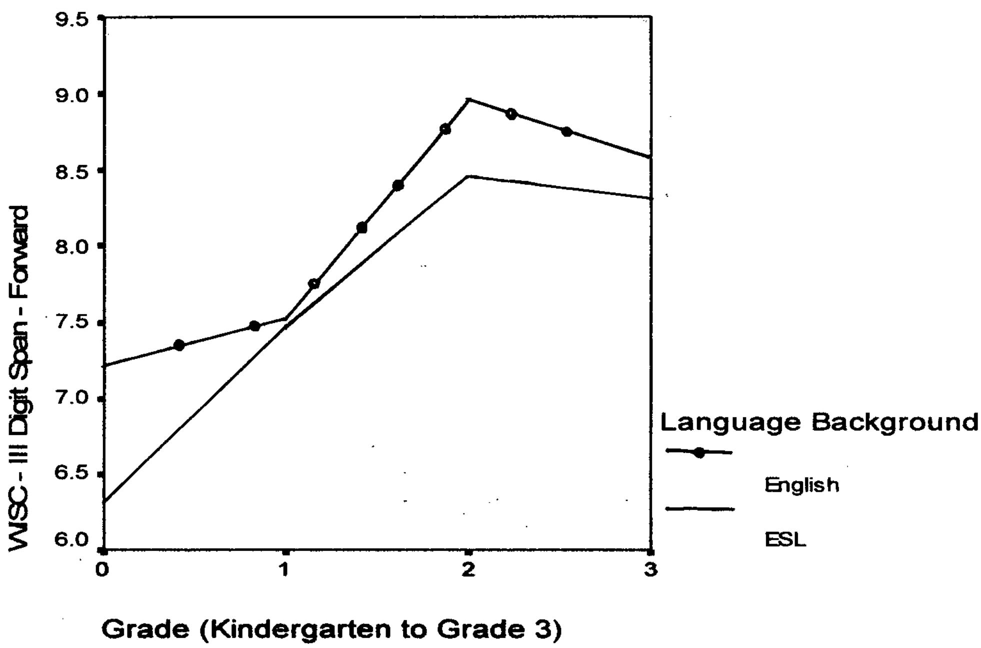
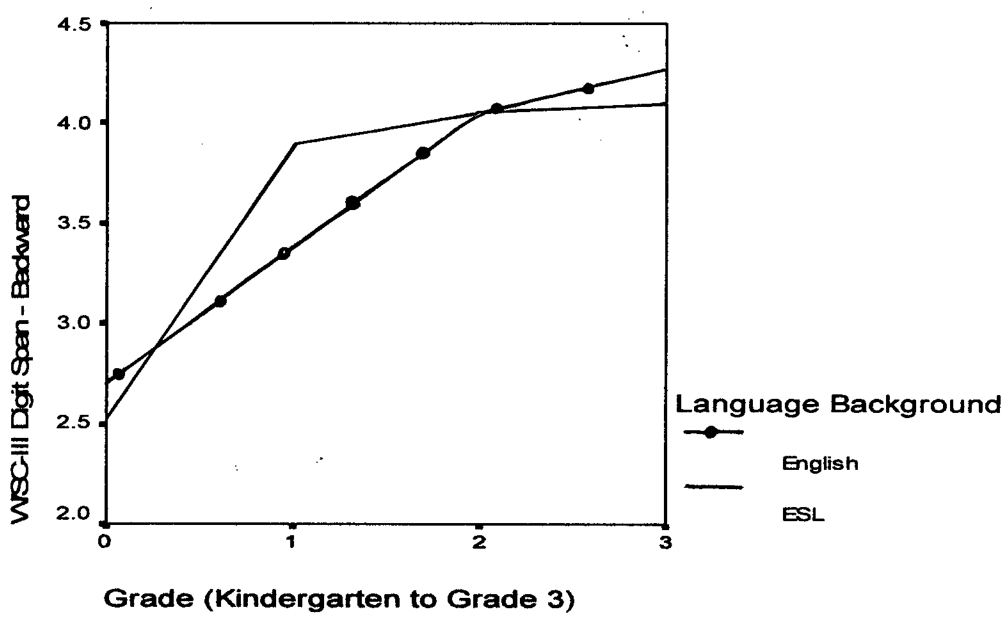


Figure 10

Mean Raw Scores of the WISC III. Digit Span - Backward Test



Correlation among kindergarten and grade 3 measures.

A Pearson-Product Moment Correlation Coefficient was used to calculate the relationship between Kindergarten and Grade three measures. Only children who were present for testing in all four grades were included in analysis (n=55). Where possible, percentiles were used. Some strong positive correlations were found between measures administered in Kindergarten and Grade three. In tables 6 to 8 below, the correlations between the measures administered in Kindergarten and grade 3 within the same area (e.g., numeracy to numeracy, literacy to literacy) are presented. In addition, table 6 shows correlations between the memory measures administered in Kindergarten and the numeracy measures administered in grade 3. All statistically significant correlations between Kindergarten and grade 3 measures are listed below the correlation tables.

Table 6

The Intercorrelation Among Numeracy and Memory Measures Administered in Kindergarten and Grade 3 (Pearson-Product moment Correlation Coefficients)

Kindergarten Measures	Grade 3 Measures						
	WRAT 3: Computational Arithmetic (percentile)	WJ-III Quantitative Concepts (percentile)	WJ-III Calculation (percentile)	WJ-III Applied Problems (percentile)	WJ-III Block Rotation (percentile)	WJ-III Math Fluency (percentile)	Rapid Automatized Naming (time in seconds)
WRAT 3: Computational Arithmetic (percentile)	0.620*	0.581*	0.521*	0.703*	0.312†	0.446*	-0.070
Number Identification (raw score)	0.148	0.184	0.260	0.218	0.132	0.265	-0.029
SATZ Recognition-Discrimination (raw score)	0.148	0.248	0.260	0.272†	0.360*	0.222	-0.103
Equivalence Concept Learning (raw score)	-0.094	-0.275†	-0.218	-0.209	0.100	-0.262	0.170
Beery-Buktenica Developmental Test of VMI (percentile)	0.477*	0.418*	0.496*	0.341†	0.221	0.346*	-0.116
Working Memory for Numbers (raw score)	0.022	0.130	0.176	0.231	0.205	0.172	-0.160
WISC III: Digit Span Subtest (scaled score)	0.146	0.172	0.206	0.426*	0.127	0.236	-0.117
WISC III: Digit Span Subtest Forward (raw score)	0.119	0.085	0.153	0.329†	0.037	0.153	-0.044
WISC III: Digit Span Subtest Backward (raw score)	0.175	0.215	0.223	0.410*	0.263	0.299†	-0.273†

* Correlation is significant at the 0.01 level (2-tailed)

† Correlation is significant at the 0.05 level (2-tailed)

Table 7

The Intercorrelation Among Memory Measures Administered in Kindergarten and Grade 3 (Pearson-Product moment Correlation Coefficients)

Kindergarten Measures	Grade Three Measures			
	Working Memory for Numbers (raw score)	WISC III: Digit Span Subtest (scaled score)	WISC III: Digit Span Subtest Forward (raw score)	WISC III: Digit Span Subtest Backward (raw score)
Working Memory for Numbers (raw score)	0.211	0.278†	0.241	0.230
WISC III: Digit Span Subtest (scaled score)	0.257	0.517*	0.436*	0.308†
WISC III: Digit Span Subtest Forward (raw score)	0.148	0.416*	0.361*	0.221
WISC III: Digit Span Subtest Backward (raw score)	0.342†	0.472*	0.401*	0.334†

* Correlation is significant at the 0.01 level (2-tailed)

† Correlation is significant at the 0.05 level (2-tailed)

Table 8

The Intercorrelation Among Literacy Measures Administered in Kindergarten and Grade 3 (Pearson-Product moment Correlation Coefficients)

Kindergarten Measures	Grade 3 Measures			
	WJ-III Word Attack (percentile)	WJ-III Letter Word Identification (percentile)	WRAT 3: Spelling (percentile)	SDRT: Diagnostic Reading Comprehension (percentile)
Letter Identification (raw score)	0.249	0.254	0.186	0.379*
Phoneme Deletion (total score)	0.464*	0.389*	0.333†	0.293†

* Correlation is significant at the 0.01 level (2-tailed)

† Correlation is significant at the 0.05 level (2-tailed)

Of all the measures administered in Kindergarten, the largest number of significant correlations was between the WRAT 3: Computational Arithmetic subtest and grade three measures. The WRAT 3: Computational Arithmetic subtest administered in Kindergarten was strongly positively correlated with following grade 3 subtests: WRAT 3: Computational Arithmetic subtest, $r(55) = 0.62, p<.01$, the WJ-III Quantitative Concepts subtest, $r(55) = 0.58, p<.01$, the WJ-III Calculation subtest, $r(55) = 0.52$, $p<.01$, the WJ-III Applied Problems subtest, $r(55) = 0.70, p<.01$, the WJ-III Block Rotation subtest, $r(55) = 0.31, p<.01$, the WJ-III Math Fluency, $r(55) = 0.45, p<.01$, the WISC III Digit Span scaled subtest, $r(55) = 0.32, p<.05$, the WJ-III Word Attack subtest, $r(55) = 0.45, p<.01$, the WJ-III Letter Identification subtest, $r(55) = 0.52, p<.01$, the WRAT 3: Spelling subtest, $r(55) = 0.50, p<.01$ and the SDRT: Diagnostic Reading Comprehension subtest, $r(55) = 0.34, p<.05$.

The Number Identification test administered in Kindergarten was significantly positively correlated with the grade 3 WISC III Digit Span Backward subtest, $r(55) = 0.33$, $p<.05$. The Kindergarten SATZ Recognition-Discrimination test was significantly positively correlated with these grade 3 tests: the WJ-III Applied Problems subtest, $r(55) = 0.27$, $p<.05$, the WJ-III Block Rotation subtest, $r(55) = 0.36$, $p<.01$, the WJ-III Letter Identification subtest, $r(55) = 0.33$, $p<.05$, and the SDRT: Diagnostic Reading Comprehension subtest, $r(55) = 0.36$, $p<.01$.The Kindergarten Equivalence Concept Learning test was significantly negatively correlated with the grade 3 WJ-III Quantitative Concepts subtest, $r(55) = -0.28$, $p<.05$. The Kindergarten Beery-Buktenica Developmental Test of Visual Motor Integration was significantly positively correlated with the grade 3 WJ-III Quantitative Concepts subtest, $r(55) = 0.42$, $p<.01$, the WJ-III Applied Problems subtest, $r(55) = 0.34$, $p<.01$, the WJ-III Math Fluency, $r(55) = 0.35$, $p<.01$, WRAT 3: Computational Arithmetic subtest, $r(55) = 0.48$, $p<.01$, the WJ-III Calculation subtest, $r(55) = 0.50$, $p<.01$, the WJ-III Letter Identification subtest, $r(55) = 0.39$, $p<.01$, the WRAT 3: Spelling subtest, $r(55) = 0.42$, $p<.01$, and the WJ-III Word Attack subtest, $r(55) = 0.41$, $p<.01$.

The Kindergarten Working Memory for Numbers test was significantly positively correlated with the grade 3 WISC III Digit Span scaled subtest, $r(55) = 0.28$, $p<.05$, and the SDRT: Diagnostic Reading Comprehension subtest, $r(55) = 0.37$, $p<.01$. The Kindergarten Digit Span Forward subtest was significantly positively correlated with the grade 3 WISC III Digit Span scaled subtest, $r(55) = 0.42$, $p<.01$, the Digit Span Forward subtest, $r(55) = 0.36$, $p<.01$, the WJ-III Applied Problems subtest, $r(55) = 0.33$, $p<.05$, the WRAT 3: Spelling subtest, $r(55) = 0.28$, $p<.05$, and the SDRT: Diagnostic Reading

Comprehension subtest, $r(55) = 0.35$, $p<.01$. The Kindergarten Digit Span Backward subtest was significantly positively correlated with the grade 3 WISC III Digit Span scaled subtest, $r(55) = 0.47$, $p<.01$, the Digit Span Forward subtest, $r(55) = 0.40$, $p<.01$, the Digit Span Backward subtest, $r(55) = 0.33$, $p<.05$, the WJ-III Applied Problems subtest, $r(55) = 0.41$, $p<.05$, the Working Memory for Numbers test, $r(55) = 0.34$, $p<.05$, and the SDRT: Diagnostic Reading Comprehension subtest, $r(55) = 0.36$, $p<.01$, and it was negatively related to the Rapid Automatized Naming test, $r(55) = -0.27$, $p<.05$. The Kindergarten Digit Span scaled subtest was significantly positively correlated with the grade 3 WISC III Digit Span scaled subtest, $r(55) = 0.52$, $p<.01$, the Digit Span Forward subtest, $r(55) = 0.44$, $p<.01$, the Digit Span Backward subtest, $r(55) = 0.31$, $p<.05$, the WJ-III Applied Problems subtest, $r(55) = 0.43$, $p<.01$, the WJ-III Letter Identification subtest, $r(55) = 0.29$, $p<.05$, the WRAT 3: Spelling subtest, $r(55) = 0.31$, $p<.05$, and the SDRT: Diagnostic Reading Comprehension subtest, $r(55) = 0.42$, $p<.01$.

A positive significant correlation was found between the Kindergarten Letter Identification subtest, and the grade 3 WISC III Digit Span scaled subtest, $r(55) = 0.28$, $p<.05$,, the Digit Span Backward subtest, $r(55) = 0.29$, $p<.05$, and the SDRT: Diagnostic Reading Comprehension subtest, $r(55) = 0.38$, $p<.01$. A significant positive correlation was also found between the Kindergarten Phoneme Deletion subtest and the grade 3 WISC III Digit Span scaled subtest, $r(55) = 0.53$, $p<.01$, the Digit Span Forward subtest, $r(55) = 0.40$, $p<.01$, the Digit Span Backward subtest, $r(55) = 0.38$, $p<.01$, the WJ-III Applied Problems subtest, $r(55) = 0.42$, $p<.01$, the WJ-III Math Fluency, $r(55) = 0.32$, $p<.05$, the WJ-III Letter Identification subtest, $r(55) = 0.39$, $p<.01$, the WRAT 3:

Spelling subtest, $r(55) = 0.33, p<.05$, the WJ-III Word Attack subtest, $r(55) = 0.46$, $p<.01$, and the SDRT: Diagnostic Reading Comprehension subtest, $r(55) = 0.30, p<.05$.

Overall results suggest that there is a strong positive relationship between many Kindergarten and grade 3 measures. Children who performed higher in Kindergarten tended to perform higher in grade 3, and this appears to be true for numeracy, literacy and memory measures.

Summary of children's performance results.

A t-test analysis demonstrated that there are no significant differences on any of the numeracy, literacy and memory measures from Kindergarten to Grade 3 between children who are native English speakers and children with ESL. The only exception was the Digit Span Backward test in grade 1, on which ESL children performed significantly higher than native English speaking children. The developmental curve analysis did not reveal a significantly different rate of learning between children who are native English speakers and children with ESL. When the Pearson Correlation Coefficient was used to calculate for the relationship between Kindergarten and grade 3 measures, many positive correlations were found, suggesting that Kindergarten performance is predictive of performance in grade 3.

Numeracy Questionnaire

Table 9
Parent Questionnaire Responses: Mathematics

Questions	"Yes" Responses		Significance Between Language Status and Response
	English (n = 65)	ESL (n = 32)	
Do you think that your child will need mathematical knowledge when she or he is an adult?	100% (65)	100% (32)	*ns*
Has your child ever had any tutoring or instruction in math outside of the classroom?	23% (15)	59% (19)	<.*01*
Is your child enrolled in any extra-curricula activities?	78% (51)	56% (18)	<.*05*
Does your child play games with the family (e.g., Monopoly, family games)? *	92% (60)	91% (29)	*ns*
Do you help your child with school assignments?	95% (62)	94% (30)	*ns*
Do you enjoy mathematics?	75% (49)	78% (25)	*ns*

Note. English = English as a first language (non-immigrant background); ESL = English as a second language (immigrant background)
* Only games involving mathematical thinking (e.g., numbers, logical reasoning, counting, memory for numbers) were counted. Examples of these games are Monopoly, Crazy Eights, Snakes and Ladders, Scrabble.

Table 9 summarizes results of the cross-tabulation analysis of the association between language status (recent immigrant ESL parent versus Canadian born native English speaking parents) and the individual responses on the numeracy questionnaire.

In the cross-tabulation analysis, it was demonstrated that a significantly higher proportion of ESL/immigrant parents than Canadian born /native English speaking parents indicated that their children have tutoring or instruction in math outside the classroom. Immigrant parents described this tutoring as being done at home and mostly by them. They indicated that they practice math skills with their children by using various workbooks, playing mathematical games, and by trying to demonstrate the real-life implications of mathematics. Some immigrant parents stated that mathematical school instructions in their home country differ from the Canadian school curriculum, and that they try to expose their children to mathematics from their home country. For example, one mother staying home with her children, who immigrated to Canada ten years ago from Iran where she worked in management, and who is now married to a machinist also from Iran, said: “In Iran, mathematics in grade 3 are more advanced, Iranian children have more practice, such as games with numbers on playgrounds. In Iran, learning was not fun but hard work. It was taken very seriously.” Another mother, who came to Canada from India, and is presently staying home with children, while her husband works as an accountant, commented: “I play many mathematical games with my children, so that they are more prepared for high school. In India, we were exposed to algebra and geometry much earlier than children are here. I buy various books and games to develop my children’s mathematical skills. I am concerned about the quality of mathematics instruction in Canada. It’s too easy, and there is too much use of calculators.”

The question about extra-curricular activities was asked to determine if children were enrolled in any after-school activities involving mathematics. No child was enrolled in after-school mathematical activities. However, a significantly higher proportion of Canadian born parents than immigrant parents indicated that their children are enrolled in extra-curricular activities such as sports (e.g., soccer, swimming, gymnastics, hockey), drama and music lessons (e.g., piano, trumpet). Interestingly, one parent of Chinese immigrant background added a note to the questionnaire saying that she has two reasons for own tutoring of her daughter, and for not enrolling her daughter in extra-curricular activities: “I can teach her a lot myself and save money.”

A majority of both immigrant and Canadian born parents said that they help their children with school assignments, that they think that mathematics is an extremely important subject at school, that they enjoy mathematics themselves, and that their children play games involving mathematical thinking (e.g., Monopoly, card games, Scrabble, Snakes and Ladders, Bingo, Checkers) with the family. All parents agreed that their children will need mathematical knowledge when they are adults.

Parents' responses and children's performance.

In order to determine if there is a difference in the mathematical performance of children whose parents responded differently (answered yes or no) on the questionnaire, t-test analyses were conducted. Only one question ("Has your child ever had any tutoring or instruction in math outside of the classroom?" was selected for this analysis. The questions "Do you think that your child will need mathematical knowledge when she or he is an adult?", "Do you help your child with school assignments?", "Does your child play games with the family (e.g., Monopoly, family games)?", and "Do you enjoy mathematics?" could not be analyzed, due to insufficient sample size of the group responding "no" (on these questions either all or a majority of parents responded "yes"). The question "Is your child enrolled in any extra-curricular activities?" was asked to determine if children are enrolled in after-school activities involving mathematics; it was found that only one child was enrolled in mathematical activities; thus, the purpose of relating mathematical performance to this question was lost.

When the mathematical performance of children whose parents responded "yes" was compared to performance of children whose parents responded "no" to the question, "Has your child ever had any tutoring or instruction in math outside of the classroom?" it was found that, on some measures, children of parents responding "yes" performed better than children of parents responding "no".

Table 10

Kindergarten Performance of Children Whose Parents Responded "Yes" or "No" on the question "Has your child ever had any tutoring or instruction in math outside of the classroom?"

	No (n =48)		Yes (n = 26)			
Measure	Mean	SD	Mean	SD	T-test	*p*
WRAT 3: Computational Arithmetic (standard score)	105.67	14.98	110.19	17.48	1.17	*ns*
Number Identification (raw score)	9.83	0.63	9.92	0.39	0.66	*ns*
SATZ Recognition-Discrimination	12.23	2.82	12.88	1.61	1.09	*ns*
Equivalence Concept Learning	10.44	2.41	10.27	1.38	0.33	*ns*
Beery-Buktenica Developmental Test of VMI	11.21	2.16	11.46	2.40	0.65	*ns*
Working Memory for Numbers	3.69	2.44	3.88	2.85	0.31	*ns*
WISC III: Digit Span Subtest Forward	6.90	1.93	6.46	1.24	1.04	*ns*
WISC III: Digit Span Subtest Backward	2.75	1.12	2.65	1.26	0.34	*ns*

In Kindergarten, there were no significant differences between the two groups on the WRAT 3: Computational Arithmetic subtest, $t(72) = 1.17$, *ns*, the Number Identification test $t(72) = 0.66$, *ns*, the SATZ Recognition-Discrimination test $t(72) = 1.09$, *ns*, the Equivalence Concept Learning test, $t(72) = 0.33$, *ns*, the Beery-Buktenica Developmental Test of Visual Motor Integration, $t(72) = 0.65$, *ns*, the Working Memory for Numbers test , $t(72) = 0.31$, *ns*, the Digit Span Forward subtest, $t(72) = 1.04$, *ns*, and the Digit Span Backward subtest , $t(72) = 0.34$, *ns*. The overall conclusion for Kindergarten performance is that the two groups do not differ on any of the measures.

Table 11

Grade 1 Performance of Children Whose Parents Responded "Yes" or "No" on the question "Has your child ever had any tutoring or instruction in math outside of the classroom?"

	No (n =48)		Yes (n = 26)			
Measure	Mean	SD	Mean	SD	T-test	*p*
WRAT 3: Computational Arithmetic (standard score)	102.23	13.20	109.46	17.00	2.03	<*.05*
WJ-III Quantitative Concepts (standard score)	105.44	12.27	111.73	14.88	2.00	*ns*
WJ-III Calculation (standard score)	105.17	11.73	112.27	15.56	2.21	<*.05*
WJ-III Applied Problems (standard score)	104.31	16.67	114.27	19.38	2.36	<*.05*
WJ-III Block Rotation (standard score)	106.10	18.61	112.46	23.03	1.29	*ns*
Rapid Automatized Naming (time in seconds)	15.63	3.21	14.31	3.30	1.67	*ns*
Working Memory for Numbers	4.15	2.31	4.50	2.12	0.65	*ns*
WISC III: Digit Span Subtest Forward	7.56	2.17	7.38	1.53	2.00	*ns*
WISC III: Digit Span Subtest Backward	3.27	1.27	3.88	1.24	2.00	<*.05*

As you can see in Table 11 above, t-test analyses of Grade 1 numeracy measures demonstrated significant differences between the two groups on the WRAT 3: Computational Arithmetic subtest, $t(72) = 2.03, p<.05$, the WJ-III Calculation subtest , $t(72) = 2.21$, $p<.05$, the WJ-III Applied Problems subtest, $t(72) = 2.36, p<.05$, and the

Digit Span Backward subtest, $t(72) = 2.00$, $p < .05$. There was no difference between groups on the WJ-III Quantitative Concepts subtest, $t(72) = 2.00$, *ns*, the WJ-III Block Rotation subtest, $t(72) = 1.29$ *ns*, the Rapid Automatized Naming test, $t(72) = 1.67$, *ns*, the Working Memory for Numbers test, $t(72) = 0.65$, *ns*, and the Digit Span Forward subtest, $t(72) = 2.00$, *ns*.

Table 12

Grade 2 Performance of Children Whose Parents Responded "Yes" or "No" on the question "Has your child ever had any tutoring or instruction in math outside of the classroom?"

	No (n =45)		Yes (n = 27)			
Measure	Mean	SD	Mean	SD	T-test	*p*
WRAT 3: Computational Arithmetic (standard score)	107.00	11.92	108.44	11.68	0.50	*ns*
WJ-III Quantitative Concepts (standard score)	106.29	14.34	112.96	11.34	2.19	*<.05*
WJ-III Calculation (standard score)	111.12	13.95	108.26	14.79	0.77	*ns*
WJ-III Applied Problems (standard score)	108.24	17.12	114.26	17.85	1.42	*ns*
WJ-III Block Rotation (standard score)	100.24	28.27	102.96	24.91	0.41	*ns*
WJ-III Math Fluency (standard score)	103.81	12.54	107.00	13.85	0.20	*ns*
Rapid Automatized Naming (time in seconds)	12.69	3.48	12.37	3.00	0.40	*ns*
Working Memory for Numbers	4.76	2.16	5.44	2.19	1.31	*ns*
WISC III: Digit Span Subtest Forward	8.96	2.03	8.30	2.09	1.32	*ns*
WISC III: Digit Span Subtest Backward	3.64	1.17	4.26	1.50	1.93	*ns*

Table 12 shows comparison between the two groups in Grade 2. As a group, the children whose parents answered "yes" performed significantly better on the WJ-III Quantitative Concepts subtest than children whose parents answered "no", $t(70) = 2.19$, *ns*, $p<.05$. There was not significant differences between the two groups on the WRAT 3: Computational Arithmetic subtest, $t(70) = 0.50$, *ns*, the WJ-III Calculation subtest , $t(70) = 0.77$, *ns*, the WJ-III Applied Problems subtest, $t(70) = 1.42$, *ns,* and the Digit Span Backward subtest, $t(70) = 1.93$, *ns,* the Digit Span Forward subtest, $t(70) = 1.32$, *ns*, the WJ-III Block Rotation subtest, $t(70) = 0.41$ *ns*, the Rapid Automatized Naming test, $t(70) = 0.40$, *ns*, and the Working Memory for Numbers test, $t(70) = 1.31$, *ns*.

Table 13

Grade 3 Performance of Children Whose Parents Responded "Yes" or "No" on the question "Has your child ever had any tutoring or instruction in math outside of the classroom?"

Measure	No (n =62) Mean	No (n =62) SD	Yes (n = 33) Mean	Yes (n = 33) SD	T-test	*p*
WRAT 3: Computational Arithmetic (standard score)	97.63	9.80	102.76	15.09	1.77	*ns*
WJ-III Quantitative Concepts (standard score)	102.27	11.07	110.21	12.40	3.19	<*.05*
WJ-III Calculation (standard score)	100.40	9.61	104.76	12.87	1.86	*ns*
WJ-III Applied Problems (standard score)	108.13	15.94	111.48	18.12	0.93	*ns*
WJ-III Block Rotation (standard score)	108.68	17.79	108.61	20.45	0.02	*ns*
WJ-III Math Fluency (standard score)	97.55	14.90	102.55	15.75	1.53	*ns*
Rapid Automatized Naming (time in seconds)	11.53	2.57	12.00	3.14	0.78	*ns*
Working Memory for Numbers	5.39	2.08	5.76	2.27	0.80	*ns*
WISC III: Digit Span Subtest Forward	8.40	1.80	8.12	1.90	0.72	*ns*
WISC III: Digit Span Subtest Backward	3.84	1.50	4.21	1.54	1.15	*ns*

Table 13 shows comparison between the two groups in Grade 3. As a group, the children whose parents answered "yes" performed significantly better on the WJ-III Quantitative Concepts subtest than children whose parents answered "no", $t(93) = 3.19$, *ns*, $p<.05$. There was no significant difference between the two groups on the WRAT 3: Computational Arithmetic subtest, $t(93) = 1.77$, *ns*, the WJ-III Calculation subtest , $t(93) = 1.86$, *ns*, the WJ-III Applied Problems subtest, $t(93) = 0.93$, *ns,* and the Digit Span

Backward subtest, $t(93) = 1.15$, *ns,* the Digit Span Forward subtest, $t(93) = 0.72$, *ns*, the WJ-III Block Rotation subtest, $t(93) = 0.02$ *ns*, the Rapid Automatized Naming test, $t(93) = 0.78$, *ns*, and the Working Memory for Numbers test, $t(93) = 0.80$, *ns*.

Overall, children whose parents answered "yes" on the question "Has your child ever had any tutoring or instruction in math outside of the classroom?" performed significantly better on some measures, especially in grade, 1 than children whose parents answered "no" on this question.

Language Background Questionnaire

Table 14

ESL/Immigrant Parent Questionnaire Responses

	Percent (number) responding			
Questions	Yes	Moderately	Extensively	N
Was your child born in Canada?	25% (7)	-	-	28
Does anybody in your home have English as a first language?	11% (3)	-	-	28
Does your child sometimes play with non-English speaking children?	78% (22)	-	-	28
Does your child regularly participate in extra-curricula activities where English is not the language of instruction?	35% (10)	-	-	29
Is mathematics an important subject in your country of origin?	100% (29)	-	-	29
Is mathematics a popular subject in your country of origin?	93% (27)	-	-	29
How much is your child exposed to a language other than English at home?	-	57% (16)	43% (12)	28

Of 32 parents, 28 parents answered the questionnaire about their language background (3 parents with immigrant background did not fill out the language background part of the questionnaire, and one parent filled out only some of the questions). The frequency results of the ESL the Language Background questionnaire are summarized in Table 14 above.

A Pearson-Product Moment Correlation Coefficient was used to calculate the relationship between the number of years immigrant parents have been in Canada and their children's performance. There was a significant positive correlation between the number of years parents have been in Canada and their children's performance on the Working Memory test in Kindergarten, $r(18) = 0.50, p<.01$, on the WJ III ACH Word Attack subtest in grade three, $r(27) = 0.40, p<.05$, and on the SDRT Reading Comprehension subtest in grade three, $r(27) = 0.51, p<.01$.

The majority (75 %) of ESL children within the sample was born outside of Canada, all were exposed extensively to moderately to their mother tongue at home. A majority of family members of ESL children had English as a second language themselves. Two parents indicated that they try use English with their children as much as possible, so they consider English to be their children's first language. One child had a mother who was an immigrant from China, and a father who was learning Mandarin, but his first language was English. According to this survey, most ESL children played with non-English speaking children. Only 35% of immigrant parents indicated that their children participate in extra-curricular activities where English is not the language of instruction (e.g., Russian, Chinese schools, Persian lessons). All immigrant parents indicated that mathematics is an important subject in their country of origin, and the majority (93%) of them also said that mathematics is a popular subject in their home country.

During interviews, some parents realized that their children are becoming more fluent in English than in their native tongue (e.g., "My son doesn't have a complete vocabulary of Farsi words in his mind and can't understand me very well, but whenever I feel that he can understand Farsi, then I am speaking Farsi"), and some accepted the fact that their children are becoming Canadian (e.g., "Language comes with culture. My daughter is more Canadian than Iranian. We try to raise a good human. That's our main goal, not to raise an Iranian or a Canadian").

Discussion/Conclusions

Performance of the Children

A tacit assumption that often underlies educators' approaches to learning difficulties among students with English as a second language is that the student's proficiency – or lack thereof – in English, and their different educational or cultural background is at the root of any learning difficulties they may encounter, no matter what the subject area. Of course, this is not an unreasonable assumption. Language skills and educational opportunities are critically important for all facets of learning, including mathematics. One might, therefore, assume that students with a first language other than English, coming from different country, struggling with mathematics, were most likely being impeded by their limitations in the language of instruction or by their limited exposure to certain mathematical curricula.

The task of this study was to test that assumption. The most significant feature of the results of this study is that there does *not* appear to be any significant difference between the two language groups (ESL versus native English speakers) on any of the indicators of numeracy analyzed, at any grade level. In addition, both groups appeared to have been developing their mathematical knowledge at similar rates across grades. There was a significant positive relationship between many kindergarten and grade 3 measures, suggesting that children who did well in Kindergarten also performed well in Grade 3. From all the measures, there was only one significant negative correlation: the Kindergarten Concept Learning test was significantly negatively correlated with the WJ III Quantitative Concept subtest. Although this relationship is negative, it is not likely that the faculties tested in these two tests would be inversely related; rather, this relationship is more likely the result of statistical factors associated with our sample. This study is, of course, too limited in scope to serve as the basis for any sweeping prescription for approaching numeracy deficits among ESL students; however, it does at least suggest grounds to question what may be a pervasive – and misleading – assumption.

As noted in the introductory section, there is considerable variability in the ESL group as a whole, not just in terms of various language and cultural backgrounds, but also in terms of English proficiency. The bilingualism of ESL students or their exposure to multiple languages may give them an advantage in general learning. Thus, their ESL status changes from a disadvantage to an advantage. Findings of a number of studies suggest that students' exposure to languages other than English at home is positively correlated with good academic achievement (Caplan, Chen, & Whitmore, 1991; 1992; Fuligni, 1997; Kao, & Tienda, 1995, Lesaux & Siegel, 2003; Rodriquez, 2002; Zhang, 2001). For example, a statistical profile of New York City elementary and middle schools revealed that English proficient students coming from homes where languages other than English are used, performed better not only than ESL students who have limited English proficiency, but they also performed better than native English speaking children (Stiefel, Schwartz, Ellen, & Conger, 2003).

All our ESL children had first-generation immigrant parents, and were exposed to non-English languages at their homes. About 25% of the children within our ESL sample were Canadian born. The fact that all ESL children within our sample came to Canada at a relatively young age or were born here may have an impact on their performance. Children within our sample were exposed to the Canadian school system relatively early, which may decrease the negative impact of their language and background status on their academic achievement. In West Germany, when the relationship between attendance and seventh-grade school placement was examined, it was found that there is a significant relationship between kindergarten attendance and later school placement, but only for children in immigrant households, not for children of German born citizens. Immigrant children who attended German kindergarten were later more likely to be placed into a higher educational level of school (Spiess, Buchel, & Wagner, 2003). Similarly, it was found that the age of immigrant children on arrival affects their school achievement in American schools and their subsequent wages. In certain cases, the immigrants who arrived at younger ages were more successful at school, and as a consequence, were more likely to earn higher wages (Gonzales, 2003).

The main finding of the present study is that ESL speaking children coming from immigrant families were performing on various numeracy and memory measures as well as native-born, native-English speaking children. A significant number of studies found evidence that ESL children from immigrant families perform well at school (Caplan, Chen, & Whitmore, 1991; 1992; Fuligni, 1997; Kao, & Tienda, 1995, Lesaux & Siegel, 2003; Zhang, 2001). If we are to understand the relationship between language and immigrant status and school achievement, the interplay of various factors needs to be considered, including English proficiency, the age upon arrival, family background and parental influences. There is considerable variability within the immigrant population; thus, the performance of various ethnic and cultural groups should be examined in order to be able to generalize the results.

Parent Questionnaire

A brief survey was administered to parents whose children's numeracy skills were examined. It was hoped that the questionnaire might offer some insight into the respective performances of the ESL and non-ESL subgroups on the tests of numeracy skills. Parental responses did not vary much between the two subgroups in most of the questions; however, there were a few notable contrasts.

First, parents of ESL students were significantly less likely to enroll their children in extra-curricular activities, including sports activities. It may be that the extra-curricular activities typical of Canadian public schools are less appealing to people of immigrant backgrounds because they are not the sort of activities with which they would be familiar from their own cultural background. Also, immigrant parents may come from cultures which are not familiar with the concept of extra-curricular activities at all. In some societies, children are expected to entertain themselves on their own, or extensively participate in the adult world. Children of recent immigrants are more likely to be from low-income families than native-born children, and this appears to be a true even for families where parents have more than a high school education, where parents work full-time, and for children living in two-parent families (Elmelech, McCaskie, Lennon, & Lu, 2002). This may also explain why immigrant parents tend to enroll their children in less extra-curricular activities, which are often expensive.

Also, it was noted that parents of ESL students were significantly more likely to tutor their children in academic subjects at home. Immigrant families naturally are concerned that their children not suffer any disadvantage in their education arising out of language deficits, cultural difference, discrimination, and other factors associated with immigrant/ESL backgrounds. This may explain the greater tendency to tutor among these parents. Also, in conversation with the author, many parents who received their education in other countries expressed distrust of Canadian schools, remarking that Canadian schools exercised lax discipline, and had lower academic expectations of students than did schools in their home countries. Parents of immigrant/ESL backgrounds frequently commented that they wanted their children to enjoy some of the benefits of the schooling typical in their country of origin, things that they thought might be lacking in the Canadian system.

There seems to be a relationship between parents with low-income and minority status, and their value of education. Parents with lower incomes greatly value their children's education, because they are aware that good education is a route to social and economic success (Delgato-Gaitan, 1992; Scott-Jones, 1995). Black and Hispanic mothers and children appeared to be putting greater emphasis on education, and showing more concerns about education than white families did (Stevenson, Chen, &Uttal, 1990). Also, it has been shown that low-income parents consider it very important to help their children with academic work (Drummond, & Stipek, 2004). The possible influence of socio-economic status on parental behavior and school attitudes in immigrant families should be examined in further studies.

It is difficult to say with certainty what influence this greater investment of time by immigrant parents in their children's early education might have; but one cannot help but think that it would be of benefit. This idea was supported when the performance of children whose parents answered "yes" on the question, "Has your child had any tutoring or instruction of math outside the classroom?" was compared to children whose parents responded "no" to this question. Children of those parents who indicated that their children received or are receiving tutoring in math outside of the classroom performed significantly higher on some measures than children whose parents said that their children never received any instruction of math outside of the classroom. Moreover, children who received after-school tutoring tended to perform slightly higher on majority of remaining measures from Kindergarten to grade 3. The largest number of differences between the two groups was found in grade one, where children who received tutoring were able to perform simple mathematical computations better than children without tutoring (WJ III Calculation subtest, and WRAT 3 Computational Arithmetic subtest), they showed better ability to recall numbers ordered backward (WISC III Digit Span Backward subtest), and better ability to analyze and to solve practical mathematical problems (WJ III Applied Problems subtest). In grades two and three, the tutoring appeared to have an influence on the ability to apply mathematical concepts, and on understanding numerical relationships (the WJ III Quantitative Concepts subtest).

Interestingly, many of the parents who indicated that they tutor their children reported that that they practice real-life applications of mathematical concepts with their children. Given the similarity of numeracy skills between the two subgroups, it makes one wonder whether or not this intervention by parents of immigrant backgrounds is not having precisely the desired effect: that is, compensating for some very real disadvantages faced by children of immigrant/ESL backgrounds in their early education.

The questionnaire used for this study was designed as a brief screener rather than a reliable measure. It provided some interesting insights into possible factors influencing mathematical achievement. However, in order to reliably determine the students' exposure to mathematics at home and attitudes of their parents towards mathematics, more detailed measures with better psychometrics would be needed. Also, factors such as parental income and education, and family dynamics were not investigated in this study. In the further research, these factors should be taken into consideration. These factors limit the degree to which the results may be generalized. The fact that the majority of questionnaires was filled out by mothers could also bias our results.

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