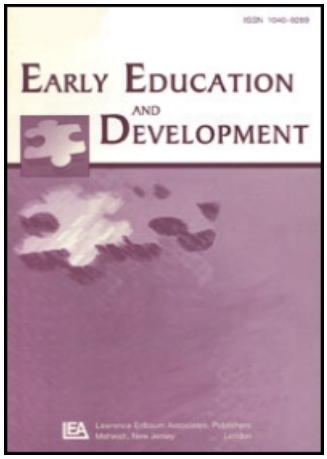

Early Education & Development
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t775653644

Predicting Early School Achievement With the EDI: A Longitudinal Population-Based Study

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Online Publication Date: 11 October 2007
To cite this Article: Forget-Dubois, Nadine, Lemelin, Jean-Pascal, Boivin, Michel, Dionne, Ginette, Séguin, Jean R., Vitaro, Frank and Tremblay, Richard E. (2007) 'Predicting Early School Achievement With the EDI: A Longitudinal Population-Based Study', Early Education & Development, 18:3, 405 - 426
To link to this article: DOI: 10.1080/10409280701610796
URL: http://dx.doi.org/10.1080/10409280701610796

EARLY EDUCATION AND DEVELOPMENT, *18*(3), 405–426

Predicting Early School Achievement With the EDI: A Longitudinal Population-Based Study

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School readiness tests are significant predictors of early school achievement. Measuring school readiness on a large scale would be necessary for the implementation of intervention programs at the community level. However, assessment of school readiness is costly and time consuming. This study assesses the predictive value of a school readiness measure, the Early Development Instrument (EDI), which relies on kindergarten teachers' ratings of children's well-being and social, emotional, and cognitive development. We also compared the predictive value of the EDI with that of a direct school readiness test and a battery of cognitive tests. Data were collected when the children were in kindergarten and a year later, as part of Quebec's Longitudinal Study of Child Development. We found that that the EDI alone explained 36% of the variance in school achievement. The complete battery of measures explained

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50% of the variance in early school achievement. Two of the EDI domains (Physical Health and Well-Being and Language and Cognitive Development) contributed uniquely to the prediction of school achievement over and above the cognitive assessments and direct school readiness test. The social and emotional domains of the EDI were at best marginal predictors of school achievement. In spite of this limitation, we conclude that the EDI predicts early school achievement as accurately as measures that take more time and resources to administer.

School readiness can be defined as a multidimensional construct that refers to cognitive, communicational, behavioral, and emotional skills, as well as basic knowledge that facilitate the child's learning and adjustment at school entry. However, school readiness is not restricted to a set of child cognitive, emotional, and behavioral child characteristics. Rather, current views of early development and education emphasize a more general, transactional, and process-oriented conception of school readiness as the product of the interaction between child skills, support provided by the family environment, and the resources from the community (La Paro & Pianta, 2000; Meisels, 1999; Snow, 2006). This general view is not uniformly shared by the research community but rather comes in different shades of theoretical assumptions. Some scholars define school readiness as a bidirectional construct embracing children's characteristics and schools' capacity to meet children's needs, whereas others, quite in line with a social constructivist approach, further emphasize the need to define school readiness as a function of the community's expectations (Meisels, 1999). Indeed, the lay definition of school readiness may vary as a function of one's role in child learning and development. For instance, parents seem to emphasize cognitive aspects of school readiness, whereas teachers stress the importance of the child's health, as well as his or her ability to self-regulate, follow directions, and behave appropriately in the classroom (Blair, 2002; Graue, 2006).

Although the notion of school readiness is still open to debate, there is some consensus on its multidimensional and developmental nature. It follows that any putative measure of the construct should explicitly reflect these aspects and provide valid information with respect to relevant developmental outcomes, including early school achievement and adjustment. In other words, the validity of these instruments should be based on their multidimensional capacity to predict later school achievement and adjustment. However, the measures used tend to be restricted in scope and do not take into account the larger social context in which the children grow.

Specific instruments must be developed to accommodate both the need to provide a valid multidimensional assessment of school readiness at the child level and the need to consider the larger context of the school district or community. The Early Development Instrument (EDI; Janus & Offord, 2007) was developed for that purpose. Contrary to many other school readiness measures that must be ad-

ministered by trained professionals, the EDI relies on kindergarten teachers' knowledge of the children in their classroom to assess the physical, social, behavioral and cognitive dimensions of their school readiness. A relatively quick assessment by teachers can provide an evaluation of school readiness for all children in a classroom. These data can be aggregated and interpreted at the community level, thus providing community-level indicators of child development outcomes.

The goal of the present study was to examine the predictive validity of the EDI with respect to early school achievement in a large longitudinal study of children. In so doing, we were also interested in comparing the predictive validity of the EDI to that of an extensive battery of measures of school readiness and cognitive development.

Measuring School Readiness

School readiness is a multidimensional construct that includes cognitive, behavioral, and emotional aspects of development, as well as basic knowledge relevant to school-based learning (Janus & Offord, 2007). The concept of school readiness includes the child's aptitude to learn as well as to perform in the classroom; children are expected to master various pre-academic notions like knowing their colors, letters, numbers, and so on, but are also expected to be able to regulate their behavior and emotions, to communicate competently, and to comply with simple instructions (Blair, 2002). However, much of the developmental research on school readiness has focused on the predictive validity of preschool cognitive abilities regarding later school achievement. This body of research has shown that preschool children's cognitive skills can forecast their early school achievement. For example, a review of 70 studies by La Paro and Pianta showed that preschool cognitive assessments, such as IQ tests, language development inventories, and pre-academic knowledge assessments (e.g., color and number knowledge) predict early school achievement with a moderate mean effect size ($r = .49$). Comparatively, the effect size of preschool social/behavioral indicators in predicting later school-based social/behavioral adjustment was smaller ($r = .27$; La Paro & Pianta, 2000).

Earlier instruments were initially developed with the goal of assessing whether children were ready to enter school or should be delayed (see reviews by Janus & Offord, 2007; Meisels, 1999). However, this approach has been limited by substantial error rates (Meisels, 1999). Other instruments have been designed to assess a set of cognitive skills presumably underlying children's school readiness. The Metropolitan Readiness Test (Nurss & McGaurvan, 1976), the shorter Lollipop Test (Chew, 1989; Chew & Morris, 1984, 1989), and the Bracken Basic Concept Scale (Bracken, 2000) are examples of such instruments. Both the Metropolitan Readiness Test and the Lollipop showed some success at predicting first, third, and fourth grade achievement when administered to kindergarten children (Chew &

Morris, 1989). The school readiness scores derived from these instruments correlated highly with different reading and mathematic achievement tests in first grade (*r*s ranging between .47 and .75). Smaller but significant correlations with reading and mathematic achievement in third and fourth grade were also observed (*r*s ranging between .30 and .68). A study showed that the Bracken Basic Concept Scale administered to children after the completion of the kindergarten year accounted for 25% of concurrent reading achievement, 36% of spelling achievement, and 31% of achievement in arithmetic (Sterner & McCallum, 1988). Other than specific standardized assessments of school readiness, measures of general cognitive development, such as IQ (e.g., Wechsler Preschool and Primary Scale of Intelligence–III; Wechsler, 2002) and vocabulary measures (e.g., Peabody Picture Vocabulary Test [PPVT]; Dunn & Dunn, 1997), have also been used to assess various aspects of cognitive school readiness (La Paro & Pianta, 2000). According to La Paro and Pianta's review, these measures are often used as predictors as well as outcome variables in studies of school readiness. Memory has also been found to be associated with aspects of school achievement, especially mathematics (Bull & Scerif, 2001). These studies showed that there is a certain amount of conceptual overlap between the measures of general cognitive development and the measures of school readiness.

As illustrated by these examples, standardized tests must be administered to the children by a trained assistant. This characteristic makes them less practical for widespread screening of school readiness. Moreover, most of these tests do not take into account the social, emotional, and behavioral characteristics of the child, which are considered by teachers to be more important than pre-academic knowledge at school entry (Blair, 2002). Thus, tests of cognitive school readiness are difficult to use in the context of large-scale screening and tend to neglect important dimensions of school readiness.

The EDI (Janus & Offord, 2007) was developed to address these issues. The EDI provides an assessment of school readiness based on ratings by teachers or educators; its goals are to provide a versatile and psychometrically sound instrument to monitor school readiness outcomes at the community level. The instrument distinguishes five dimensions: (a) Physical Health and Well-Being, (b) Social Competence, (c) Emotional Maturity, (d) Language and Cognitive Development, and (e) Communication Skills and General Knowledge. As for any measure of school readiness, the usefulness of the EDI relies on its predictive validity with respect to relevant developmental outcomes, including later school achievement. This information is presently lacking.

Specific Objectives

The goal of this study was to assess the psychometric properties and the predictive validity of the EDI in the context of a large, representative sample of children from

the Province of Quebec, Canada. First, we documented the psychometric validity of the EDI domains and compared the results to published standards. Second, we evaluated the predictive validity of the EDI domains with respect to school achievement in first grade. Third, in order to explore further the relative strengths and weaknesses of the EDI ratings as predictors of school achievement, we compared the predictive value of the EDI to that of a battery of cognitive measures and a formal test of school readiness.

METHOD

Participants

This study was based on data drawn from the Quebec Longitudinal Study of Child Development (QLSCD). The QLSCD (Jetté & Des Groseillers, 2000a) is a prospective longitudinal study of children, starting at the age of 5 months, who were sampled to be representative of the population of children born in the Province of Quebec, Canada. All singleton infants between 59 and 60 gestational weeks of age in 1998 whose mothers lived in the Province of Quebec were targeted, with the exception of infants born at less than 24 (or at more than 42) weeks of gestation or for whom the duration of gestation could not be determined from the birth record. Infants in the Far North administrative region, Cree and Inuit regions, or those living on Aboriginal reservations were also excluded. A total of 2,940 infants were therefore selected through a region-based stratified sampling design, of which 2,223 families (75.6%) participated in the study when the infant was aged 5 months between the months of March and November 1998. The QLSCD database is public and is available for scientific research.[1]

The person most knowledgeable about the child, who was the biological mother in 99.7% of the cases, provided sociodemographic data relevant to the child's family (Jetté & Des Groseillers, 2000b). At the start of the study, when the children were aged 5 months, 80% of children lived in intact two-parent families, 10.8% in stepfamilies, and 9.2% in single-parent families. The mean age of mothers and fathers was 28.8 and 31.9 years, respectively. The children were described as having Canadian ancestry in 67.7% of the cases; 48.6% declared European origins, 3.5% were of African or Haitian origins, and 20.5% of children had other origins (respondents could declare more than one ethnic origin). The language most often spoken at home was French in 75.2% and English in 10.1% of the families; the remaining 14.7% spoke other languages or a combination of languages. However, all respondents had a sufficient comprehension of English or French for the interview

[1]An extensive description of the QLSCD's participants and measures is available on the study's Web site (http://www.jesuisjeserai.stat.gouv.qc.ca/default_an.htm).

to be adequately conducted. Most parents had graduated from high school, as only 17.9% of mothers and 17.6% of fathers had no high school diploma. At the onset of the study, 27.6% of children lived in families below the low income cutoff, an index taking into account the number of persons in the household, the region of residence, and the income. This relatively high figure could have reflected a temporary situation for many families, as the mothers' maternity leave decreased the household income (Jetté & Des Groseillers, 2000b).

Children were then assessed longitudinally at approximately 17, 29, 41, 50, 62, 74, and 86 months. For the purpose of the current study, we used cognitive and school readiness data collected in kindergarten (*M* age = 73.8 months, *SD* = 3.05) and in first grade (*M* age = 85.8 months, *SD* = 3.06). The EDI was available for 965 participants (513 girls and 452 boys; *M* age = 73.7 months, *SD* = 3.07). This relatively low figure is attributable to the low rate of teachers' response, as only 33% of teachers returned a fully completed questionnaire (i.e., no missing items) about the target child and his or her best friend (Fontaine & Plante, 2005). Assessments of school achievement in first grade were available for 1,305 children (688 girls and 617 boys; *M* age = 85.7, *SD* = 3.07). The number of participants included in the different steps of the analyses varied between 737 and 988; missing cases were mainly due to the low response rate to the teacher questionnaire that included the EDI. The analysis of partial nonresponse showed associations, both negative and positive, between nonresponse to the teacher's questionnaire and measures of cognitive abilities in the children (see Fontaine & Plante, 2005, for a detailed analysis). It was difficult to find a clear pattern of bias in nonresponse, but the children for whom the EDI is missing in part or in its entirety tended to have lower scores on cognitive ability measures.

Schools

The children were scattered in 699 schools in kindergarten and 692 schools in first grade. All children had different teachers in kindergarten and in first grade. The mean number of children per school was 1.5 (ranging from 1 to 7) in kindergarten and 1.4 (ranging from 1 to 5) in first grade. There was only one child per school in 65.2% of the cases in kindergarten and 70.2% of the cases in first grade.

Procedure

Children were assessed at the end of the kindergarten and administered a battery of tests composed of several cognitive and language measures, including a standardized school readiness test (Lollipop Test; Chew, 1989), the PPVT (Dunn & Dunn, 1997), the Visually Cued Recall task (VCR; Zelazo, Jacques, Burack, & Frye, 2002), and the Number Knowledge Test (NKT; Okamoto & Case, 1996). These tests were counterbalanced (administered in various orders) to avoid potential bi-

ases in assessment. A total of 1,134 children were assessed in the kindergarten evaluation. Of these, 94% were assessed in the school setting. The remaining 6% were assessed at home to accommodate the parents' wishes. The EDI ratings were also obtained from teachers at the end of the kindergarten year. At the end of first grade, teachers' school achievement ratings were collected. All the instruments of the study were available in French and English. The respondents were asked to choose the language of the instruments and interviews.

Instruments

School Readiness Measures (Kindergarten)

EDI. The EDI (Janus & Offord, 2007) is a 104-item checklist designed to provide a teacher-rated assessment of children's school readiness in five domains: Physical Health and Well-Being, Social Competence, Emotional Maturity, Language and Cognitive Development, and Communication Skills and General Knowledge. The first four domains encompass 15 subdomains: Physical Health and Well-Being is composed of 3 subdomains (Gross and Fine Motor Skills, Physical Readiness for School Day, Physical Independence), Social Competence comprises 4 subdomains (Responsibility and Respect, Approaches to Learning, Overall Social Competence, Readiness to Explore New Things), Emotional Maturity is composed of 4 subdomains (Prosocial and Helping Behavior, Hyperactivity and Inattention, Anxious and Fearful Behavior, Aggressive Behavior), and Language and Cognitive Development can also be subdivided in 4 subdomains (Basic Numeracy Skills, Basic Literacy Skills, Advanced Literacy Skills, Interest in Literacy/Numeracy and Memory; Janus & Duku, 2005).

The items of the EDI are rated on different scales: Some are rated in yes/no categories and others are rated using 3-point or 5-point Likert scales. Following Janus and Offord's (2007) recommendations, we recoded all items on a scale of 0 to 10. This allowed combining the items to obtain total scores for the five domains.

In the current study, we used a shortened version of the original EDI instrument. A total of 10 items were removed in order to shorten the teacher questionnaire: 1 item from the Physical Health and Well-Being domain, 1 item from the Social Competence domain, 7 items from the Emotional Maturity domain, and 1 item from the Communication Skills and General Knowledge domain. In order to assess the validity of this shortened questionnaire, we compared the mean domain scores obtained with the standards provided by Janus and Duku (2004). These results are presented below. Appropriate transformations (i.e., reflect and logarithm or reflect and inverse) were done to reduce negative skewness as recommended by Tabachnick and Fidell (2007). The original EDI is in English; the French translation was obtained by translating the questionnaire into French and retranslating it into English to assess the validity of the translation.

Lollipop Test. The Lollipop Test (Chew, 1989) is a well-validated diagnostic screening test of school readiness (Chew & Morris, 1984). Scores on the original version of the Lollipop have been found to predict successfully future school achievement (Chew & Lang, 1990; Chew & Morris, 1989; Eno & Woehlke, 1995). Venet, Normandeau, Letarte, and Bigras (2003) showed that the French version of the Lollipop was reliable and stable over time, and predictive of academic performance 3 years later. A recent study (Lemelin et al., in press) confirmed the predictive validity of the Lollipop in a large twin sample with respect to early school achievement. The Lollipop is composed of four subtests, each assessing a component of cognitive school readiness: (a) Identification of Colors and Shapes; (b) Picture Description and Spatial Recognition; (c) Identification of Numbers and Counting; (d) Identification of Letters and Writing. The Lollipop was administered by a trained research assistant during the school visit. We derived four scores corresponding to the four subscales. The purpose of using the Lollipop in the present study was to compare the predictive validity of the EDI, a teacher-reported measure, to a standardized and direct measure of cognitive school readiness. Appropriate (reflect and logarithm or reflect and inverse) transformations were done to reduce negative skewness.

Cognitive and Language Measures

Cognitive and language abilities and school readiness are closely related, to the point that some studies have considered IQ tests and similar cognitive measures as proxies of school readiness (La Paro & Pianta, 2000). It was deemed important to control for children's general cognitive and language abilities to better assess the predictive validity of the construct of school readiness as measured by the EDI. The main goal of this article was to compare the predictive validity of an instrument based on teacher ratings with the predictive validity of formal tests regarding early school achievement. The QLSCD assessments included general cognitive ability, receptive vocabulary, short-term memory, and number knowledge. All these cognitive abilities have been shown to relate to and predict school achievement. We used these measures as a basis for comparing the predictive value of the EDI. Appropriate action was taken to reduce skewness and/or eliminate outliers in the distribution of each instrument scores.

General cognitive abilities. Measures of general cognitive abilities and IQ have been used as proxies for school readiness and also as measures of achievement (La Paro & Pianta, 2000). General cognitive abilities were assessed with the Block Design (BD) subtest of the Wechsler Preschool and Primary Scale of Intelligence–Revised (Wechsler, 1989). This Performance Scale subtest has excellent internal consistency and test–retest reliability (see Sattler, 2001). Of all of the Wechsler Preschool and Primary Scale of Intelligence–Revised Performance

Scale subtests, the BD is the one most highly correlated with the Full Scale score (r = .62) and that is considered a fair measure of general cognitive abilities, as 47% of its variance can be attributed to general cognitive abilities. The BD subtest is composed of 14 models that the child must reproduce using blocks. The test is terminated after three consecutive failures. Bonus points can be obtained for some models as a function of time. Raw scores thus vary from 0 to 42. In this study, the BD score was available for 1,155 children (M = 19.98, SD = 9.88). A square root transformation was used to reduce moderate positive skewness.

Receptive vocabulary. Children's receptive vocabulary was assessed using the PPVT-III (Dunn & Dunn, 1997). Like measures of IQ and general intelligence, the PPVT has been used both as a predictor and as a measure of school achievement (La Paro & Pianta, 2000). The PPVT-III is a standardized language test frequently used in both research and clinical settings, with good internal consistency and established validity for use with both French- and English-speaking Canadian youths (Flipsen, 1998). The version used in the present study contained 170 cards each depicting four different objects, actions, or emotions. The child was asked to point at the correct image corresponding to the word said by the tester. One point was awarded for each correct answer until the stop criteria was reached (i.e., six errors within a sequence of eight cards).

Short-term memory. Another aspect of cognitive development included in the analyses is memory. Children's short-term memory was assessed using the VCR (Zelazo et al., 2002). Stimuli may be encoded verbally, visually, or spatially. In this task, children had to remember a gradually increasing number of items shown on a card, representing 11 different levels (see Huijbregts et al., 2006). The test is terminated if the child makes two errors on two subsequent levels. The total score corresponds to the highest level reached by the child (N = 1,193, M = 5.94, SD = 2.37). A square root transformation was used to reduce moderate positive skewness.

Number knowledge. Children's number knowledge was assessed using a shortened version of the NKT developed by Case and colleagues (Okamoto & Case, 1996). The emergence of a central numerical structure is seen as a fundamental aspect of school readiness, and the NKT was designed to reliably assess individual differences with respect to the emergence and progressive integration of knowledge regarding numeracy (Case, Griffin, & Kelley, 1999; Okamoto & Case, 1996). In this test, children had to answer a series of questions regarding the understanding of the base 10 system of whole numbers. These questions are grouped in two levels, increasing in difficulty, based on the different abilities required to respond in a successful manner (see Case, Demetriou, Platsidou, & Kazi, 2001). Five items addressed the first level and 13 items the second level. All items were scored

on a pass or fail basis. The child has to get at least three successful items at the first level to reach the second level. The test was terminated after three consecutive failures. The total score corresponds to the number of successful items (N = 1,185, M = 13.29, SD = 3.27). A reflect and square root transformation were used to reduce moderate negative skewness.

School Achievement (First Grade)

School achievement was assessed using teacher ratings of children's school performance in four categories (reading, writing, mathematics, and overall achievement). No direct school achievement assessments were available in the QLSCD study. For each of these categories, teachers had to compare the performance of each child to the average performance of his or her schoolmates on a 5-point Likert scale, where 1 indicated *clearly under average*, 3 indicated *average*, and 5 indicated *clearly above average*. The four assessments were very highly correlated (with *r*s ranging between .74 and .90) and therefore were not analyzed independently. Instead, a total school achievement score was calculated (mean of the four ratings) and used in the analyses. The reliability of this composite score was high (Cronbach's α = .91). Teacher ratings of school achievement have been demonstrated to be valid and highly correlated with other measures of school achievement; this kind of measure takes advantage of the teacher's extensive observation of the child's ability in everyday life, as opposed to decontextualized standardized tests (Hoge & Coladarci, 1989; Mattanah, Pratt, Cowan, & Cowan, 2005; Vitaro, Larocque, Janosz, & Tremblay, 2001; Walker, Petrill, Spinath, & Plomin, 2004). The teachers were asked to rate the children by the end of the school year so they could base their ratings on numerous previous assessments of the children's achievement relative to that of their classmates.

Control Variables

Gender, precise age of the child, and socioeconomic status (SES) of the family were entered as control variables in the regression models. Age and gender were controlled to take into account the maturity level of the children. Because previous studies have shown an association between school readiness and SES (McLoyd, 1998; Stipek & Ryan, 1997), we controlled for this variable in order to better assess the specific contribution of school readiness. The SES standardized score was calculated from a combination of the household income, parents' education level, and occupational prestige at the time of the school readiness assessment.

RESULTS

Descriptive statistics (means, standard deviations, and internal consistency coefficients) for the five domains of the EDI are presented in Table 1, along with the de-

TABLE 1
Comparison of Sample Means With the EDI's Normative Sample

Domain	*N*	*M (of Normative Sample)*	*SD (of Normative Sample)*	α
Physical Health and Well-Being	965	8.90 (8.79)	0.96 (1.05)	.78
Social Competence	965	8.57 (8.29)	1.47 (1.74)	.94
Emotional Maturity	964	7.82 (8.05)	1.51 (1.51)	.88
Language and Cognitive Development	958	8.39 (8.36)	1.49 (1.82)	.88
Communication Skills and General Knowledge	965	7.89 (7.73)	1.74 (1.94)	.92

Note. The descriptive statistics drawn from the "gold standard" normative sample of the EDI (Janus & Duku, 2004) are shown in parentheses. Data courtesy of the Institut de la Statistique du Québec. EDI = Early Development Instrument.

scriptive statistics reported for the original normative sample of the EDI (from Janus & Duku, 2004), which are shown in parentheses. Internal consistencies were generally high. The means and standard deviations were very similar to those reported for the normative sample of the EDI, which suggested that using a shortened version did not significantly affect the scores obtained for the five global domains.

Correlations between the five EDI domains are presented in Table 2. In this table, we also report the correlations from the normative sample (Janus & Duku, 2004). All correlations were significant ($p < .001$) and of moderate to high magnitude. Again, the correlations obtained in the present sample were very similar to those obtained for the normative sample. Only one correlation, that between the Emotional Maturity and the Communication Skills and General Knowledge subscales, was significantly higher than the same correlation in the normative sample.

TABLE 2
Correlations Between the EDI Domains

Domain	*Social Competence*	*Emotional Maturity*	*Language and Cognitive Development*	*Communication Skills and General Knowledge*
Physical Health and Well-Being	.60 (.59)	.54 (.49)	.51 (.53)	.63 (.61)
Social Competence	—	.78 (.79)	.55 (.59)	.61 (.57)
Emotional Maturity		—	.45 (.46)	.52 (.45)[a]
Language and Cognitive Development			—	.63 (.62)

Note. The correlation coefficients drawn from the "gold standard" normative sample of the EDI (Janus & Duku, 2004) are shown in parentheses. All correlations are significant at $p < .001$. Data courtesy of the Institut de la Statistique du Québec. EDI = Early Development Instrument.

[a]Difference between the sample correlation and normative correlation significant at $p < .001$.

The magnitude of the correlations indicated significant overlap between the domains, but not to the point of redundancy except perhaps in the case of the two domains related to social and behavioral development (i.e., Social Competence and Emotional Maturity).

Is the EDI Predictive of School Achievement?

We addressed this question by first conducting a standard multiple regression analysis with the school achievement score as the dependent variable. The scores of the five domains of the EDI were entered as predictors simultaneously in a single block. This initial model was significant, $F(5, 805) = 82.07$, $p < .001$, and accounted for 33.8% of the variance in school achievement a year later. All domain scores (with the exception of Social Competence) significantly predicted school achievement in first grade. We assessed multicollinearity with the variance inflation factor (VIF). The VIF associated with each predictor ranged between 1.39 and 2.48. Although these indices are well under the usual threshold of 10, it has been suggested that a mean VIF above 1 could be indicative of collinearity (Field, 2005). The mean VIF associated with the EDI domains in this analysis was 1.87. Thus, we cannot rule out the possibility that the regression model is affected by multicollinearity.

Subsequently, a second regression was done, controlling for age, gender, and SES in order to remove the effects of the children's differing level of maturity and the possibly confounding effect of SES, which is associated with both school readiness and school achievement (Table 3). The control variables alone explained

TABLE 3
Sequential Regression Analysis Predicting School Achievement From Early Development Instrument Domains

Variable	ΔR^2	ΔF	*df*	*Step 1* β	*Step 2* β
Step 1	.13	37.68***	3,791		
Age				.12***	.04
Gender				–.10**	–.00
Socioeconomic status				.32***	.15***
Step 2	.23	56.85***	5,786		
Physical Health and Well-Being					.14***
Social Competence					.04
Emotional Maturity					.07
Language and Cognitive Development					.30***
Communication Skills and General Knowledge					.12**

Note. Overall model $R = .60$, $R^2 = .36$, $F(8, 786) = 54.65$, $p < .001$. $N = 795$. Data courtesy of the Institut de la Statistique du Québec.

**$p < .01$. ***$p < .001$.

13% of the variance. The EDI domains added 23% for a total of 36% of explained variance in school achievement. The most important predictor was the Language and Cognitive Development domain, followed by the Physical Health and Well-Being domain and the Communication Skills and General Knowledge domain. Neither of the two social–emotional domains (Social Competence and Emotional Maturity) significantly predicted school achievement. These two domains were very highly correlated and may have attenuated each others' association to the outcome.

Finally, given their likely statistical redundancy, we investigated further potential contributions of the Social Competence and the Emotional Maturity domains by conducting two additional regression models analog to the last one, but including only one of these dimensions. In the first model, we did not include the Social Competence domain. In the second model, we did not include the Emotional Maturity domain. In the first model, the Emotional Maturity domain was a significant predictor of school achievement ($\beta = .09$, $p < .05$). In the second model, the Social Competence domain was a significant predictor of school achievement ($\beta = .08$, $p < .05$). Thus, although these two domains were significantly predictive of school achievement when considered independently, their contribution was marginal.

What Proportion of the Variance in School Achievement Can Be Predicted Independently From the Cognitive Measures (BD, PPVT, VCR, NKT) and From the Lollipop Test?

We addressed this question by conducting two sequential multiple regression analyses with the school achievement score as the dependent variable. In the first analysis, the control variables (age, gender, SES) were entered in the first step. The scores of the four cognitive measures (BD, PPVT, VCR, NKT) were entered as predictors simultaneously in the second step. The overall model was significant, $F(7, 913) = 75.17$, $p < .001$ ($N = 921$), and explained 36% of the variance in school achievement. The first step explained 13% of the variance in school achievement; the cognitive measures added 23% to the explained variance. All of the cognitive and language measures were significant predictors, whereas two of the control variables (gender and SES) remained significant.

In the second analysis, the control variables (age, gender, SES) were again entered in the first step. The scores from the four subtests of the Lollipop (Identification of Colors and Shapes, Picture Description and Spatial Recognition, Identification of Numbers and Counting, Identification of Letters and Writing) were then entered as predictors simultaneously in the second step. The overall model was significant, $F(7, 913) = 75.17$, $p < .001$ ($N = 988$). The four subscales of the Lollipop were all significant predictors of school achievement and added 23% of explained variance in school achievement. The contribution of SES remained significant. The overall model explained 36% of the variance in school achievement. In

other words, with respect to the prediction of school achievement, the EDI explained a very similar amount of variance as combinations of more extensive and direct assessments of cognitive abilities and school readiness.

What Proportion of the Variance in School Achievement Can Be Predicted From the EDI Scales Above and Beyond the Variance Accounted for by Cognitive Measures and the Lollipop Scales?

To address this question, we conducted a sequential multiple regression analysis with the total school achievement score as the dependent variable. Gender, age, and SES were entered as control variables in the first step. The scores from the four cognitive and language measures (BD, PPVT, VCR, NKT) were entered simultaneously in the second step. The four Lollipop subtests were entered simultaneously in the third step. The five EDI domains were entered simultaneously in the fourth and final step. The results are summarized in Table 4. After controlling for the effects of the cognitive measures on school achievement, the Lollipop subtests explained an additional 8% of the variance in school achievement. Significant contributors to this prediction were the Identification of Colors and Shapes and Identification of Letters and Writing subtests. After controlling for the effects of the cognitive measures and the Lollipop subtests on school achievement, the EDI domains explained an additional 5% of the variance in school achievement. Significant contributors to this prediction were Physical Health and Well-Being, and Language and Cognitive Development. In sum, two EDI domains made a unique contribution to the variance in school achievement over and above the variance accounted for by cognitive and language abilities and a direct measure of school readiness.

Further Exploration of the EDI Domains

The five EDI domains encompass a large array of interrelated constructs. In the last step of the analysis, we further explored the contribution of the EDI to the prediction of school achievement in first grade by assessing the predictive value of the specific subdomains that composed the two domains identified as significant predictors (Physical Health and Well-Being, and Language and Cognitive Development). The examination of the subdomains showed weak or inadequate reliability for two of three subdomains of the Physical Health and Well-Being domain (Cronbach's αs were .26, .55, and .86, respectively). Therefore, we selected only the subdomains of the Language and Cognitive Development domain (Cronbach's αs ranging between .69 and .78). We conducted a sequential regression entering gender, age, and SES as control variables in the first step, the four EDI subdomains in the second step, and the Lollipop subtests in the third step. Results are presented in Table 5. Before entering the Lollipop subtests, all of the EDI subdomains were

TABLE 4
Sequential Regression Analysis Predicting School Achievement From the Cognitive Ability Measures, the Lollipop Subtests, and the Early Development Instrument Domains

Variable	ΔR^2	ΔF	*df*	*Step 1* β	*Step 2* β	*Step 3* β	*Step 4* β
Step 1	.13	34.76	3, 733				
Age				.12***	.03	.00	–.01
Gender				–.10**	–.10**	–.03	.01
Socioeconomic status				.32***	.14***	.11***	.07*
Step 2	.25	70.99	4, 729				
Block Design					.11**	.09**	.06
Visually Cued Recall task					.09**	.09**	.08**
Peabody Picture Vocabulary Test					.17***	.13***	.10**
Number Knowledge Test					.35***	.24***	.19***
Step 3	.08	24.33	4, 725				
Identification of Colors and Shapes						.10**	.09**
Picture Description and Spatial Recognition						.02	.03
Identification of Numbers and Counting						.08*	.05
Identification of Letters and Writing						.26***	.20***
Step 4	.05	14.29	5, 720				
Physical Health and Well-Being							.10**
Social Competence							.03
Emotional Maturity							.04
Language and Cognitive Development							.12***
Communication Skills and General Knowledge							.07

Note. Overall model $R = .70$, $R^2 = .50$, $F(16, 720) = 44.05$, $p < .001$. $N = 737$. Data courtesy of the Institut de la Statistique du Québec.
*$p < .05$. **$p < .01$. ***$p < .001$.

TABLE 5
Specific Contribution of the Subdomains Composing the Language and Cognitive Development Domain and of the Lollipop Assessment

Variable	ΔR^2	ΔF	*df*	*Step 1* β	*Step 2* β	*Step 3* β
Step 1	.13	36.64	3,790			
Age				.12***	.06*	.03
Gender				–.09***	–.05	.00
Socioeconomic status				.33***	.19***	.15***
Step 2	.20	59.73	4,786			
Basic Numeracy Skills					.28***	.21***
Advanced Literacy Skills					.11**	.04
Interest in Literacy/Numeracy and Memory					.14**	.09*
Basic Literacy Skills					.06	.05
Step 3	.10	35.26	4,782			
Identification of Colors and Shapes						.11***
Picture Description and Spatial Recognition						.05
Identification of Numbers and Counting						.09**
Identification of Letters and Writing						.28***

Note. Overall model $R = .66$, $R^2 = 0.43$, $F(11, 782) = 54.38$, $p < .001$. $N = 73$. Data courtesy of the Institut de la Statistique du Québec.

*$p < .05$. **$p < .01$. ***$p < .001$.

significant predictors (except for the Basic Literacy Skills scale). The Basic Numeracy and the Interest in Literacy/Numeracy and Memory subdomains made a unique contribution to the variance in school achievement, even after the Lollipop subtests were entered in the model. Of interest is the fact that the strongest predictor in the final model was the Identification of Letters and Writing subtest of the Lollipop, a measure conceptually close to the nonsignificant Basic Literacy Skills subdomain of the EDI.

DISCUSSION

The main goal of this article was to explore the EDI's predictive validity with respect to school achievement in a large, population-based sample of children. We found that the EDI was a substantial predictor of school achievement as reported by the first-grade teacher a year after the EDI ratings. Together, and without controlling for other measures, the five domains explained 34% of the variance in first-grade school achievement. By comparison, La Paro and Pianta (2000) reported a mean explained variance of 25% for instruments predicting academic achievement in first and second grade from cognitive/pre-academic measures. Of the three domains that showed a significant effect, the most important predictor was a set of measures of cognitive school readiness assessing literacy, numeracy,

and communication skills. By contrast, the social–emotional domains did not predict school achievement in the initial analysis. It must be noted that the high correlation between the two scales suggests that they may not be sufficiently differentiated empirically. This overlap between the constructs seems to introduce collinearity in the regression model and decrease their predictive value; their effect is small but significant when entered one at a time in the regression model. Thus, our results are not completely in contradiction with previous studies that reported significant association between behavioral and emotional child characteristics such as self-regulation and interpersonal skills and early school achievement, even though the effect sizes are smaller than those observed for cognitive predictors (e.g., Di Perna, Lei, & Reid, 2007; Graziano, Reavis, Keane, & Calkins, 2007; Howse, Lange, Farran, & Boyles, 2003; La Paro & Pianta, 2000; Normandeau & Guay, 1998). Our results suggest further refinement of the social and emotional domains of the EDI to increase their specificity. Combining the two highly correlated domains would probably increase the predictive validity of the EDI, but at the cost of the specificity of the measure. Finally, the Physical Health and Well-Being domain predicted school achievement. This domain comprised items evaluating, for example, whether the child was adequately dressed and how frequently he or she arrived at school hungry. Thus, it is of particular interest to note that the predictive value of this domain held after SES was taken into account. Although school readiness has often been associated with SES, the effect of physical readiness and health on school achievement cannot be reduced to an effect of SES.

The EDI was designed to obtain a school readiness measure on a large scale as an instrument that can be used quickly and easily by teachers and educators. Most of the other measures of school readiness rely on tests that are time consuming and require the presence of trained research assistant. We wanted to better define the relative contribution of the EDI to the prediction of school readiness when compared with more traditional tests and to assess its unique contribution. Taken individually, the EDI, the Lollipop school readiness measure, and a set of four measures of cognitive abilities and language each explained a similar proportion of variance in school achievement, roughly a third of the total variance. Two of the EDI domains made an independent contribution. When other measures were taken into account, the most interesting contribution of the EDI (both conceptually and statistically) came from its Language and Cognitive Development domain, which seemed to complement the test measures. The Physical Health and Well-Being domain also seemed to tap into an important aspect of school readiness that is not evaluated by the other instruments. The independent contribution of the EDI over the other instruments was small. However, because our goal was to assess the EDI's ability to replace more complex measures, the variance shared between the EDI, the Lollipop, and the cognitive assessments was of bigger interest: It showed that the EDI accounted for almost exactly the same amount of variance in school achievement as a battery of formal tests. However, in combination with these tests,

the EDI still made a modest independent contribution to the prediction of early school achievement.

We compared further the contribution to school achievement prediction of a direct test of school readiness like the Lollipop with the EDI scales comprising the Language and Cognitive Development domain because this domain represented the most important predictor among the EDI domains. The two measures together explained as much as 43% of the variance in school achievement. In this analysis, the strongest predictor was the Identification of Letters and Writing subtest of the Lollipop, which assesses approximately the same abilities as the Basic Literacy subdomain of the EDI. Even before controlling for the Lollipop subtests, the Basic Literacy subdomain was not significantly related to school achievement. Furthermore, an examination of the characteristics of the two measures showed that the teachers reported that most children mastered basic literacy skills, whereas the Lollipop tested directly the children's knowledge of letters and showed greater variance. These results suggest that teachers' ratings of basic literacy do not discriminate as well between children as a formal test does. There seems to be more variance among children in basic literacy skills than teachers reported. In this context, the reliability of teachers' ratings of children's advanced literacy skills could also be questioned. Ideally, the EDI assessment should be supplemented with direct measures of these important aspects of school readiness.

To sum up, this article showed that the kindergarten-teacher-rated EDI is a valid instrument for predicting school achievement in first grade, thus building on the existing concurrent validity data (Brinkman et al., this issue; Guhn, Gadermann, & Zumbo, this issue; Janus & Duku, this issue; Janus & Offord, 2007). All together, the battery of tests and ratings used in this study could explain as much as 50% of the variance in school achievement. With the EDI only, we could explain 34% of the variance, which is almost equivalent to the variance explained by measures that demand more time and resources to administer. However, not all of the five domains of the EDI were significantly related to school achievement; the domains assessing social competence and emotional maturity were not predictive of school achievement as rated by the first-grade teacher. The importance of social, behavioral, and emotional characteristics of children as predictors of school achievement have received much less attention from researchers than cognitive abilities and pre-academic knowledge. In the present study, the insufficient specificity of the social competence and emotional maturity constructs may explain the absence of relation with the school achievement outcome. It would be important to assess the ability of the EDI scales to predict children's later behavior and social adjustment.

The EDI scale that assesses Language and Cognitive Development is one of the best predictors of school achievement among those considered in the present study, showing that a teacher rating in kindergarten can be almost as effective as formal measures of cognitive abilities and pre-academic knowledge in assessing school readiness. More unusual is the finding that Physical Health and Well-Being signifi-

cantly predicted achievement a year later, even when SES was controlled for. Unfortunately, the individual scales composing this domain were not reliable enough to allow further exploration of the implications of this finding.

Our results suggest that the EDI represents a very promising instrument for assessing school readiness quickly and easily, which could facilitate the assessment of school readiness on a large scale. However, this instrument also showed several weaknesses. First, the social and emotional domains may represent too general of constructs and share too much variance to be useful predictors of school achievement when considered together. The predictive value of a selection of their most valid subdomain could be the subject of a future study. Second, although the Physical Health and Well-Being domain is an interesting predictor, two of its three subscales did not reach acceptable reliability. Third, we noted that the EDI Basic Literacy Skills scale did not discriminate between children. Literacy is a crucial aspect of school readiness; in our analysis, the best overall predictor of school achievement in first grade is the Identification of Letters and Writing subtest of the Lollipop, which underlies the necessity of evaluating basic literacy with a valid instrument. We therefore suggest that, whenever feasible, the EDI should be supplemented with a formal test of basic literacy skills such as the Lollipop's Identification of Letters and Writing subtest.

A limitation of this study was the absence of a formal measure of school achievement. No such measure was available in the QLSCD. Moreover, although teachers were asked to assess children's achievement in reading, writing, and mathematics, the ratings were so highly correlated that it was not informative to examine the predictive validity of the EDI for specific domains of achievement. The drawbacks of teacher ratings are variability across teachers and the possibility that student-related characteristics moderate the accuracy of the ratings (Hoge & Coladarci, 1989). Another limitation to consider is the possibility of an attrition bias. The general attrition rate was low for the whole sample, varying between 0.3% and 9.5% per year as long as the parents were the only respondents; however, the attrition rate was more important when teachers became respondents. There is some evidence that the participants for which the complete EDI was unavailable differed from the rest of the sample, particularly on cognitive measures (Fontaine & Plante, 2005). The variance of the sample may be somewhat restricted, and, consequently, the prediction of school achievement by the EDI may have been affected. Our results need to be replicated with different samples and more specific measures of achievement in first grade and after. Finally, we did not model aggregation at the school level in the analyses for two reasons. First, there was only one child per school in the majority of cases. Second, the outcome variable of school achievement did not show any evidence of school-level aggregation (i.e., the intraclass correlation was not significant). For these reasons, multilevel analyses could not be conducted (for a multilevel validity study of the EDI, see Lapointe, Ford, & Zumbo, this issue).

In spite of these limitations, this study showed that the EDI represents a promising instrument for assessing school readiness in kindergarten and, should our results be replicated, could be used on a large scale to evaluate the needs of children regarding preparation for school at a community level.

ACKNOWLEDGMENTS

We are grateful to the parents of the children in the Quebec Longitudinal Study of Child Development. We thank the Institut de la Statistique du Québec and its partners, Mireille Jetté and Bertrand Perron, for the data collection. We also thank Qian Xu, Bei Feng, and Hélène Paradis for their assistance in data management and preparation. This research was supported by grants from the Ministère de la santé et des services sociaux du Québec, the Ministère de la famille et des ainés du Québec, and the Ministère de l'éducation, du loisir et du sport du Québec; the Social Sciences and Humanities Research Council of Canada (SSHRC), the Québec Fund for Research Training and Support to Research, the Fonds de la recherche en santé du Québec (FRSQ), the Fonds québécois de la recherche sur la société et la culture (FQRSC), the Canadian Institute for Advanced Research, and the Canadian Institutes of Health Research (CIHR); the Molson Foundation; and the Fondation Lucie et André Chagnon. Jean R. Séguin was supported by a career award from the CIHR and the FRSQ; Jean-Pascal Lemelin was supported by postdoctoral fellowships from the SSHRC, the FQRSC, and the Institut de recherche pour le développement social des jeunes; and Richard E. Tremblay and Michel Boivin by the Canada Research Chair Program.

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