Institut de la statistique Québec

QUÉBEC LONGITUDINAL STUDY OF CHILD DEVELOPMENT (QLSCD 1998-2002)

FROM BIRTH TO 29 MONTHS

Cognitive Development in Children Aged 17 to 29 Months

COLLECTION Health and Wellness

Volume 2, Number 8

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Foreword

The publication of this second volume of the QLSCD 1998-2002 series is the result of close collaboration among university researchers, the public health network and the *Direction Santé Québec* [1] (Health Québec Division) of the *Institut de la statistique du Québec* – ISQ (Québec Institute of Statistics), who have been working on this project since 1996.

Two years after the publication of Volume 1 in this series, an interdisciplinary group of more than 80 researchers contributed to producing this second volume, which presents the very first longitudinal results of our survey. These much-anticipated results describe the environment and development of the children based on the first three data collections conducted when they were 5, 17 and 29 months of age. To fully comprehend the importance of these data on early childhood, I would like to remind the reader of the primary goal of the Québec Longitudinal Study of Child Development 1998-2002 as stated in Volume 1 of this series. The QLSCD will help gain a better understanding of the PRECURSORS of social adjustment by first studying adjustment to school, identifying adjustment PATHS and PROCESSES, and examining the CONSEQUENCES of these later in life.

By analyzing data from the first three years of the survey, the ISQ is pleased to be associated with the development of a such powerful survey and research instrument, and particularly with the accomplishment of a study that will serve both as a preventive tool and an aid in the design of effective early interventions. As Director General, I cannot help but take great pride in the model of partnership which has produced such impressive results, many of which may indeed be harbingers of the future.

Yvon Fortin
Director General

1. Certain French appellation in italics in the text do not have official English translations. The first time one of these appears, the unofficial English translation is shown immediately after it. Following this, for ease in reading, only the official French name appears in the text in italics and it is suggested the reader refer to the Glossary for the English translation.

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This analytical paper is also available in French. (Ce numéro et aussi disponible en version française sous le titre « Le développement cognitif des enfants de 17 mois à 29 mois » dans *Étude longitudinale du développement des enfants du Québec (ÉLDEQ 1998-2002) – De la naissance à 29 mois*, Québec, Institut de la statistique du Québec, vol. 2, n^{o} 8).

A Word of Caution, Symbols and Abbreviations can be found in Section "Review of the Methodology and Caution"

Acknowledgements

Given that the QLSCD 1998-2002 has been in existence for more than six years, the task of thanking each person who has collaborated on the project seems daunting, and frankly, nearly impossible. Each year new colleagues join those who have been with us from the very beginning, and they in turn have faced innumerable logistical and methodological challenges, whether in terms of the contents of the survey or navigating their way through a world of knowledge which is in a state of constant progress.

Indeed, the network of university researchers associated with the QLSCD now stretches across Québec to include the rest of Canada and beyond our nation's borders. Hence the wealth of data from this survey is being disseminated through a variety of channels, whether in post-doctoral work being pursued by young researchers outside of Québec, or the multiplier effect of seasoned veterans constantly establishing new international working relationships in this era of the globalization of knowledge. This multiplication of partnerships is closely linked to the exceptional leadership shown by the scientific director of the QLSCD. In addition to contributing to the advance of knowledge, our "conglomerate" of research teams has resulted in the injection of significant funds devoted to analyzing the wealth of data being generated. Indeed, the pooling of research funds obtained through the excellence of the scholars involved has maximized the investment in the QLSCD 1998-2002 by the *ministère de la Santé et des Services sociaux*, sole sponsor of the project's 10 data collections, surveys and pretests.

New partners in our public health network are constantly joining this ever-expanding group of researchers. Increasing numbers of health professionals are becoming actively involved in the QLSCD, coming from the *ministère de la Famille et de l'Enfance* (Ministry of Family and Child Welfare), the education network, etc.

The increase in the number of external experts and growing complexity of this first provincial longitudinal study has led to more ISQ staff devoting their time, in whole or in part, to the QLSCD. New statisticians from the *Direction de la méthodologie et des enquêtes spéciales – DMES* are now associated with the survey. Their tasks include addressing all questions related to the sample design, analyzing the results of the annual data collections in terms of response rates, and producing the weights required to infer the results to the population of children targeted by this large-scale survey. They also provided support to QLSCD researchers in conducting statistical analyses published in this report. With regards to the *Direction Santé Québec (DSQ)*, chief architect of the QLSCD, it was necessary to hire two people experienced in longitudinal analyses to consolidate the rather small team who have been overseeing the surveys year after year, with all the intense concentration of energy this implies. By coordinating the work of numerous partners, developing new tools and instruments to understand the real world of the growing child, closely collaborating with the survey firm collecting the data, and participating in the dissemination of knowledge by publishing original analyses, the seven members of the *Direction Santé Québec* QLSCD team have accomplished their mission with remarkable success.

Over the years, another partnership that continues to flourish is the one we have with the coordinators of the National Longitudinal Study of Children and Youth (NLSCY, Canada). The fact that these pioneers allowed the QLSCD to use certain instruments administered by the CAPI (Computer Assisted Personal Interview) has meant that our Québec longitudinal study is complementary and comparable to this large-scale Canadian study, and at a reasonable cost.

Québec hospitals, who continually face many challenges because of increasing demands for efficiency, are also important partners in our study, as are birthing centres. They manage to weather whatever storms they face by continuing each year to provide certain data from the medical records of the mothers and children. These data are sent to us with the strict proviso that the mothers have furnished prior written consent.

The *Bureau d'interviewers professionnels (BIP)*, the survey firm, continues to be an indispensable partner in arranging and conducting this first large-scale survey of a cohort of Québec children. BIP, masterfully managed with a hands-on approach by its president, is responsible for organizing and ensuring the smooth functioning of the annual data collections in both the pretests and surveys. Their data is of invariably high quality, and the data banks they produce biannually retain a high degree of reliability. BIP's team of interviewers[2] and recruiters, skilfully supervised by a seasoned veteran of field work, has become expert in winning and maintaining the loyalty of the some 2,000 families who annually participate.

Finally, we would like to single out the exceptional participation of Québec families. We truly believe that the success of the QLSCD comes first and foremost from the hours of precious time they grant us every year, during which we feel privileged to share moments in the lives of their little munchkins who, in 2000, were 2½ years of age.

Acknowledging how difficult it is to truly thank everyone who contributed to the day-to-day accomplishment of this Québec first, we would like to cite the words of Serge Bouchard:

> Progress is a totally collective process in both time and space. We owe so much to others... We desire a society of good people..., because there is a link between individual and collective excellence.[3]

A heartfelt thank-you!

Mireille Jetté
Coordinator
Direction Santé Québec,
Institut de la statistique du Québec

2. All the interviewers in this survey were women.

3. BOUCHARD, Serge (2001). "Je ne suis pas seul sur terre", *Le Devoir Édition Internet*, 23 juillet. (Unofficial translation).

Introduction to QLSCD 1998-2002

When this second report is published, the children in the QLSCD study will have begun their fifth year on this planet. Despite the use of extraordinary tools to closely monitor their development, it is obvious that, in early childhood, development is too fast for science to keep up with.

In our first report, we described our observations concerning the data collected five months after birth. Because of the cross-sectional nature of these observations, our study was limited to describing the characteristics of the children and their families. We mainly wanted to describe the situation of babies born in Québec in 1997 and 1998. Bursting with enthusiasm and eager to understand things, the researchers who, at the time, provided the broad strokes of analyses to explain the observed characteristics were fully aware those were just the first in a long series of analyses designed to provide a deeper understanding of children's development.

This second report, however, is based on the collective data gathered when the children were respectively 5, 17 and 29 months old. At last, we can now describe the changes that occur in the lives of children and their families from birth to the third year. This is the first time that such a large sample of Québec newborns has been studied as intensively during early childhood. As far as we know, this is the very first time since science began studying children's developmental that researchers have tried to understand the factors leading to academic success or failure by collecting data as frequently as this from such a large sample of such young children.

Researchers now have available more data than ever before about this stage of life. But this abundance of data has a perverse effect. If cross-sectional studies allow us to draw conclusions on the causes of problems observed, why shouldn't we go ahead and indulge in longitudinal data as well? When one has access to data available to no one else, it is easy to forget the limitations of such data. However, while the researchers involved in drafting this report tried to obtain the maximum benefit from prospective longitudinal data collected at three different stages during early childhood (at 12-month intervals), they also accepted to respect the limitations of this data.

This prospective longitudinal study allows us to describe the changes over time for each measured variable concerning each individual. The researchers thus recorded the changes during the first three years of the children's lives. Profiles of children, parents and families as well as some developmental trajectories were drawn based on the data collected during these three stages. These original results should facilitate discerning the beginning of the course taken by the children and their families. However, it is important to remember that these results only described the first three points of a curve that ideally should comprise fifteen points of time. Since in most cases, it is not very likely that behaviour is consolidated at 2½ years, we asked the authors to primarily limit themselves to describing the development of observable changes. It is obviously too early in the child's life for us to attempt causal analyses in order to identify determinants, especially since these would only be associations. Finally, whenever we approach a problem, our questions are generally much too simplistic. Longitudinal studies such as the QLSCD indicate that there are many ways to observe a problem and that it is dangerous to draw definitive conclusions after the first analyses, no matter how brilliant these appear to be.

It is important to remember that the main objective of the QLSCD is to understand the paths during early childhood that lead to success or failure once the child enters the school system. In order to successfully reach this objective, we must obviously wait for information collected once the child begins school. The QLSCD children will complete their first school year in the spring of 2005. At the time when this report will be published, they will be old enough to enter Junior Kindergarten, which some of them will do in September 2002. Data collection is also planned for the end of Junior Kindergarten year (spring 2003) and at the end of Senior Kindergarten (spring 2004). If, as desired, these significant data collections are funded, the information generated will allow us to check the level of preparation for school at the entry into the first cycle of elementary school. Later during

this longitudinal study, description of the developmental trajectories of these children is planned throughout their school years. If, following the example of many researchers in Québec, the Québec Government confirms its financial involvement in pursuing QLSCD throughout the children's elementary and secondary school, we can increase our understanding of the factors that lead to academic success and therefore be in the best possible position to improve support to the all-too-many children for whom school is an endless succession of failures.

Through recent discoveries about the development of the human brain, we have come to see the importance of investing early in children's development, just as it is important to invest early in our pension plans. Longitudinal studies on the development of children must obviously be based on the same principle. They must begin as soon as possible, and this is what the *ministère de la Santé et des Services sociaux* did as early as 1997, by investing nearly $5 million in a study on Québec children aged 5 to 54 months old. And obviously, just like for a pension plan, in order for these investments to bear fruit and provide the best possible returns, they must be maintained and even increased.

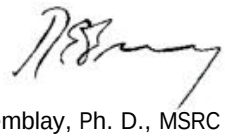

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Table of Contents

List of Tables and Figures

Tables

Figures

Review of Methodology and Caution

The Québec Longitudinal Study of Child Development (QLSCD 1998-2002), launched in 1998, is being conducted on a cohort of nearly 2,000 children surveyed annually from the age of 5 months to approximately 4 years. This second volume covers longitudinal data from the first three rounds when the children were approximately 5, 17 and 29 months of age respectively.

The longitudinal analyses of data collected in the 1998, 1999 and 2000 rounds allow inferences to be made to the population of children born in Québec in 1997 and 1998 (singleton births) who in 2000 were still living in Québec or who had only left the province temporarily. Therefore, in terms of the methodological approach, choosing not to sample children from those who arrived in Québec after birth limits inferences to this population.

Participation of families in the 1999 and 2000 rounds of QLSCD was excellent. Indeed, 94% of families who participated in the 1998 round continued to participate in the second and third rounds, for a 71%[1] longitudinal response rate for the two main questionnaires, the Interviewer Completed Computerized Questionnaire (ICCQ) and the Interviewer Completed Paper Questionnaire (ICPQ). Response rates for the Self-Administered Questionnaire for the Mother (SAQM) and Self-Administered Questionnaire for the Father (SAQF) remained stable from 1998 to 2000, namely 96% for the former and 90% for the latter, among annual respondents to the ICCQ. However, since respondent families were not necessarily the same from one round to the next, the weighted proportion of families who participated in all the rounds was lower, namely 92% for the SAQM and 83% for the SAQF, among respondents to the ICCQ in all three rounds (n = 1,985). The longitudinal response rates of these instruments, obtained by multiplying the weighted proportion of longitudinal respondents to the SAQM or SAQF by the longitudinal response rate of the ICCQ, were 65% and 59% respectively.

1. The unweighted number of families who responded to QLSCD went from 2,120 in 1998 to 2,045 in 1999, to 1,997 in 2000. The number of families who participated in the three rounds of the survey was 1,985 (namely 94% of the 2,120 families in the first round).

It was decided to minimize potential biases induced by non-response by adjusting the weights based on characteristics differentiating respondents from non-respondents for the five major instruments of QLSCD – the ICCQ, ICPQ, SAQM, SAQF and the IST (Imitation Sorting Task testing cognitive development). Since only respondents to the 1998 round were eligible for longitudinal study, longitudinal weights were based on the cross-sectional weights of the ICCQ calculated in 1998. In addition, for longitudinal analyses involving data from the SAQM, SAQF or IST, an additional adjustment to the weights was required to compensate for overall longitudinal non-response in each of these instruments. Unfortunately, in the third round as in the first, even though the response rates of non-resident fathers improved, it was impossible to weight their data since response rates to the SAQFABS were still too low.

Moreover, given QLSCD's complex sample design, it was important that the variance associated with the estimates was correctly identified. This required using a software program that could take into account the complex sample design, otherwise the variance would tend be underestimated, thereby resulting in a threshold of statistical significance that would be too low. SUDAAN (Survey Data Analysis; Shah *et al.*, 1997) was therefore used for prevalence estimates, chi-square tests, repeated measures analyses of variance, linear regressions, logistic regressions and Cox regressions. The threshold of significance for these statistical tests was set at 0.05. With regards to other tests not supported by SUDAAN such as the McNemar, the threshold was lowered to 0.01 to prevent identifying results as significant that might not be, given the complex sample design.

All the data presented that have a coefficient of variation (CV) higher than 15% are accompanied by one or two asterisks to clearly indicate their variability.

N.B. For further information on the survey's methodology, please read Number 1 of both Volume 1 and Volume 2. For more detailed information on the sources and justifications of questions used in the first three rounds of QLSCD as well as the components of the scales and indexes, please read Number 12 of both Volume 1 and Volume 2.

Caution

Unless indicated otherwise, “n” in the tables represents the sum of the individual weights reset to the size of the initial sample. This quantity is used to estimate the prevalences, and is slightly different from the real sample, namely the number of children in a given sub-group. In the body of the text, the number presented to describe the sample size also represents the sum of the individual weights reset to the size of the initial sample. This occurs when an analysis concerns a particular sub-group. The weighted frequency in these cases serves only as a link with the tables. The real sample size, and coefficient of variation remain the quantity to interpret as far as the precision of the estimates is concerned.

Because the data were rounded off, totals do not necessarily correspond to the sum of the parts.

Unless explicitly stated otherwise, all the differences presented in this report are statistically significant to a confidence level of 95%.

To facilitate readability, proportions higher than 5% were rounded off to the nearest whole unit in the text, and to the nearest decimal in the tables and figures.

Symbols

.. Data not available
... Not applicable (N/A)
- Nil or zero
p < Refers to the threshold of significance

Abbreviations

CV	Coefficient of variation
Not signif.	Not significant

Cognitive Development in Children Aged 17 to 29 Months

1. Introduction

The period between the second and fourth year of life is particularly rich in terms of acquiring new skills - behavioural, motor and cognitive. During this transition between infancy and preschool age, children begin to walk, becoming increasingly mobile and autonomous. Language acquisition is marked by a rapid increase in vocabulary. Around the age of 18 months, many cognitive skills emerge. Children become capable of processing complex sets of information at the same time and actively categorizing objects by putting them in two distinct places (Gopnick and Meltzoff, 1987). They can also solve simple problems by predicting the effect of their actions. At this age, children acquire the notion of object permanence, namely an understanding that from now on objects have a separate existence from themselves. For example, a child of 20 months can find an object hidden under container C, after it had been first placed under A and B, whereas a younger child cannot do so. The development of new cognitive skills in these crucial years helps the child understand and adapt to the world around him.

Many researchers have attempted to identify the cognitive structures that develop in young children allowing them to acquire more complex behaviours in reaction to environmental stimuli (Case, 1985; Pascual-Leone, 1980; Piaget, 1952; Siegler, 1991). Some suggest that cognitive development in early childhood can be explained in part by mental-attentional capacity (Case, 1984; Pascual-Leone, 1980). This is defined as the ability to simultaneously process many schemes or units of information, allowing the child to solve increasingly complex problems (Alp, 1988, 1994; Benson, 1989; Pascual-Leone and Johnson, 1991).

In spite of significant changes in the mental functioning of the young child in the course of the second and third years of life, few recent epidemiological studies have focused on measuring cognitive development in a direct and systematic fashion before the age of 5 years. Longitudinal research on cognitive development in young children has largely been based on standardized tests such as the Bayley Scales of Infant Development (1993) for children under 3 ½ years and the Stanford-Binet Intelligence Scale (Thorndike *et al.*, 1986) for children 2 years of age and over. However, these measurement tools are not very suitable for repeated testing of a large sample of children on a time continuum that spans several years. First, the materials are expensive and administering the scales requires nearly an hour of time. Second, to ensure the validity of the scores, specific training is required for each scale. Third, since one scale cannot test cognitive development from birth to preschool age, it is difficult to compare the results obtained from them at different ages. Therefore, in conducting epidemiological research, it is imperative to have simple measurement instruments that can be administered in a relatively short period of time, and that can provide reliable indices of cognitive development in young children that are comparable over several years.

The Quebec Longitudinal Study of Child Development (QLSCD 1998-2002) is following a representative sample of children born in Québec in 1997-1998 from the age of 5 months to school entry. One of the main objectives of the study is to gain a better understanding of the contribution of various aspects of development in early childhood to the psychosocial adjustment of children when they enter school. Cognitive development is one of these. Similar to other longitudinal surveys conducted on large samples, QLSCD could not use standardized scales to measure cognitive development. It was therefore deemed appropriate to choose an alternative measurement instrument better adapted to epidemiological research, namely the Imitation Sorting Task (IST). The IST makes it possible to differentiate children in terms of a specific aspect of their cognitive skills – mental-attentional capacity. This paper is devoted to the analysis of cognitive development based on this instrument in children aged 17 to 29 months.[1]

1. The results of the assessment of the mental-attentional capacity in the children when they were 5 months old are presented in Volume 1, Number 8.

2. How is Cognitive Development Being Assessed in QLSCD?

Testing toddlers between 17 and 29 months of age is certainly a challenge for any researcher. It seems difficult to find a procedure that can provide a valid measurement of cognitive development in young children whose language skills are still rudimentary. Children in this age group need to be assessed using a short and simple task that captures their attention and is playful enough to maintain their interest for several minutes. A task which seems to be a game during which the child can touch and manipulate objects would likely elicit their cooperation.

In recent years, researchers have developed an experimental task to measure the mental-attentional capacity of young children (Alp, 1988, 1994, 1996; Benson, 1989). The Imitation Sorting Task (IST) involves inviting the child to imitate the sorting of various objects into one or the other of two containers. This instrument is based on a well-documented theoretical model from the neo-Piagetian school (Baillargeon *et al.*, 1998; Pascual-Leone and Baillargeon, 1994). Though the theory upon which the task is based is not universally accepted, the IST nevertheless constitutes an accurate and valid measure of mental-attentional capacity in young children (Alp, 1994, 1996, 2001; Benson, 1989). The results obtained in the assessment of many samples of children between 12 and 36 months of age using this instrument show good test-retest reliability (Alp, 1994, 1996). Indeed, children who were assessed a few weeks after the first test essentially produced the same results. An analysis of the task's scores six months after the first test also revealed that, despite an increase in the number of objects, the classification of children remains the same. This task also has a number of advantages. It is suitable for assessing the mental-attentional capacity of children from various cultural backgrounds, and it seems to be quite reliable in producing similar results when different people administer it (Alp, 1996). The task makes it possible to test children on a time continuum of several years, so that annual data can be compared. Furthermore, relatively strong correlations have been observed between IST scores and those obtained from the object permanence task (Uzgiris and Hunt, 1975), balance beam task (Inhelder and Piaget, 1958), Elicited Imitation Task (Bauer, 1996) and two language skill tests, the Semantic-Pragmatic Paradigm and Semantic Complexity Task (Alp, 2001; Benson, 1989). These strong correlations suggest that the IST can provide a general index of content-free cognitive development.

As indicated above, very little research has been devoted to studying cognitive development in a large sample of young children or the development of their cognitive skills over time. The main goal of the analyses presented in this paper is to assess the mental-attentional capacity of Québec children 17 and 29 months of age and to verify whether there are pronounced individual differences in the development of this capacity as indicated by the data from the 1999 and 2000 rounds of QLSCD.[2] Other objectives are to determine whether boys and girls develop at the same pace, and whether children whose mental capacity seemed less advanced than the majority of other children at 17 months catch up and develop at the same pace as other children at 29 months.

2. These are children who were born in Québec in 1997 or 1998 who at the age of 29 months had not permanently left the province.

3. Assessing the Mental-Attentional Capacity of Young Children – The Imitation Sorting Task (IST)

The mental-attentional capacity of children 17 and 29 months of age was tested using the IST (Alp, 1988, 1994, 1996, 2001; Benson, 1989) specifically adapted by one of the authors of this report to fulfill the needs of the survey. The number of objects to sort and trials by level of difficulty were reduced. The task consists in asking the child to imitate the sorting of different objects into two containers. For each item in the task, the interviewer shows the child one or more small plastic objects while naming them – a human figure, an animal, a geometric form, a letter, a number, etc. Each of the objects is placed on a space-defining oval piece of cloth in front of the child. A black and a red cylinders are placed at each end of the cloth. While capturing the attention of the child, the interviewer takes each object in turn and places it in one or the other container. All the objects are then removed from the containers and put within reach of the child according to a preset order. The order is determined in such a way that the objects which must be placed together are not side by side. The interviewer then invites the child to place the objects in the two containers.

The degree of difficulty of the task, namely the number of objects to sort into the containers, is increased with the child's age. At 17 months, there are three levels of difficulty – sorting one, two and three objects respectively. At 29 months, a fourth is added – the child has to sort four objects. The child has two trials at 17 months to do each of the three sorting tasks. At 29 months, there is one trial for each level of difficulty, namely a total of four trials instead of the six for three levels of difficulty at 17 months. The interviewer scores the child's response to each trial. In cases where the child does not do the task or only partially, the interviewer records the reason. A value of success or failure is then assigned to each item in the task. In the data presented in this paper, a successful mark indicates correct sorting of the objects into the two containers independent of being placed in the exact same containers as demonstrated by the interviewer. For even numbers of objects (2 and 4), the same quantity of objects is to be placed in each of the two containers. For the sorting of three objects, two are to be placed in one container and one in the other.

4. Methodological Aspects

4.1 Sample

Several criteria were used to define the samples employed in the analyses of the results at 17 and 29 months. First, non-participation refers to children whose data for the IST are missing, either for all the trials (overall non-response) or some of them (partial non-response). The main reasons for non-participation in the IST were the child's refusal, absence during the survey interview, or the child was sick or asleep. All cases of overall non-participation (all trials missing) were considered as non-respondents to the task. The sub-group of non-respondents also included children who were sick, asleep or tired, but who had undertaken the task, and those whose parent had intervened during the course of the task, thereby invalidating the results. Some children whose record was impossible to score were also categorized as non-respondents. Children who began the task but did not complete all the trials and for whom no reason explaining non-participation had been noted on the protocol were considered to be partial respondents. However, they were excluded from the sample described below, which comprised children who completed all the trials at 17 months (6 items) and 29 months (4 items).

In the 1999 round of QLSCD, 1,934 children with a mean age of 17 months participated in the IST (94.5% of respondent families). Among these, 1,715 children (853 girls and 862 boys) completed the 6 trials of the task. Analyses of the cognitive performance of the 17-month-old children are based on this sample of 1,715[3] respondents. Among the 1,985 families who participated in both the 1999 and 2000 rounds of the survey, 1,795 children were considered respondents to the IST (90.4% of respondent families). The results presented for the analysis of the cognitive profile of the 29-month-old children are based on a sample of 1,692 children (839 girls and 853 boys) who completed both the 6 trials at 17 months and the 4 at 29 months, namely 94% of respondents to both rounds. Out of a total of 1,795 children who participated in the IST, 6% did not do all the trials (partial respondents).

3. The figures shown here represent the real size of the sample.

To be able to generalize the results of the IST from the sample of children who participated in the second and third rounds to all Québec children targeted by the survey, a specific weight was calculated to compensate for the characteristics of children and families considered non-respondents.[4] Since partial non-respondents (6%) who were excluded *a posteriori* obtained lower success rates in the completed trials than those who did all the trials, it is possible that the results tend to slightly underestimate the failure rate in the study population.

4.2 Statistical Models

Latent Class Analysis (LCA) (Clogg and Sawyer, 1981) was used as the statistical method to differentiate children in terms of their mental-attentional capacity as measured by their performance in the IST. From the success or failure data collected for each trial in the IST, latent classes (categories) were identified, each comprising respondents with similar characteristics (sorting the same number of objects into the containers), suggesting the same stage of mental-attentional capacity. This analysis served as a means of assessing whether an underlying latent variable which cannot be directly observed, such as mental-attentional capacity, could account for the covariance between the observed categorical variables, namely the success-failure scores of the various trials in the IST.

Latent Class Analyses provided two estimates. The first indicates the prevalence of each class in the population, namely the proportion of individuals in each category representing a certain level of cognitive development. The second indicates the probability of a response (success or failure) in the various trials of the IST in each class. Following the distribution of respondents into various classes, each class is

4. The weight associated with each child was adjusted to compensate for overall non-response to the IST, which varied in sub-groups formed from 10 variables describing the child's characteristics (behaviour, temperament and autonomy) and the family environment (language spoken at home, use of child care services, mother's employment status, mother's stimulation of the child). Weight adjustment is described in more detail in Number 1 of this volume.

labelled by observing the conditional probability of children succeeding at each level of difficulty in sorting one, two, three objects, etc. For instance, a class of 17-month-old children with a .95 probability of sorting one object and a .05 probability of sorting two and three objects is labelled as a class of children capable of sorting one object.

The results obtained from the latent class analyses are based on the estimates of the probability of a child being in a particular class (ex.: sorting one object, sorting two objects, etc.) and not on real data related to performance in each item of the IST.[5] For example, a class labelled "Sorted One Object" groups together children for whom their estimated mental capacity is based on them sorting one single object (according to their response pattern in the various items of the IST). It is possible that some children were not correctly distributed. A child could be categorized as being capable of sorting objects without really being able to do so (false positive). In contrast, a child may be capable of sorting a certain number of objects but was not categorized as being able to do so (false negative). The models used to estimate the probability of response for each category of children in the population compensate for this error rate (Clogg and Sawyer, 1981). These models provide a means of validating the existence of categories of children, while postulating that for each trial there is a probability of false positives and false negatives, namely an incorrect distribution of certain children in the various classes.

Based on previous results obtained with the IST, it was postulated that a latent class model composed of four classes would appropriately differentiate children in the population according to their mental capacity at 17 months. These classes were defined as follows: 1) children who do not succeed at sorting any object into the containers, 2) children who succeed at sorting one, 3) children who succeed at sorting two, and 4) children who succeed at sorting three. At 29 months, a fifth category was added, namely children who succeed at sorting four objects into the containers. By definition, children in the same class, based on their performance in the IST, present the same mental-attentional capacity. By the same token, children in different classes do not present the same mental-attentional capacity. Analysis of the transition between 17 and 29 months provides a means of assessing the movement of children from one class to another.

Several latent class models were simultaneously tested for the data of the children at 17 months and 29 months in order to select the final model. In addition, longitudinal analysis of the development of mental-attentional capacity at 29 months, taking into account that at 17 months, also required the testing of a number of different models to determine the one that would have the best fit with the data. A similar modeling process was undertaken for all the analyses. First, an independence model was tested, namely a model with one latent class containing all the children. Then, models with several latent classes (ex.: 3, 4 and 5) were analyzed to determine how many categories of children were in the population in terms of their mental-attentional capacity at 17 and 29 months of age. Various limits related to the rate of false positives and false negatives were imposed on the models (an equal or unequal error rate for false positives and false negatives, specific error rate for each trial or identical rate for all trials, etc.). Finally, limitations on the influence of the sex of the children were applied to the models to verify whether girls and boys showed different mental-attentional capacity.

All the analyses were conducted using the lEM software program (Vermunt, 1997). The most parsimonious models with the best fit with the data were chosen to present the results in this paper. For hierarchical models, a comparison of the L^2 (likelihood-ratio chi-square statistic) values and their associated degrees of freedom determined which one best fit the data. The model which presented the lowest adjusted L^2 value in terms of the degrees of freedom compared to another model was chosen. With non-hierarchical models, adjustment criteria such as the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC) were used. A good fit was reflected by low AIC and BIC values. Each model with many latent classes was tested 100 times with various starting values to ensure that the suggested solution was not the result of an estimate that converged to a local maximum (which is possible with an iterative process involving the estimation of maximum likelihood used in latent class analysis).

5. These conditional probabilities are presented in Annex 1, Tables A.1 and A.2.

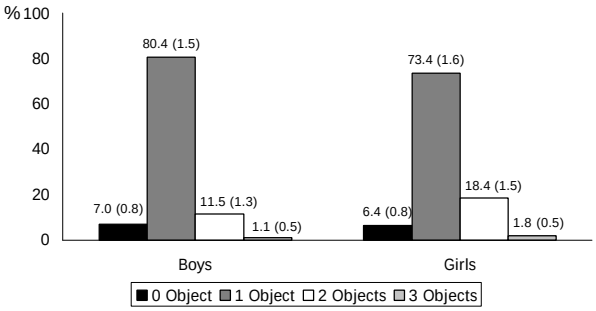
For ease in reading and to facilitate comprehension, only the most salient results describing the mental-attentional capacity of Québec children 17 and 29 months of age are presented in the section that follows. Various latent class models that were rejected are not presented. However, the models that were retained are described in Tables A.3 and A.4 in Annex 2.

5. Results

5.1 Profile of the Mental-Attentional Capacity in 17-Month-Old Children

The results indicate that Québec children at 17 months of age differed in terms of their mental-attentional capacity as measured by the Imitation Sorting Task. As hypothesized, it was possible to divide them into four classes (categories), namely those who did not succeed at placing any object in the containers, those who placed one, those who placed two, and those who placed three.[6] The majority of 17-month-old children, 73% of girls and 80% of boys, succeeded at sorting a single object in the containers; whereas 18% of girls and 12% of boys succeeded at sorting at least two. Figure 5.1 presents the estimated probabilities of boys and girls belonging to each of the four categories. The data show that compared to boys, girls had a greater chance (1.76) of sorting two objects rather than one.[7]

Figure 5.1
Mental-attentional capacity at approximately 17 months : distribution of boys and girls by latent class, Québec, 1999 and 2000[1]



1. The estimates of precision do not take into account the complex sample design and are therefore slightly under-estimated.

Source: *Institut de la statistique du Québec*, *QLSCD 1998-2002*.

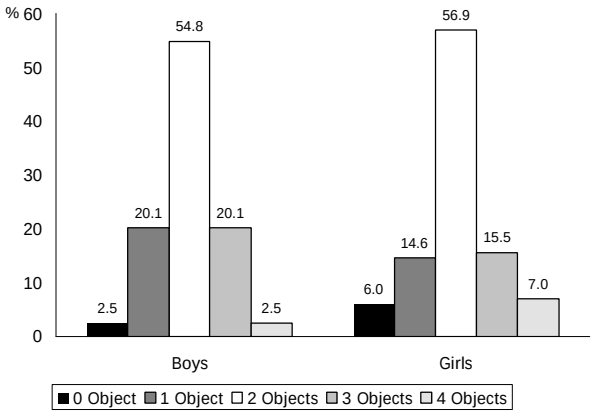
5.2 Profile of the Mental-Attentional Capacity in 29-Month-Old Children

According to the results obtained from the IST at 29 months, the children fell into five classes in terms of their mental-attentional capacity. A fifth class of children appeared – those who succeeded at sorting four objects into the containers. The probability estimates presented in Figure 5.2 show that slightly more than half of children at 29 months, 57% of girls and 55% of boys, succeeded at sorting two objects in the containers. Nearly a quarter of children (both sexes) were capable of sorting three or four objects. The odds of being in one category rather than another differed for boys and girls. Girls had a greater chance (1.40) than boys of being capable of sorting two objects rather than just one. Girls also had a greater chance (3.66) of sorting four objects rather than three compared to boys. However, the odds were greater for boys (3.19) compared to girls in terms of placing one object rather than none. This will be discussed in more detail below.

6. However, it should be noted that the proportion of children in the class labelled "3 Objects" was very low and could not be estimated with precision (CV > 25%). The paucity of members in this class makes it difficult to estimate the probability of being in the mental-attentional classes at 29 months for children who were capable of sorting "3 Objects" at 17 months (Table 5.1).

7. This value represents an odds ratio. It is calculated by first dividing the estimated probabilities of compared classes for girls and boys. For instance, a comparison of the estimated probabilities of sorting two objects rather than one results in the following: .1843/.7340 = .2511 for the girls and .1149/.8040 = .1429 for the boys. The odds ratio for girls and for boys provides an indicator of the relative chance, by sex, of placing two objects rather than one (.2511/.1429 = 1.76). All the odds ratios presented in this paper were calculated in this manner, and were tested to see if they were significantly different from 1. The tests were based on estimated probabilities and do not compensate for either the complex sample design or variance related to latent class analysis. The threshold of significance is therefore underestimated. Because of this, only the results significant at a threshold of 0.01 are presented. In addition, only values indicating a difference in the odds ratios for girls and boys being in a certain class rather than another are presented in the body of this paper. However, all the estimated probabilities of sorting the objects at 17 and 29 months are presented in Tables A.1 and A.2 in the Annex 1.

Figure 5.2
Mental-attentional capacity at approximately 29 months : distribution of boys and girls by latent class, Québec, 1999 and 2000



Source: *Institut de la statistique du Québec, QLSCD 1998-2002.*

5.3 Development of Mental-Attentional Capacity in Children Between 17 and 29 Months of Age

To analyze the development of mental-attentional capacity in children between 17 and 29 months of age, performance in the IST at 29 months was conditioned on that at 17 months. Table 5.1 shows the percentages of girls and boys capable of sorting a certain number of objects at 29 months according to their performance at 17 months. The results indicate that a large proportion of children, approximately 74% of girls and 87% of boys, who did not sort objects at 17 months, succeeded in sorting at least one at 29 months. Over half of these children were capable of sorting at least two (57% of girls and 63% of boys). Among children who succeeded at sorting one object at 17 months, namely the vast majority of children in the survey, approximately 79% of girls and 77% of boys were capable of sorting at least two at 29 months, while 15% of girls and 21% of boys continued to sort only one. Among those who had already sorted two objects at 17 months, more than half (approximately 60% of girls and 56% of boys) maintained their performance at 29 months, while over a quarter (28% of girls and boys) were then capable of sorting three or four at 29 months. Finally, in the category of children who succeeded at correctly sorting three objects at the age of 17 months, more than a quarter (28% of girls and boys) succeeded in sorting three or four at 29 months.

The odds ratio calculation indicated that the chance of being able to sort one object rather than none at 29 months was greater in children who succeeded at doing so at 17 months (4.82).

Table 5.1
Percentages of boys and girls capable of sorting a number of objects at approximately 29 months according to their performance at 17 months, Québec, 1999 and 2000[1]

		Categories at 29 months									
		Boys					Girls				
		0 Object	1 Object	2 Objects	3 Objects	4 Objects	0 Object	1 Object	2 Objects	3 Objects	4 Objects
Categories at 17 months	0 Object	12.6	24.6	47.4	13.7	1.7	26.5	16.3	43.8	9.2	4.2
		(4.0)	(5.5)	(5.3)	(3.8)	(0.7)	(5.5)	(4.2)	(5.1)	(2.8)	(1.2)
	1 Object	2.2	20.5	55.0	19.8	2.5	5.2	15.4	57.6	15.0	6.8
		(0.7)	(2.4)	(2.4)	(2.7)	(0.8)	(1.0)	(2.4)	(2.6)	(2.6)	(1.1)
	2 Objects	0.3	15.1	56.2	25.2	3.2	0.8	11.4	59.6	19.4	8.8
		(0.4)	(3.8)	(4.8)	(4.2)	(1.1)	(0.9)	(3.1)	(4.6)	(3.6)	(1.8)
	3 Objects	0.3	15.1	56.2	25.2	3.2	0.8	11.4	59.6	19.4	8.8
		(0.4)	(3.8)	(4.8)	(4.2)	(1.1)	(0.9)	(3.1)	(4.6)	(3.6)	(1.8)

1. The standard errors associated with these percentages are in parentheses. The estimates of precision do not take into account the complex sample design and are therefore slightly underestimated.

Source: *Institut de la statistique du Québec, QLSCD 1998-2002.*

6. Conclusion

The data indicate that the IST was appropriate and useful as a direct measurement of mental-attentional capacity in children 17 and 29 months of age in QLSCD. It proved to be easy and fast to administer. In addition, its high participation rate reveals that it is an instrument which minimizes the lack of cooperation in children being tested. This is probably due in part to its play aspect. The child is asked to manipulate objects and imitate the actions of an adult, a procedure which primarily calls upon his psychomotor rather than language skills. From this perspective, using the IST as an instrument to measure the mental-attentional capacity of young children in epidemiological surveys seems promising.

The results show that Québec children present differences in terms of their mental-attentional capacity at both 17 and 29 months. Their performance in the IST resulted in their belonging to various categories exhibiting differing rhythms of development. A large proportion of children seemed to be developing as expected – capable of sorting one or two objects at 17 months and two or three objects at 29 months. However, the results should be interpreted with caution, since the partial respondents excluded from the sample used for analysis showed higher failure rates.

These results appear to be compatible with those obtained from various samples of children tested at similar ages (Alp, 1988, 1994, 1996, 2001; Benson, 1989). For example, Alp (1994) showed that children sort a mean of 1.2 objects at 12-17 months, 2.4 objects at 18-23 months and 3.3 objects at 24-29 months. Direct comparison of previous results with those presented in this paper is limited however in that they were obtained using different statistical methods. It is difficult to compare a mean of 2.4 sorted objects calculated from a range of scores (ex.: mean = 2.4, range = 1 to 5 sorted objects, age range = 18 to 23 months) to the estimated prevalence of children capable of sorting two objects at 17 months furnished by latent class analysis. However, the QLSCD results match those of research based on tasks somewhat related to the IST showing that few children are capable of sorting two objects into two different categories before the age of 18 months (Gopnick and Meltzoff, 1987; Sugarman, 1982).

At 29 months, approximately 20% of children did not succeed at sorting more than one object, implying a less advanced mental capacity. By the same token, approximately 7% of children at 17 months did not sort at least one object. Do these proportions of children showing slower development of mental-attentional capacity reflect the reality of the study population? As a matter of reference, the Stanford-Binet Intelligence Scale (Thorndike *et al.*, 1986) indicates that children over 2 years of age who obtain a result that is one standard deviation below the mean are in the 14th percentile of the normal curve. Thus 14% of children tested with the Stanford-Binet scale obtain a score that is one standard deviation below the mean. This suggests that the version of the IST used in QLSCD can also differentiate children in their mental-attentional capacity, since it can identify the proportion of children in the population who underperform. However, it will be important in future research to verify if the results obtained with the IST correlate with those of other measurement instruments used to test cognitive development in young children. At the very least, it will be possible to evaluate whether the IST scores will significantly correlate with those of other instruments measuring cognitive development in future rounds of QLSCD, since the IST is only being used at 17, 29 and 41 months. It will also be interesting to see whether other instruments, such as the Picture Peabody Vocabulary Test (PPVT) at 41 months, will identify the same proportion of children with less than optimal cognitive development as indicated by the results of the IST.

The estimates obtained in this study make it possible to support a theoretical model postulating that mental-attentional capacity significantly increases between the ages of 1 ½ and 2 ½ years (Alp, 1994; Benson, 1989). The majority of children succeeded at sorting an additional object between the age of 17 and 29 months. Therefore, the vast majority of children whose mental-attentional capacity seemed appropriate at 17 months (placing at least one object) continued to develop at 29 months. In children who

did not succeed at sorting any object at 17 months (about 5.6% of girls and 4.9% of boys), approximately a quarter of girls (27%) and an eighth (13%) of boys continued to be unable to sort one object at 29 months. A large proportion of children who did not succeed at sorting any object at 17 months were able to catch up at 29 months, since approximately 57% of girls and 70% of boys were capable of sorting between two and four objects at this age. It can be hypothesized that these children were just on the verge of being able to sort one object at 17 months when they were tested.

The results of this study point to significant differences between boys and girls in terms of the development of mental-attentional capacity. The performance of girls especially differed from boys at both ends of the distribution at 29 months. On the one hand, girls had a greater chance of sorting no object rather than one, and on the other hand they had a greater chance of sorting the maximum number of objects, four rather than three. These results appear difficult to interpret. It seems that the performance of girls at 29 months was more variable than that of boys. Some researchers report that during adolescence girls demonstrate greater verbal skills than boys, whereas the latter clearly excel in visual-spatial and mathematical skills (Maccoby and Jacklin, 1974). The standardization of the Wechsler Preschool and Primary Scale of Intelligence (Wechsler, 1967) and Stanford-Binet Intelligence Scale (Thorndike *et al.*, 1986) revealed slight differences between girls and boys in both total scores and certain non-verbal sub-tests (Sattler, 1992). However, these differences are very small and do not support a clinical differential in cognitive functioning. To the best of our knowledge, research indicates no differences between the sexes in terms of the development of mental-attentional capacity. However, that being said, research shows that the physical development of girls may be more rapid than that of boys (Tanner, 1978). It is therefore possible that more advanced physical development allows girls to develop their mental-attentional capacity at a faster rate. This hypothesis, as well as the results obtained in this study, should be further explored to determine with more confidence how the sex of a child may be related to the development of mental-attentional capacity. Finally, it is also possible that other variables related to the child or family can in part explain this association.

The results presented in this paper provide a general portrait of the development of mental-attentional capacity in children in the target population (excluding partial respondents) from the second to the third year of life. However, this study has certain limitations. The measure of cognitive development is based solely on the IST, still relatively unknown and not widely used. Therefore, it will be necessary to validate these results in order to confirm the capability of this task as a reliable indicator of cognitive development in young children. Nevertheless, since few prospective epidemiological surveys have focused on measuring cognitive development in young children, these data are invaluable and can serve to open new avenues of thought.

Analysis of IST data on cognitive development gathered in a future round when the children will be 41 months of age will no doubt help gain a better understanding of the development of mental-attentional capacity. Examining possible associations between the mental capacity of children and other variables such as behaviour, temperament and aspects of the family environment will also help in shedding light on various factors that may contribute to optimal cognitive development in young children, an important precursor to social and school adjustment.

Annexes

Annex 1

Table A.1
Probabilities of boys and girls belonging to each class at about 17 and 29 months, Québec, 1999 and 2000[1]

	Class 1 (0 Object)	Class 2 (1 Object)	Class 3 (2 Objects)	Class 4 (3 Objects)	Class 5 (4 Objects)
			17 months		
Girls	0.0641	0.7340	0.1843	0.0175	
	(.0073)	(.0164)	(.0153)	(.0045)	
Boys	0.0702	0.8040	0.1149	0.0109	
	(.0075)	(.0151)	(.0130)	(.0032)	
			29 months		
Girls	0.0592	0.1463	0.5693	0.1548	0.0704
Boys	0.0253	0.2010	0.5473	0.2014	0.0251

1. The standard errors of these probabilities are in parentheses.
Source: *Institut de la statistique du Québec, QLSCD 1998-2002.*

Table A.2
Conditional probabilities of succeeding in the IST trials for each class at approximately 17 and 29 months, Québec, 1999 and 2000[1]

Objects Sorted	Class 1 (0 Object)	Class 2 (1 Object)	Class 3 (2 Objects)	Class 4 (3 Objects)	Class 5 (4 Objects)
			17 months		
1 Object (1st Trial)	.0338	**.9662**	**.9662**	**.9662**	
	(.0049)	**(.0049)**	**(.0049)**	**(.0049)**	
1 Object (2nd Trial)	.0242	**.9758**	**.9758**	**.9758**	
	(.0045)	**(.0045)**	**(.0045)**	**(.0045)**	
2 Objects (1st Trial)	.1448	.1448	**.8552**	**.8552**	
	(.0111)	(.0111)	**(.0111)**	**(.0111)**	
2 Objects (2nd Trial)	.1260	.1260	**.8740**	**.8740**	
	(.0110)	(.0110)	**(.0110)**	**(.0110)**	
3 Objects (1st Trial)	.0736	.0736	.0736	**.9264**	
	(.0066)	(.0066)	(.0066)	**(.0066)**	
3 Objects (2nd Trial)	.0670	.0670	.0670	**.9330**	
	(.0065)	(.0065)	(.0065)	**(.0065)**	
			29 months		
1 Object	.0305	**.9695**	**.9695**	**.9695**	**.9695**
	(.0052)	**(.0052)**	**(.0052)**	**(.0052)**	**(.0052)**
2 Objects	.0703	.0703	**.9297**	**.9297**	**.9297**
	(.0254)	(.0254)	**(.0254)**	**(.0254)**	**(.0254)**
3 Objects	.0901	.0901	.0901	**.9099**	**.9099**
	(.0279)	(.0279)	(.0279)	**(.0279)**	**(.0279)**
4 Objects	.0481	.0481	.0481	.0481	**.9519**
	(.0067)	(.0067)	(.0067)	(.0067)	**(.0067)**

1. The standard errors of these probabilities are in parentheses beside the values.
Probability of failure = 1 – (probability of success).
Source: *Institut de la statistique du Québec, QLSCD 1998-2002.*

Annex 2

Latent Class Analysis Models Retained

The final model retained for the data at 17 months comprised four latent classes representing the probabilities of children falling into four categories: 1) children who did not succeed at sorting any object in the containers 2) those who succeeded at sorting one object 3) those who succeeded at sorting up to two objects, and 4) those who succeeded at sorting three objects. This model stipulates that the rate of false positives and false negatives are equal but different for each trial (Item-Specific Model, Clogg and Sawyer, 1981). It also assumes that the estimated probability of each class in the population varies with the sex of the children. However, the conditional probabilities of response to the trials (success or failure) in each class is equal for girls and boys. A restriction is also imposed on the association between the latent variable and the observed variables. The latent variable was processed as a nominal variable and the scores of the trials as an interval-type variable. Preliminary analyses determined that the model with five latent classes was the one which had the best fit with the data at 29 months (a fifth class was added representing the capacity to sort four objects). The results for the model retained for goodness of fit with the data and comparisons with the model of independence, the model with three classes and the model with no association with the sex of children for the data at 17 months are shown in Table A.3 in this annex.

The results obtained for the most parsimonious model explaining the transition between the four classes at 17 months and the five classes at 29 months, plus comparisons with the main models that were rejected, are shown in Table A.4. As in the model for 17 months, the model retained for 29 months imposes constraints in terms of the equality of classification errors specific to each trial and the variation in the probabilities estimated in each class by sex. The association between the two latent variables, namely mental capacity at 17 and at 29 months and the observed variables in this model is log-linear.

Table A.3
Mental-attentional capacity at approximately 17 months, Québec, 1999

	L^2	df	p	AIC	BIC
Model					
Final 4 Classes (0,1, 2, 3 Objects)	144.85	114	.0270	-704.16	-83.15
4 Classes (No Sex Effect)	156.88	117	.0082	-714.48	-77,12
4 Classes (Uniform Sex Effect)	153.73	116	.0109	-710.18	-78,27
Independence (1 Class)	896.90	120	0	3.20	656,90
3 Classes (0, 1, 2 Objects)	199.12	116	0	-664.78	-32,88
	Difference L^2	Difference df	p		
Comparison of Models					
Final 4 Classes vs. No Sex Effect	12.03	3	.0073 *		
Final 4 Classes vs. Uniform Sex Effect	8.88	2	.0118 *		
Final 4 Classes vs. Independence	752.05	6	.0000 *	752.05/896.90 = 83.8% of variance explained	
Final 4 Classes vs. 3 Classes	54.27	2	.0000 *		

Note: L^2 = likelihood-ratio chi-square statistic, df = degrees freedom, AIC = Akaike Information Criterion [L^2-(2df)], BIC = Bayesian Information Criterion [L^2-(df) (logN)].

* The final model had a significantly better fit with the data than the comparison model.

Source: *Institut de la statistique du Québec*, *QLSCD 1998-2002.*

Tableau A.4

Mental-attentional capacity at approximately 29 months given that at 17 months, Québec, 1999 and 2000[1]

	L^2	df	p (bootstrap)	AIC	BIC
Model					
Final Model {YS, ass2(Y, X, 5a, 3, 4)}	635.82	2018	.022	-3,400.2	-14,365.0
Saturated Model (Y/XS)	606.80	1998	.041	-3,389.2	-14,245.4
Log-Linear Model (YX, YS)	618.60	2010	.044	-3,401.4	-14,322.8
Uniform Association Model {YS, ass2(Y, X, S, 2b)}	649.26	2020	.007	-3,390.7	-14,366.4
	Difference L^2	Difference df	p		
Comparison of Models					
Final Model vs. Saturated	29.02	20	.0874 [a]		
Final Model vs. Log-Linear	17.22	8	.0279 [a]		
Final Model vs. Uniform Association	13.44	2	.0012 *		

1. X = Latent variable of mental capacity at 17 months (4 classes), Y = latent variable of mental capacity at 29 months (5 classes), S = sex.

Note: L^2 = likelihood-ratio chi-square statistic, df = degrees of freedom, AIC = Akaike Information Criterion [L^2-(2dl)], BIC = Bayesian Information Criterion [L^2-(dl) (logN)].

a. The comparison model did not have a significantly better fit with the data than the final model.

* The final model had a significantly better fit with the data than the comparison model.

Source: *Institut de la statistique du Québec, QLSCD 1998-2002.*

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Glossary

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Direction des normes et de l'information, ISQ	Standards and Information Division, ISQ
Direction Santé Québec, ISQ	Health Québec Division, ISQ
Institut de la statistique du Québec	Québec Institute of Statistics
ministère de la Famille et de l'Enfance (MFE)	Ministry of Family and Child Welfare
ministère de la Santé et des Services sociaux du Québec (MSSS)	Ministry of Health and Social Services of Québec
Personne qui connaît le mieux l'enfant (PCM)	Person Most Knowledgeable (PMK)

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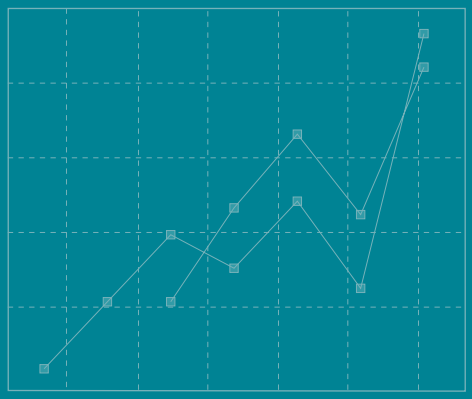
From infancy to preschool age, young children develop numerous cognitive and language skills. Around the age of 18 months, they become capable of processing several items of information at the same time, which leads them to solving increasingly complex problems. The question is how this capacity to understand and interact with their environment develops in the first few years of life. The Québec Longitudinal Study of Child Development (QLSCD 1998-2002) provides a unique opportunity to study this question by assessing the development of mental-attentional capacity in a large representative sample of children born in Québec at the end of the 1990s. This paper paints a general portrait of the development of mental-attentional capacity in young children between 17 and 29 months. It also addresses the question of whether pronounced individual differences exist among children, and whether girls and boys differ in terms of the development of their mental capacity.



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