

Motor, Social and Cognitive Development

Section II

Cognitive Development



Introduction

According to many specialists in the field, cognitive development in children progresses through a number of stages. Between the ages of 0 and 18 months, six stages constitute what is called the sensory-motor period of cognitive development (Piaget, 1936, 1937).

Table 1
Relationship between the Six Stages of the Sensory-Motor Period of Cognitive Development and Mental-Attentional Capacity in Children

Mental-Attentional Capacity	Stage	Approximate Age in Months
0	Reflex acts	0-1
1	Primary circular reactions and begins to develop skills.	1-4
2	Secondary circular reactions and repeats actions that by chance produce interesting results.	4-8
3	Secondary circular reactions and applies acquired skills to new situations.	8-12
4	Tertiary circular reactions and seeks to acquire new skills through active experimentation.	12-18
5	Invents new skills by interiorizing combinations of them.	18-26

Source: Piaget (1936, 1937).

The passage from one stage to the next may be due, at least in part, to the growth of the mental-attentional capacity of the child with age. Mental-attentional capacity is defined as the number of units of information or schemes a child can simultaneously coordinate in a single action directed towards a goal. (Alp, 1988, 1994; Benson, 1989; Pascual-Leone & Johnson, 1991). Table 1 illustrates the relationship between the six stages of the sensory-motor period and the mental-attentional capacity of children. For example, a child progresses to the third stage when he is able to coordinate two schemes. A typical achievement in this period, which appears around the age of five months, is the ability to visually track an object, reach for it and grasp it in the field of vision. Studies conducted over 30 years ago demonstrate that the exercise of the schemes of visual tracking and grasping can considerably accelerate the acquisition of the vision-grasping super-

scheme (White, 1967, 1971; White, Castle & Held, 1964; White & Held, 1966). Thus, infant experience may play a determining role in cognitive development in the first year of life.

A possible indicator of the quality of experience provided by the environment is the socioeconomic status of the family²⁰. Some studies show a link between family socioeconomic status and infant cognitive development in the first year of life, while others have not observed this (for a literature review (see Golden & Birns, 1983; Slater, 1995). This divergence in results may be explained by a number of factors. According to the model developed by Wachs (Haywood & Wachs, 1981; Wachs & Gruen, 1982) on the role of experience in cognitive development, at least four factors can explain the divergence.

First, family socioeconomic status is a variable with many aspects – ages and educational levels of the mother and father, family income, number of children, etc. It is possible that one of these could have an impact on the cognitive development of the child in the first year, and another might not.

Second, cognitive development in the first year of life is a complex phenomenon that covers various domains such as spatial-temporal and logical-mathematical. It is possible that one of these may be affected by family socioeconomic status and another not. In this regard, mental-attentional capacity defined as the ability to coordinate a number of schemes in one action directed

20. Please note that the authors of this section use “socioeconomic status of the family” to designate a possible indicator of the quality of experience provided by the environment. This indicator is different from the derivative variable “socioeconomic status” developed by *Santé Québec* and used in the majority of analytical papers in Volume 1 of the ÉLDEQ 1998-2002 series. This derivative variable is called **ainfd08** in ÉLDEQ’s databank.

towards a goal is considered to be independent of these domains, because the number is not supposed to be dependent on the type of scheme – spatial-temporal, logical-mathematical, etc.

Third, the possible influence of family socioeconomic status on infant cognitive development in the first year of life may depend on characteristics of the child. For example, there could be an association with boys, but not with girls.

Fourth, an influence could vary with the age of the child. An association may be present at a given age, while it may not be at a younger or an older age.

Furthermore, another factor could explain, at least in part, the aforementioned seemingly contradictory results. None of the above studies examined a representative sample of the target population. Therefore, they may have produced biased estimates of the relationship between family socioeconomic status and cognitive development in the first year of life. All these factors could explain, at least in part, why there is absence of consensus in the scientific community on this question.

The main objective of this study was to assess mental-attentional capacity of 5-month-old infants. Do infants at 5 months of age in the population differ in terms of the rate of growth of their mental-attentional capacity? If so, is there a link between certain characteristics of the socioeconomic status of the family and the rate of growth of mental-attentional capacity during the first 5 months of life?

1. Testing Infant Mental-Attentional Capacity: The One, Two, Three Hands Task and Socioeconomic Status of the Family

In the 1998 cycle of the ÉLDEQ survey, the mental-attentional capacity of 5-month-old infants was assessed using the One, Two, Three Hands Task. It comprises two eliciting situations adapted from Uzgiris and Hunt (1989). In the first situation, called “facilitating,” the infant has to grasp a plastic ring presented to him/her in front of the nose or mouth. In the second situation, called “misleading,” the infant has to grasp a small object (i.e. a plastic farm animal), after a ring had been placed in each of his/her hands. Both of these situations require coordinating the visual tracking and grasping schemes in order to grab an object in their field of vision.²¹ In addition, the misleading situation requires prior inhibition of the grasping scheme to one or the other or both rings.

Administering the task always begins with the facilitating situation. Each situation comprises three trials. The procedures of administering the One, Two, Three Hands Task are described in detail in the Appendix.

A number of socioeconomic characteristics of the family were analyzed in this study: (a) mother’s age at the time of the survey (i.e., under 20, 20-24, 25-29, 30-34 or 35 years of age and over); (b) father’s age (i.e., under 25, 25-29, 30-34, 35-39 or 40 years of age and over); (c) and (d) educational level of the mother and father (i.e., no high school diploma, high school diploma, partial high school, vocational/technical school diploma,

CEGEP (junior college) diploma or university degree); (e) type of family (i.e., intact two-parent, stepfamily or single-parent); (f) income level (i.e., above or below the low-income cut-off);²² (g) number of brothers and sisters usually living in the household, including step brothers or sisters (i.e., 0, 1, 2 or 3 and more); (h) mother’s immigrant status (i.e., non-immigrant, immigrant of European origin or immigrant of non-European origin);²³ (i) mother’s age at the birth of her firstborn (i.e., under 21 years of age or not).

21. The schemes of visual tracking and grasping are considered to be in the repertory of schemes of 5-month-old infants, except perhaps in those who have particular disabling diseases such as cerebral palsy. Children with serious disabilities were excluded from the study. However, 9% of ÉLDEQ children had a chronic health condition diagnosed by a doctor at about five months of age such as allergies, kidney or heart problems, epilepsy, etc. (see no. 3 in this series).

22. In this study, income sufficiency status is based on the low income cut-off for a given size of household and region of residence as defined by Statistics Canada (see numbers 2 and 12 in this series of analytical papers).

23. In this study, immigrant status of the father was not analyzed.

2. Statistical Models Used to Account for the 5-Month-Old Infants' Behaviours in the One, Two, Three Hands Task

Latent Class Analysis (LCA) (Lazarsfeld & Henry, 1968) was the main statistical method used in this study. For each situation in the One, Two, Three Hands Task, there were 3 trials with 5 response options for each. Therefore, *a priori*, there were 125 (5^3) categories (i.e., latent classes) of infants for each of the two situations. The main objective of latent class analysis was to identify a limited number of categories of 5-month-old infants from the data collected from the Task's six trials. By definition, infants belonging to the same category will all present the same ability to coordinate visual tracking and grasping. Infants in two different categories will differ as to this same ability. The three LCA models used to analyze infants' behaviours in the Task are presented in the Appendix. The Appendix also contains a brief description of the three statistical models used to examine the possible link between each characteristic of family socioeconomic status and the rate of growth of infant mental-attentional capacity. It also contains technical details on the estimation of the parameters of these statistical models and an assessment of their fit with the data collected in the survey.

3. Results

3.1 Mental-Attentional Capacity of 5-Month-Old Infants in the Population

Among the 2,120 infants who participated in the One, Two, Three Hands Task, 1,851 (87.3%), that is 946 boys and 905 girls, completed the three trials for each of the two situations.²⁴ The results presented in this paper were obtained from the data on these 1,851 babies. They were specially weighted for the Task so that they could be generalized to the Québec population of infants approximately 5 months of age.

Did these infants differ in terms of the rate of growth of their mental-attentional capacity? The results showed that indeed there was a differential, and that the observed differences were not associated with the sex of the infants. The results obtained from the three latent class models are shown in the Appendix. They reveal that the infants belonged to five different categories for both situations, those who: (a) look at the object but do not try to reach for it; (b) try to reach for it but neither touch nor grasp it; (c) touch the object but do not grasp it; (d) grasp it without having previously opened their hand(s); and, (e) grasp it having previously opened their hand(s). Five-month-old infants in the fourth or fifth categories were able to coordinate the schemes of visual tracking and grasping. Infants in the third category were able only in part, whereas those in the first and second were not. Figures A.1 to A.6 in the appendix present the cumulative probabilities of demonstrating a behaviour of a given level of complexity or lower in light of membership in a given category for each of the six trials in the One, Two, Three Hands Task.

Table 3.1 shows the distribution of category membership for the facilitating situation: 56.2% of 5-month-old infants coordinated the visual tracking and grasping schemes to grab an object in their field of vision (i.e., categories 4 and 5); 10.0% coordinated these two schemes in part (i.e., category 3); and 33.8% (i.e., categories 1 and 2) did not demonstrate coordination of these two schemes.

However, we can gain a better understanding of the infants' capacity to coordinate the two schemes by simultaneously examining their performance in both the facilitating situation and the misleading one. Table 3.2 shows the joint conditional distribution of category membership for the misleading situation by given category membership for the facilitating one.

Table 3.1
Distribution of Category Membership in the Facilitating Situation, 1998

Category	Description	Estimated Percentage
1	Looks at the object but does not try to reach for it	25.5
2	Tries to reach for the object but neither touches nor grasps it	8.3
3	Touches the object but does not grasp it	10.0
4	Grasps the object without having previously opened the hand(s)	9.7
5	Grasps the object having previously opened the hand(s)	46.4

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

24. For more details, see no. 1 in this series of papers.

It was observed that only 51.0% of 5-month-old infants in the fifth category for the facilitating situation were in this same category for the misleading one (see Table 3.2). Table 3.2 also shows, in parentheses, the joint non-conditional distribution of category membership for both situations. The findings were as follows: 23.5% of infants belonged to the fifth category in both situations (see Table 3.2); 61.9% coordinated the two schemes (i.e., categories 4 and 5), in at least one of the two situations (percentages identified by the letter "a"), that is 20.6% in the facilitating situation only, 5.7% in the misleading

situation only, and 35.6% in both situations. It was found that 10.8% of infants 5 months of age coordinated, in part, the visual tracking and the grasping schemes (i.e., category 3) in at least one of the two situations (percentages indicated by the letter "b"); namely, 5.4% in the facilitating situation only, 2.6% in the misleading situation only, and 2.7% in both situations. Finally, 27.3% did not coordinate the two schemes (i.e., categories 1 and 2) in either situation (percentages indicated by the letter "c").

Table 3.2
Joint Conditional Distribution of Category Membership in the Misleading Situation Given Category Membership in the Facilitating Situation, 1998

Category Membership in the Facilitating Situation	Category Membership in the Misleading Situation				
	Looks at the object but does not try to reach for it (1)	Tries to reach for the object but neither touches nor grasps it (2)	Touches the object but does not grasp it (3)	Grasps the object without having previously opened the hand(s) (4)	Grasps the object having previously opened the hand(s) (5)
1. Looks at the object but does not try to reach for it	0.79 (20.1) ^c	0.09 (2.3) ^c	0.03 (0.8) ^b	0.03 (0.7) ^a	0.07 (1.7) ^a
2. Tries to reach for the object but neither touches nor grasps it	0.43 (3.6) ^c	0.16 (1.4) ^c	0.22 (1.8) ^b	0.10 (0.8) ^a	0.09 (0.7) ^a
3. Touches the object but does not grasp it	0.33 (3.3) ^b	0.21 (2.1) ^b	0.27 (2.7) ^b	0.07 (0.7) ^a	0.11 (1.1) ^a
4. Grasps the object without having previously opened the hand(s)	0.33 (3.2) ^a	0.06 (0.6) ^a	0.17 (1.6) ^a	0.33 (3.2) ^a	0.11 (1.1) ^a
5. Grasps the object having previously opened the hand(s)	0.18 (8.2) ^a	0.04 (1.9) ^a	0.11 (5.1) ^a	0.17 (7.8) ^a	0.51 (23.5) ^a

Note : The joint non-conditional distribution of category membership for the two situations are indicated in parentheses.

- a. Infants who coordinated the schemes of visual tracking and to grab an object in the field of vision.
- b. Infants who coordinated in part the schemes of visual tracking and to grab an object in the field of vision.
- c. Infants who did not coordinate the schemes of visual tracking and to grab an object in the field of vision.

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

3.2 Links Between Socioeconomic Characteristics and the Growth Rate of Mental-Attentional Capacity in 5-month-old Infants

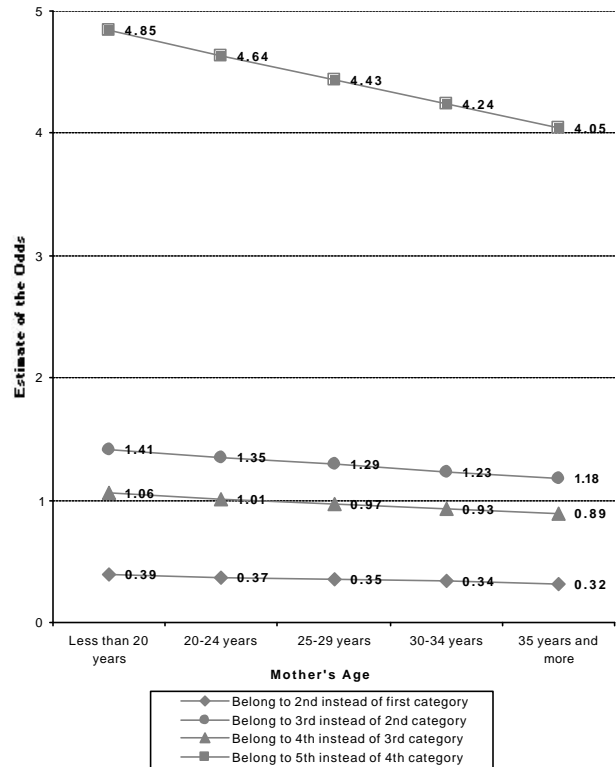
Are there links between certain family socioeconomic characteristics and the growth rate of mental-attentional capacity during the first 5 months of life? The results did not show a link between mental-attentional capacity and the following: mother's and father's educational levels, type of family, and mother's age at the birth of her firstborn.

However, the results showed that mother's and father's ages, household income sufficiency status, number of brothers and sisters, and mother's immigrant status were associated with the rate of growth of mental-attentional capacity in the Québec population of 5-month-old infants. Furthermore, the results showed that these associations did not differ for boys and girls except for income sufficiency in the misleading situation. The results of the three statistical models used to estimate the possible effect of each family socioeconomic characteristics on mental-attentional capacity in 5-month-old infants are shown in the Appendix (Tables A.1 to A.9). What follows are details on the statistically significant associations.

3.2.1 Association Between Mother's Age and the Growth Rate of Mental-Attentional Capacity in 5-Month-Old Infants in the Québec Population

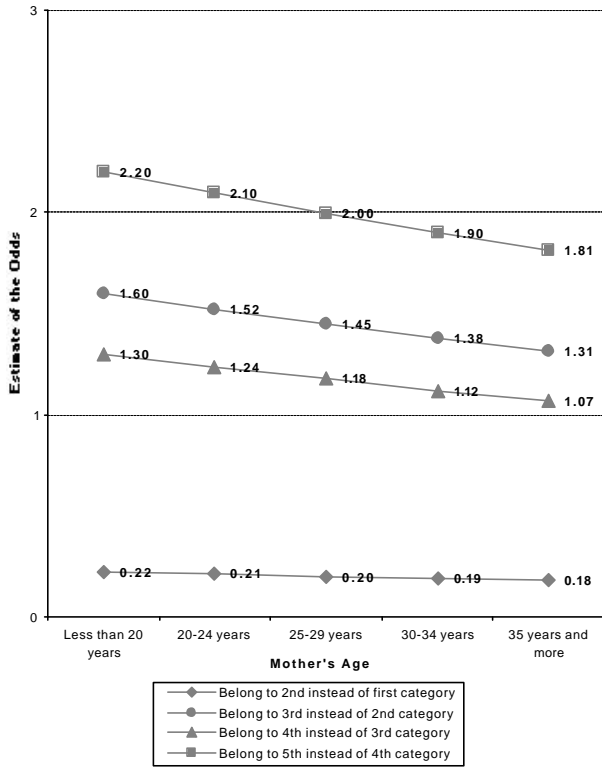
Five-month-old infants with younger mothers were more likely to coordinate the schemes of visual tracking and to grab an object in their field of vision. Figures 3.1a and 3.1b show the estimates of the odds of being in a given category rather than in the next lower one given the age of the mother for the facilitating and misleading situation respectively. For example, for the facilitating situation, infants whose mothers were under 20 years of age were 4.6 times more likely (5.0 for the misleading situation) to be in the fifth rather than the fourth category, compared to those whose mothers were between 20 and 24 years of age.

Figure 3.1a
Odds of Being in a Given Category Rather Than the Next Lower One Given Mother's Age for the Facilitating Situation, 1998



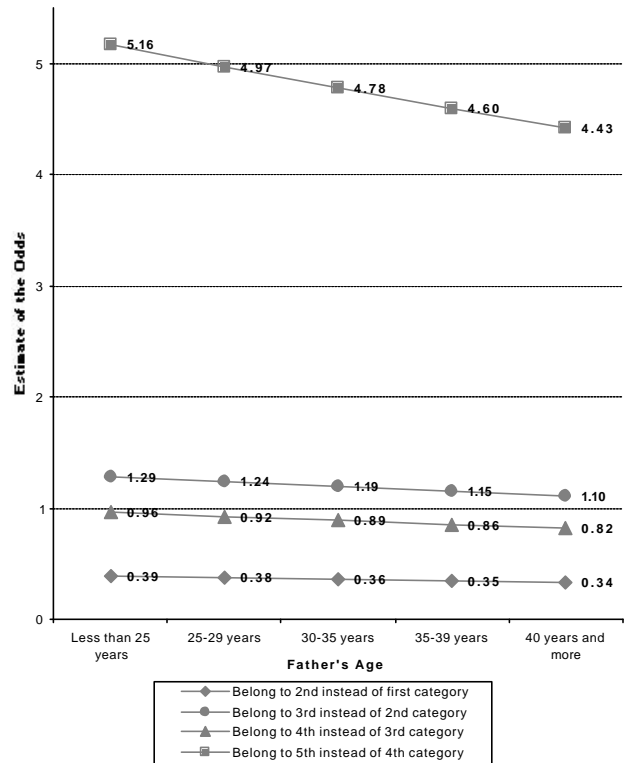
Source: *Institut de la statistique du Québec, ÉLDEQ 1998-2002.*

Figure 3.1b
Odds of Being in a Given Category Rather Than the Next Lower One Given Mother's Age for the Misleading Situation, 1998



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

Figure 3.2a
Odds of Being in a Given Category Rather Than the Next Lower One Given Father's Age for the Facilitating Situation, 1998

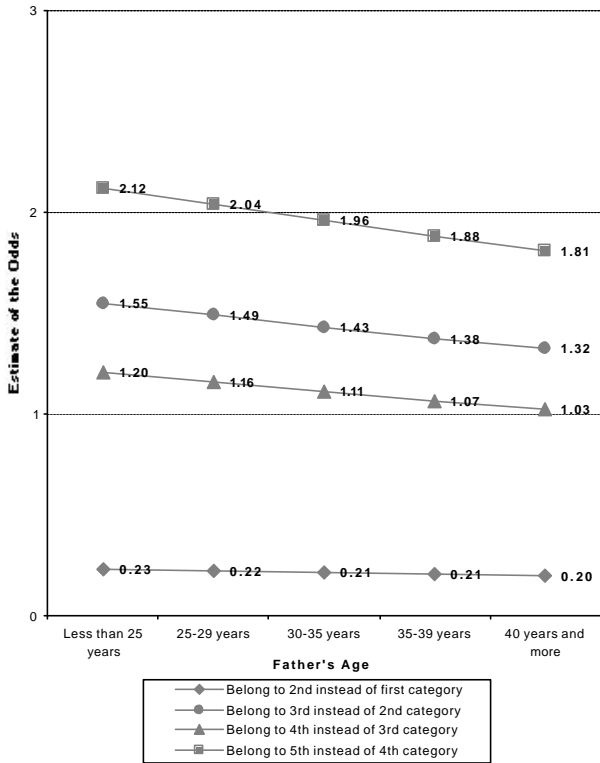


Source: *Institut de la statistique du Québec, ÉLDEQ 1998-2002.*

3.2.2 Association Between Father's Age and the Growth Rate of Mental-Attentional Capacity in 5-Month-Old Infants

Five-month-old infants with younger fathers were more likely to coordinate the schemes of visual tracking and to grab an object in their field of vision. Figures 3.2a and 3.2b show the estimates of the odds of being in a given category rather than the next lower one, given the age of the father for the facilitating and misleading situation respectively. For example, for the facilitating situation, infants whose fathers were under 25 years of age were 3.9 times more likely (4.1 for the misleading situation) to be in the fifth rather than the fourth category, compared to those whose fathers were between 25 and 29 years of age.

Figure 3.2b
Odds of Being in a Given Category Rather Than the Next Lower One Given Father's Age for the Misleading Situation, 1998



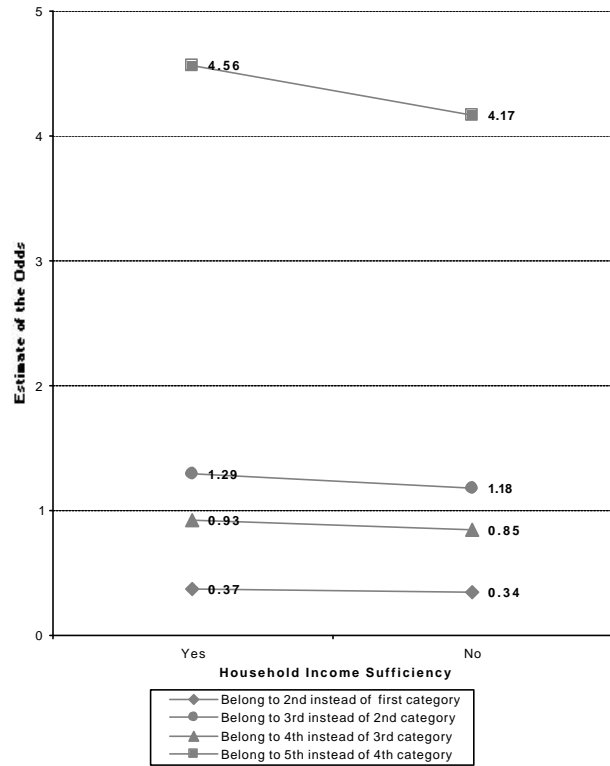
Source: *Institut de la statistique du Québec, ÉLDEQ 1998-2002.*

3.2.3 Association Between Household Income Sufficiency Status and the Growth Rate of Mental-Attentional Capacity in 5-month-old Infants

Five-month-old infants in households with income below the low income cut off were less likely to coordinate the schemes of visual tracking and to grab an object in their field of vision. Figure 3.3a shows the estimates of the odds, for the facilitating situation, of being in a given category rather than the next lower one, given income sufficiency status. Infants whose family income was below the low income cut off were 9.3 times less likely to be in the fifth rather than the fourth category compared to those whose family income was above the cut off. Figure 3.3b shows the odds, for the misleading situation, of being in given category rather than the next lower

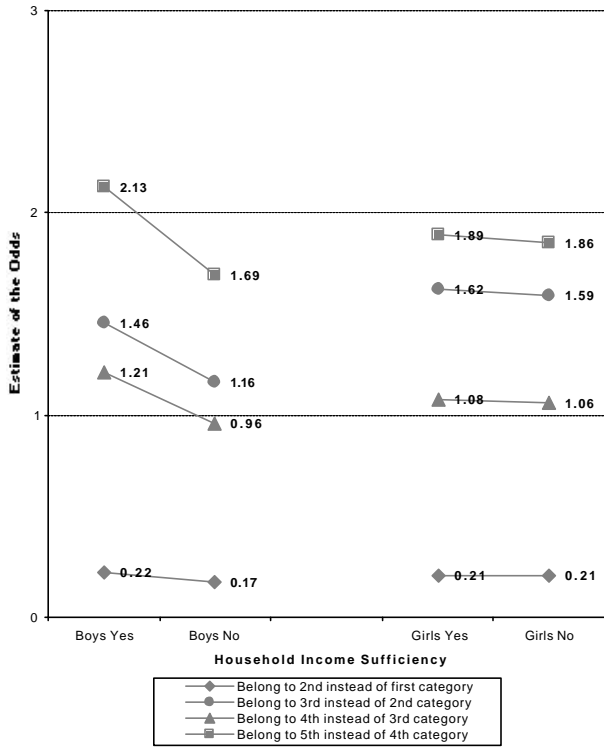
one, given household income sufficiency status. Five-month-old boys in the population whose family income was below the low-income cut off were 29 times less (2.1 times for girls) likely to be in the fifth rather than the fourth category, compared to those whose family income was above the cut off.

Figure 3.3a
Odds of Being in a Given Category Rather Than the Next Lower One Given Household Income Sufficiency Status for the Facilitating Situation, 1998



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

Figure 3.3b
Odds of Being in a Given Category Rather Than the Next Lower One Given Household Income Sufficiency Status for the Misleading Situation, 1998

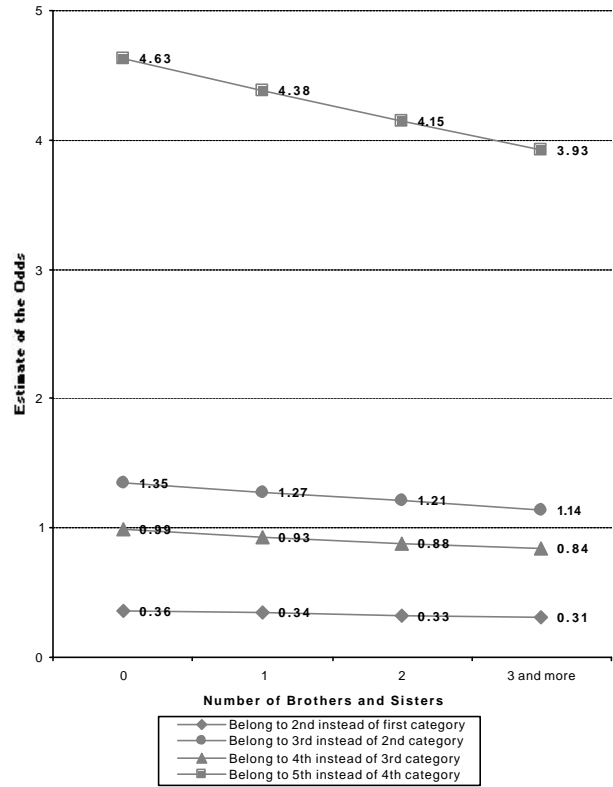


Source: *Institut de la statistique du Québec, ÉLDEQ 1998-2002.*

3.2.4 Association Between Number of Brothers and Sisters and the Growth Rate of Mental-Attentional Capacity in 5-Month-Old Infants

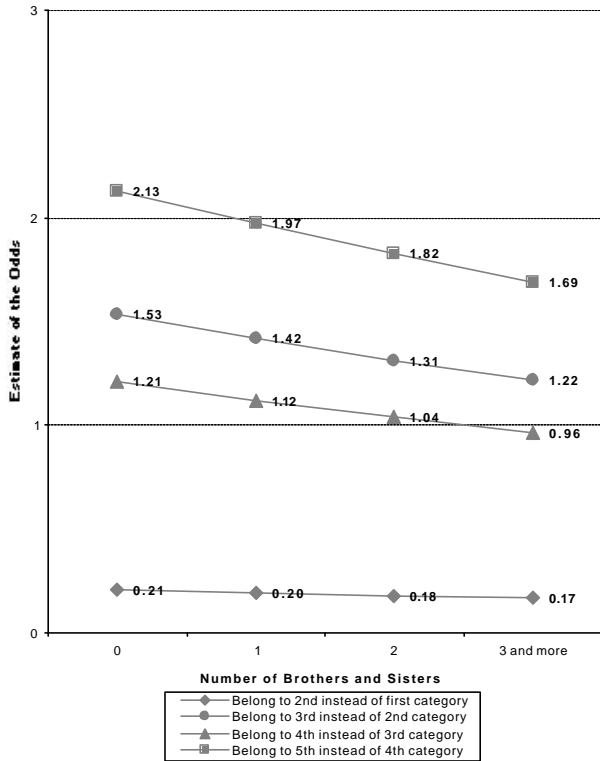
Five-month-old infants in the population who had fewer brothers and sisters were more likely to coordinate the schemes of visual tracking and to grab an object in their field of vision. Figures 3.4a and 3.4b present the odds of being in a given category rather than the next lower one, given the number of brothers and sisters for the facilitating and misleading situation respectively. Infants with no brothers and sisters were, for the facilitating situation, 5.6 times more likely (8.0 times for the misleading situation) to be in the fifth rather than the fourth category, compared to those who had a brother or sister.

Figure 3.4a
Odds of Being in a Given Category Rather Than the Next Lower One Given Number of Brothers and Sisters for the Facilitating Situation, 1998



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

Figure 3.4b
Odds of Being in a Given Category Rather Than the Next Lower One Given Number of Brothers and Sisters for the Misleading Situation, 1998

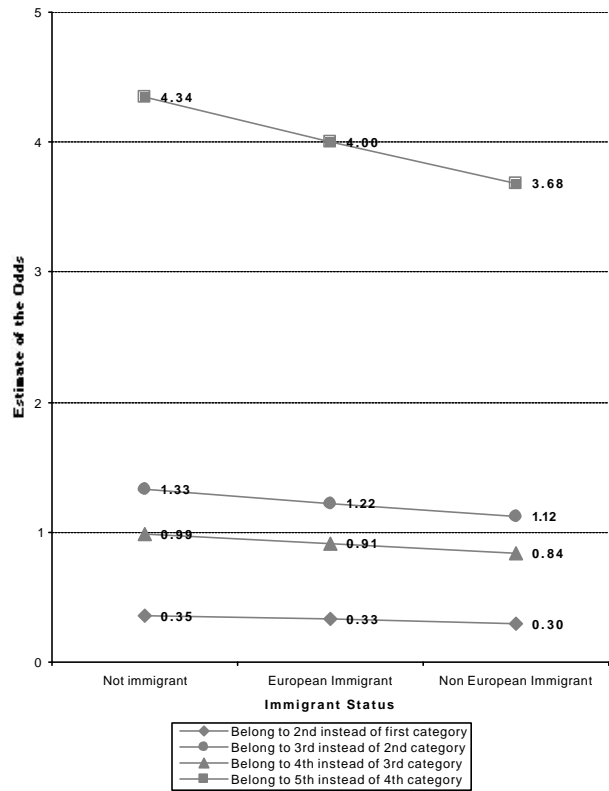


Source: Institut de la statistique du Québec, ÉLDEQ 1998-2002.

3.2.5 Association Between Mother’s Immigrant Status and the Growth Rate of Mental-Attentional Capacity in 5-Month-Old Infants

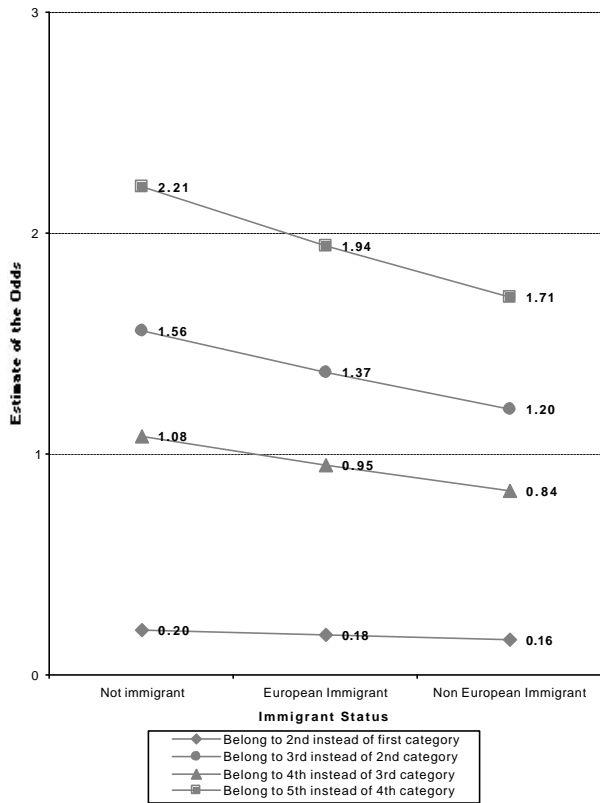
Five-month-old infants whose mother was not an immigrant (or immigrant of European origin) were more likely to coordinate the schemes of visual tracking and to grab an object in their field of vision. Figures 3.5a and 3.5b present the estimates of the odds of being in a given category rather than in the next lower one, given the immigrant status of the mother for the facilitating and misleading situation respectively. Five-month-old infants whose mother was not an immigrant were, for the facilitating situation, 8.7 times more likely (13.7 times for the misleading situation) to be in the fifth rather than the fourth category, compared to those whose mother was of European immigrant origin.

Figure 3.5a
Odds of Being in a Given Category Rather Than the Next Lower One Given Mother’s Immigrant Status for the Facilitating Situation, 1998



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

Figure 3.5b
Odds of Being in a Given Category Rather Than the Next Lower One Given Mother's Immigrant Status for the Misleading Situation, 1998



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

Conclusion

This study has shown that 5-month-old infants in the Québec population differ in terms of mental-attentional capacity growth rate. It was estimated that 38.1% of 5-month-old infants in Québec did not demonstrate the capacity to coordinate the schemes of visual tracking and to grab an object in their field of vision. However, this finding should be interpreted in light of the fact that the One, Two, Three Hands Task, as with any good screening tool, tends to minimize false negatives, namely those who were not able to coordinate two schemes but not identified as such. Therefore, the above figure is likely an over-estimation of the percentage of 5-month-old infants in the Québec population who are not able to coordinate two schemes in one action directed towards a goal. Following these infants over the coming years in the longitudinal survey will allow researchers to determine whether the infants who presented what appears to be a slower rate of development will eventually catch up to the other infants, or if this differential will remain the same or even become larger.

This study has also shown a link between the rate of growth of mental-attentional capacity of 5-month-old infants in the Québec population and certain family socioeconomic characteristics. These were age of the mother and father, income sufficiency status, number of brothers and sisters, and immigrant status of the mother. No doubt all of these characteristics are inter-related, but several studies suggest that the number of brothers and sisters maybe at the heart of the mechanism behind the observed link (Zajonc, 2001; Zajonc & Markus, 1975). For example, older or immigrant parents generally have more children. In addition, for a given income, the number of children in the family determines in large part income sufficiency status. Five-month-old infants who have fewer brothers and sisters may possibly benefit from greater attention on the part of their parents, which might contribute to accelerated cognitive development (Blake, 1981; Downey, 2001). If this is the case, this

socioeconomic characteristic may increase rather than decrease the differences among children in the same family with regards to the growth rate of their mental-attentional capacity. It is still too early to say whether the number of brothers and sisters could have a more or less long-term impact on the mental-attentional capacity of infants. Once again, only longitudinal monitoring will allow for determining whether or not this is the case.

This study was not without limits, however. First, only the coordination of the visual tracking and grasping schemes to grab an object in the field of vision was used to assess the capacity of the infant to coordinate two schemes, whatever they may be, in one action directed towards a goal. Second, visual tracking and grasping coordination, as conceived by Piaget, implies grabbing an object that is not immediately in the child's field of vision. Therefore, this study did not demonstrate that infants who succeeded at grasping an object would have done so if the object had not been in their field of vision.

1. Administering the One, Two, Three Hands Task

1.1 Facilitating Situation

The interviewer presents a coloured ring in front of the infant's nose or mouth at a distance of approximately 12.5 to 15 centimeters from his/her face. The object of this part of the task is for the infant to grab the ring. The procedure is repeated three times with different coloured rings. For each of the three trials, the interviewer notes the infant's behaviour by using the following six descriptions: (a) looks at but does not try to reach for the ring; (b) tries to reach for the ring but neither touches nor grasps it; (c) touches the ring; (d) grasps the ring without having previously opened the hand(s); (e) grasps the ring having previously opened the hand(s); and (f) other (e.g., the test was not administered because the infant was not available).

1.2 Misleading Situation

The interviewer presents a small plastic farm animal in front of the infant's nose or mouth approximately 12.5 to 15 centimeters from the face. The interviewer had previously placed a ring in each of the infant's hands. The object of this part of the task is for the infant to grab the animal. This procedure is repeated three times with different animals. For each trial, the interviewer notes the infant's behaviours using one of the following six descriptions: (a) looks at but does not try to reach for the animal; (b) tries to reach for the animal with his/her hands full but neither touches nor grasps it; (c) tries to reach for the animal with his/her hands full, drops one or both rings to touch the animal; (d) tries to reach for the animal with his/her hands full, drops one or both rings to grasp the animal; (e) drops one/both ring(s) and to grasp the animal; and (f) other (e.g., the test was not administered because the infant was not available).

Administering this task always begins with the facilitating situation. During the entire experiment the infant remains comfortably seated in the arms of an adult, usually the mother, or in a car seat or high chair. The interviewer ensures that the infant has both hands free, except of course in the misleading situation, and as much as possible, nothing in his/her mouth, such as a soother.

2. Latent Class Models Used to Account for the Behaviours of 5-Month-Old Infants in the One, Two, Three Hands Task

1. A model with two, so-called latent variables, one for the facilitating situation, and the other for the misleading one. Each comprises a single latent class, i.e. a single category of infant.
2. A model with two latent variables, one for the facilitating situation, and the other for the misleading one. The following is a description of the characteristics of this model. First, each of the two latent variables comprise five latent classes: (a) infants who look at but do not try to reach for the object; (b) infants who try to reach for the object but neither touch nor grasp it; (c) infants who touch the object but do not grasp it; (d) infants who grasp the object without having previously opened their hand(s); (e) infants who grasp the object having previously opened their hand(s). Infants in the first latent class tend to look at the object but do not try to reach for it. However, the probability of these infants showing other behaviours is not nil, given that an infant can show behaviours that differ from one trial to another. Second, the cumulative probability of showing a behaviour of a given level of complexity or lower decreases or remains the same from the first to the fifth latent class. For example, the probability of looking at an object but not trying to reach for it decreases or remains the same from the first to the fifth latent class. Third, being in a latent class for the

misleading situation is dependent on latent class membership for the facilitating situation, since the former was administered after the latter. Fourth, the cumulative probability of being in a given latent class or lower for the misleading situation decreases or remains the same from the first to the fifth latent class of the facilitating situation. Fifth, this model's parameters do not vary with the sex of the infants.

3. A model similar to the preceding one, except that the parameters could vary with the infant's sex.

3. Statistical Models Used to Estimate the Possible Relationship Between Socioeconomic Characteristics and the Growth Rate of Mental-Attentional Capacity in 5-Month-Old Infants

1. A null association model between the family socioeconomic characteristic and the mental-attentional capacity of 5-month-old infants.
2. A model of association between the family socioeconomic characteristic and the mental-attentional capacity of 5-month-old infants which does not vary with the sex of the infants.
3. A model similar to the preceding, but the association between the family socioeconomic characteristic and the mental-attentional capacity of 5-month-old infants may vary with the sex of the infants.

These last two association models do not vary with the joint conditional distribution region (Clogg & Shihadeh, 1994). This means a single parameter is sufficient to describe the association between the family socioeconomic characteristic and the mental-attentional capacity of 5-month-old infants.

4. Parameters Estimates of the Statistical Models and Evaluation of their Fit with the Survey Data

The parameter estimates of the various statistical models described above were obtained using the IEM program, version 1 (Vermunt, September 18, 1997). For each model, these estimates were obtained from one set of initial values. Unfortunately, the version of IEM used in this study did not provide standard errors for these estimates given the aforementioned constraints (see sections 2 and 3 above). However, IEM did allow for weighting specially designed for the One, Two, Three Hands Task, which made it possible to make inferences about the results for the target population, namely 5-month-old Québec children. Given that SUDAAN does not estimate latent class models, a statistical threshold of 0.25 was adopted to take into account the design effect of the survey.

The fit of the statistical models to the data collected in the survey was assessed using the likelihood-ratio chi-square statistic (L^2). The L^2 follows asymptotically the chi-square distribution with a certain number of degrees of freedom. A high L^2 value compared to the degrees of freedom indicates that the model is not a good fit to the data. Conversely, a low L^2 value compared to the degrees of freedom indicates that the model is a good fit to the data. In addition, given that the L^2 can be precisely partitioned, it can be used to compare the adjustment of two hierarchically related models (i.e., one model includes a sub-group of the other's parameters) by subtracting the L^2 and the degrees of freedom associated with the two models in question (Fienberg, 1980). The comparison of models was also conducted using the AIC [Akaike's Information Criterion; AIC: $L^2 - (2 \times \text{degrees of freedom})$] and the BIC [Bayesian Information Criterion; BIC: $L^2 - (\text{degrees of freedom}) (\log N)$]. The model with the lowest AIC (BIC) value was considered to be the most parsimonious and was therefore retained (Bollen, 1989).

5. Results of the Three Latent Class Models Used to Analyze the Behaviours of 5-Month-Old Infants in the One, Two, Three Hands Task

The L^2 associated with the model of the two latent variables each comprising five classes of which the parameters may vary according to infant sex was 3,862.22 with 31,055 degrees of freedom ($p = 1.0$),²⁵ which suggests that this model is appropriate for describing the behaviours of the 5-month-old infants in the One, Two, Three Hands Task. The L^2 associated with the model of the two latent variables each comprising one class was 12,024.27 with 31,200 degrees of freedom ($p = 1.0$). This shows a substantial increase in the L^2 compared to that of the degrees of freedom (i.e., $L^2 = 12,024.27 - 3,862.22 = 8,162.05$; degree of freedom = $31,200 - 31,055 = 145$; $p = .00$). This means that the hypothesis that 5-month-old infants do not differ in terms of the growth rate of their mental-attentional capacity can be discarded. The L^2 associated with the model of the two latent variables each comprising five classes the parameters of which do not vary with infant sex was 3,955.40 with 31,129 degrees of freedom ($p = .07$).²⁶ This increase in the L^2 was not a substantial one compared to the increase in the degrees of freedom ($L^2 = 3,955.40 - 3,862.22 = 93.19$; degree of freedom = $31,129 - 31,055 = 74$; $p = .07$). Moreover, it is this last model that presented the lowest AIC and BIC values. This means, therefore, that the hypothesis that 5-month-old boys and girls in the population do not differ in terms of the growth rate of their mental capacity cannot be discarded.

25. The probability of obtaining an equal or smaller L^2 value given that the model is true.

26. This model explained 67.11% (i.e., $1 - [3,955.40 / 12,024.27]$) of the variance observed in the behaviours of the 5-month-old infants in the Imitation Sorting Task.

6. Cumulative Probabilities of Showing a Behaviour of Given Complexity or Lower Given Membership in a Latent Class for Each of the Six Trials in the One, Two, Three Hands Task

Figures A.1 to A.6 show the cumulative probabilities of showing a behaviour of a given complexity or lower given membership in a latent class for each of the six trials of the One, Two, Three Hands Task. A look at these cumulative probabilities indicates that the five latent classes represent increasing levels of performance:

1. The cumulative probability of looking at the object but not trying to reach for it was relatively high in 5-month-old infants in the first latent class whereas it was much lower for those in the other four latent classes.
2. The cumulative probability of at most attempting to reach for the object but not touching or grasping it was relatively high in 5-month-old infants in the first two latent classes whereas it was much lower for those in the three other latent classes.
3. The cumulative probability of at most touching the object but not grasping it was relatively high in 5-month-old infants in the first three latent classes whereas it was much lower for those in the other two latent classes.
4. The cumulative probability of at most grasping the object without having previously opened the hand(s) was relatively high in 5-month-old infants who were in the first four latent classes whereas it was much lower for those in the fifth latent class.

Figure A.1
Cumulative Probability of Showing a Behaviour of a Given Complexity or Lower By Category for the First Trial in the Facilitating Situation, 1998

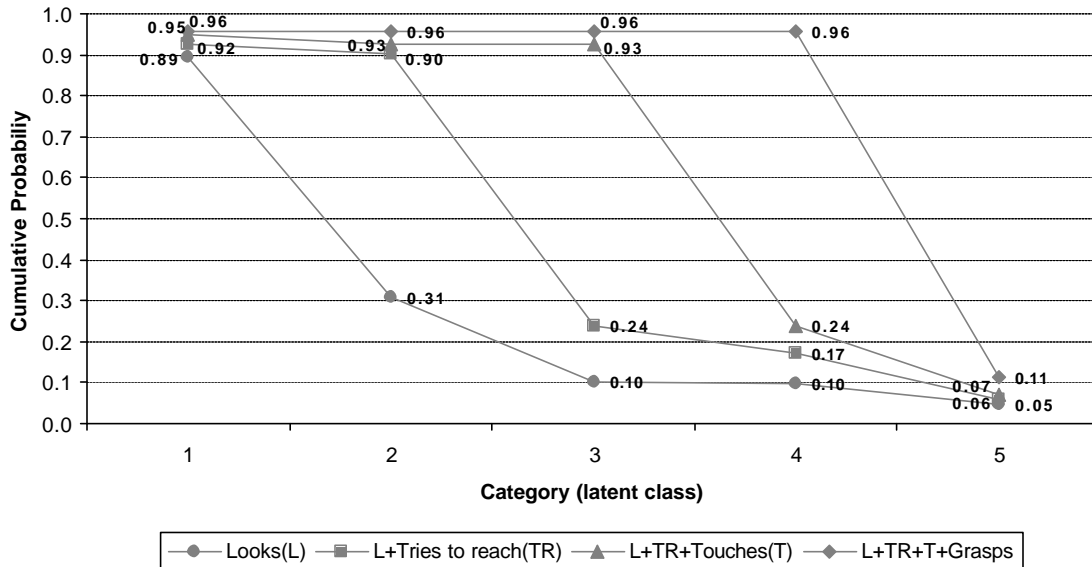
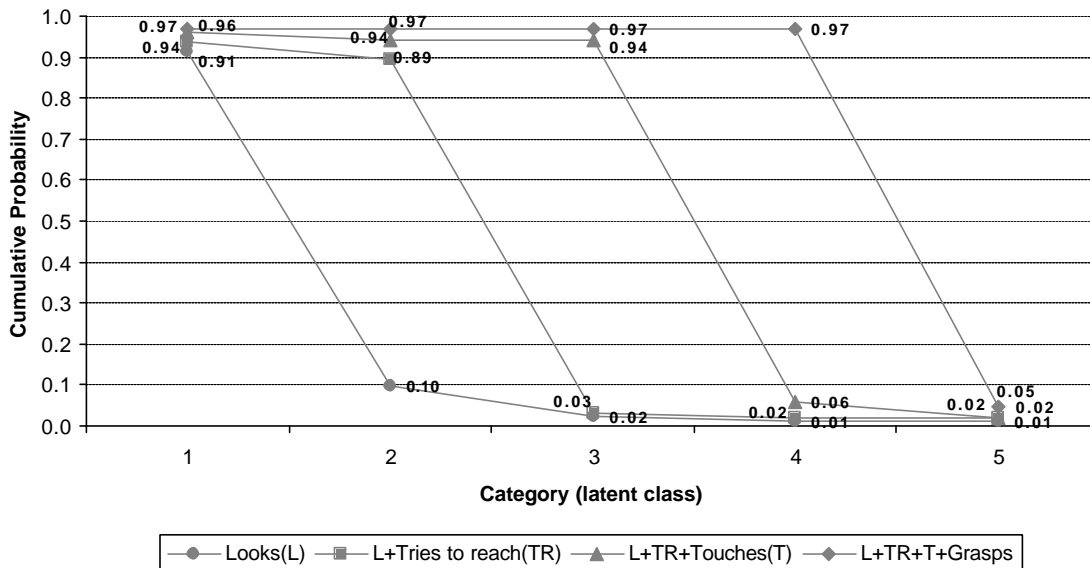


Figure A.2
Cumulative Probability of Showing a Behaviour of a Given Complexity or Lower By Category for the Second Trial in the Facilitating Situation, 1998



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

Figure A.3
Cumulative Probability of Showing a Behaviour of a Given Complexity or Lower By Category for the Third Trial in the Facilitating Situation, 1998

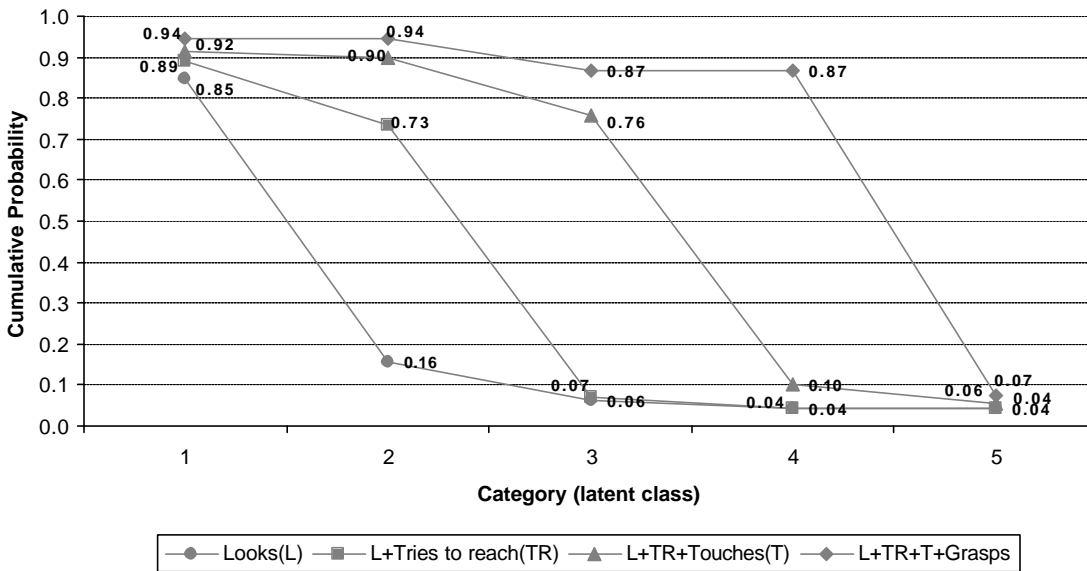
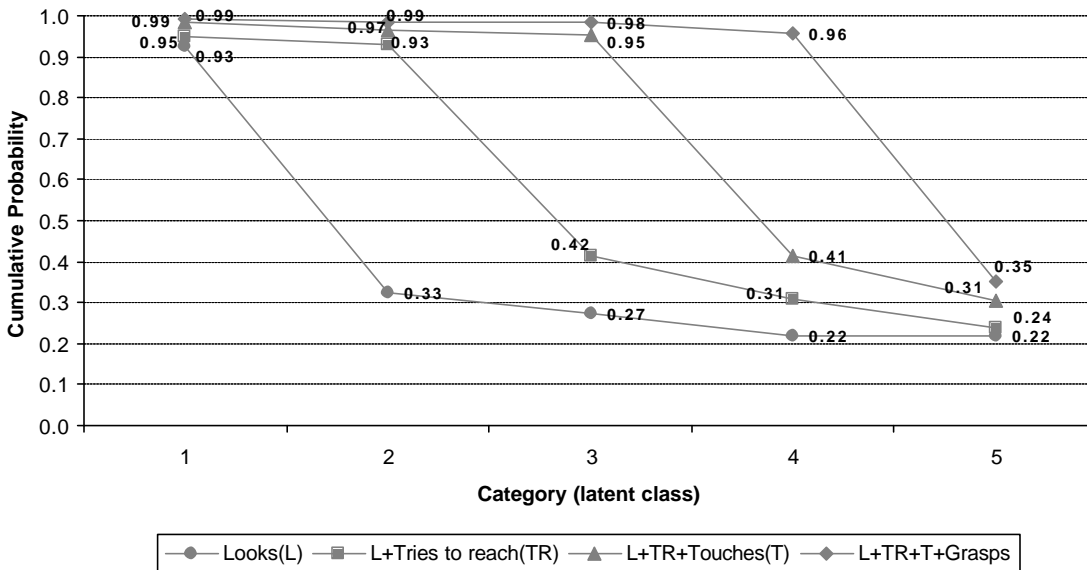


Figure A.4
Cumulative Probability of Showing a Behaviour of a Given Complexity or Lower By Category for the First Trial in the Misleading Situation, 1998



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

Figure A.5
Cumulative Probability of Showing a Behaviour of a Given Complexity or Lower By Category for the Second Trial in the Misleading Situation, 1998

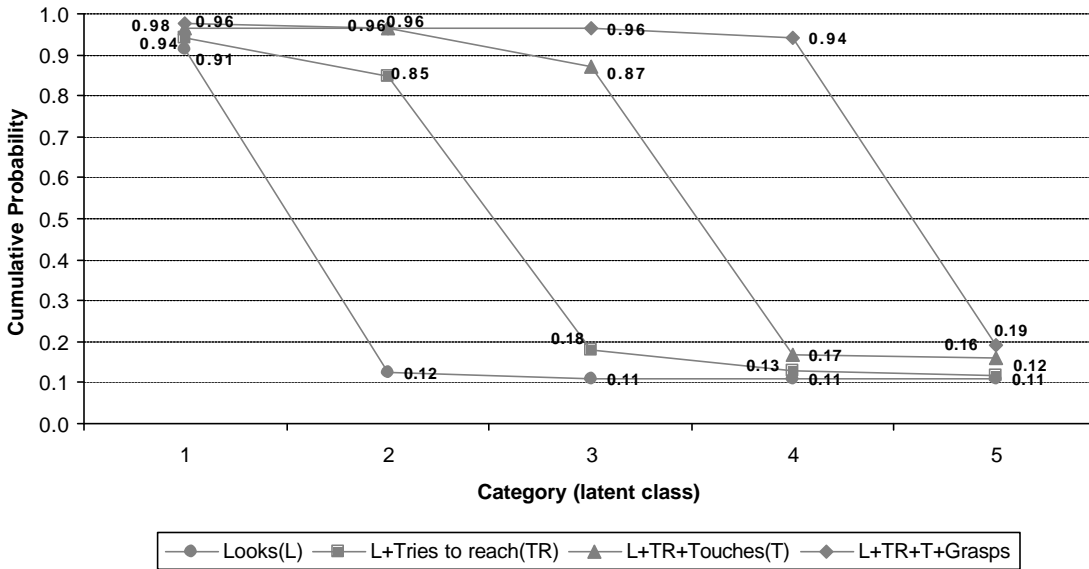
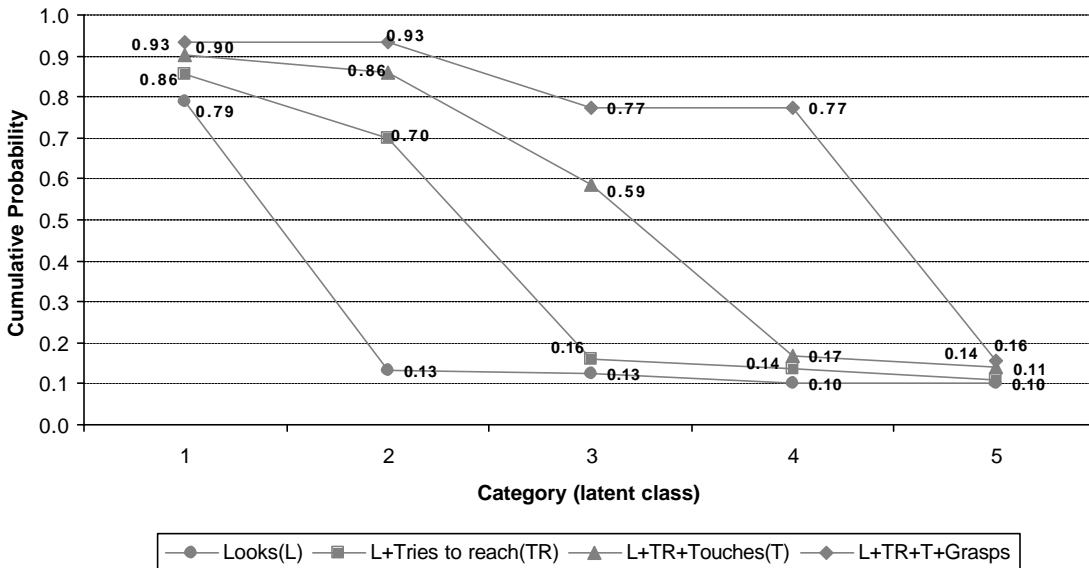


Figure A.6
Cumulative Probability of Showing a Behaviour of a Given Complexity or Lower By Category for the Third Trial in the Misleading Situation, 1998



Source: Institut de la statistique du Québec, ÉLDEQ 1999-2002.

7. Results of the Three Statistical Models Used to Estimate the Possible Relationships Between Family Socioeconomic Characteristics and the Growth Rate of Mental-Attentional Capacity in 5-Month-Old Infants

Tables A.1 to A.9 show the results of the three statistical models used to estimate the possible relationship between each characteristic of family socioeconomic status and the growth rate of mental-attentional capacity in 5-month-old infants. For both situations, for each characteristic, the L^2 associated with the model of association between the socioeconomic characteristic and mental-attentional capacity which varied with infant sex was small compared to the degrees of freedom (see Tables A.1 to A.9). Therefore this model was an appropriate one for indicating the association between the socioeconomic characteristic of the family and mental-attentional capacity. For both situations, the model of null association between the socioeconomic characteristic and the mental-attentional capacity showed a substantial increase in the L^2 compared to that in the degrees of freedom for age of the mother and father, household income sufficiency status,²⁷ number of brothers and sisters, and mother's immigrant status (see Tables A.1 to A.9). Therefore, for these particular characteristics, the hypothesis that there would be no association between socioeconomic status and the mental-attentional capacity of 5-month-old infants was discarded. Indeed, for these characteristics, the model of association between socioeconomic characteristics and mental-attentional capacity which does not vary

with infant sex, did not show a substantial increase in the L^2 compared to that in the degrees of freedom for the two situations, except for income sufficiency status in the misleading situation (see Tables A.1 to A.9). Moreover, it was this model that had the lowest AIC and BIC²⁸ values for both situations, except for income sufficiency status in the misleading situation.

27. In the facilitating situation, for household income sufficiency status, it became clear that the hypothesis of no association between household income sufficiency and mental-attentional capacity should be discarded if we compare the null association model to the association model that does not vary with infant sex ($L^2 = 427.57 - 420.26 = 7.31$; degree of freedom = $440 - 439 = 1$; $p = .01$).

28. In the facilitating situation, for income insufficiency status, the BIC suggests that the null association model is the most parsimonious, whereas the AIC and the L^2 values suggest that the model of association that does not vary with infant sex is a better model, and was therefore the one retained.

Table A.1

Mother's Age and Mental-Attentional Capacity of 5-Month-Old Infants, 1998

	Facilitating Situation				
	L ²	df	p	AIC	BIC
Model					
1	916.74	1,185	1	- 1,453.26	- 7,997.94
2	905.83	1,184	1	- 1,462.17	- 8,001.33
3	905.76	1,183	1	- 1,460.24	- 7,993.88
1 versus 3	10.99	2	0.004	–	–
2 versus 3	0.07	1	0.79	–	–
	Misleading Situation				
	L ²	df	p	AIC	BIC
Model					
1	1,022.08	1,180	1	- 1,337.92	- 7,854.99
2	1,010.64	1,179	1	- 1,347.36	- 7,858.91
3	1,009.78	1,178	1	- 1,346.22	- 7,852.24
1 versus 3	12.30	2	0.002	–	–
2 versus 3	0.86	1	0.35	–	–

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

Note for Tables A.1 to A.9 : Model 1: Null association between a given socioeconomic characteristic and mental-attentional capacity of 5-month-old infants. Model 2: Association between a given socioeconomic characteristic and mental-attentional capacity of 5-month-old infants which does not vary with infant sex. Model 3: Association between a given socioeconomic characteristic and mental-attentional capacity of 5-month-old infants that varies with infant sex. L²: Likelihood-ratio chi-square statistic. df: degree of freedom. AIC: (Akaike's Information Criterion): L² – (2df). BIC (Byesian Information Criterion): L² – (df) (log N).

Table A.2

Father's Age and Mental-Attentional Capacity of 5-Month-Old Infants¹, 1998

	Facilitating Situation				
	L ²	df	p	AIC	BIC
Model					
1	869.68	1,183	1	- 1,496.32	- 7,938.25
2	861.51	1,182	1	- 1,502.45	- 7,938.97
3	861.07	1,181	1	- 1,500.93	- 7,931.97
1 versus 3	8.61	2	0.01	–	–
2 versus 3	0.44	1	0.51	–	–
	Misleading Situation				
	L ²	df	p	AIC	BIC
Model					
1	1,047.12	1,179	1	- 1,310.88	- 7,731.03
2	1,039.61	1,178	1	- 1,316.39	- 7,731.09
3	1,037.96	1,177	1	- 1,316.04	- 7,725.29
1 versus 3	9.15	2	0,01	–	–
2 versus 3	1.65	1	0,20	–	–

1. Given that the partial non-response rate was higher than 5% namely 7.51%, these results are for information purposes only

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

Table A.3

Mother's Educational Level and Mental-Attentional Capacity of 5-Month-Old Infants, 1998

	Facilitating Situation				
	L ²	df	p	AIC	BIC
Model					
1	1,038.22	1,433	1	- 1,827.79	- 9,741.38
2	1,038.12	1,432	1	- 1,825.88	- 9,733.96
3	1,038.11	1,431	1	- 1,823.89	- 9,726.44
1 versus 3	0.10	2	0.95	–	–
2 versus 3	0.01	1	0.93	–	–
	Misleading Situation				
	L ²	df	p	AIC	BIC
Model					
1	1,291.35	1,428	1	- 1,564.65	- 9,450.64
2	1,288.70	1,426	1	- 1,563.30	- 9,438.24
3	1,286.84	1,425	1	- 1,563.17	- 9,432.59
1 versus 3	4.51	2	0.10	–	–
2 versus 3	1.87	1	0.17	–	–

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

Table A.4

Father's Educational Level and Mental-Attentional Capacity of 5-Month-Old Infants, 1998¹

	Facilitating Situation				
	L ²	df	p	AIC	BIC
Model					
1	1,033.10	1,431	1	- 1,828.90	- 9,607.01
2	1,030.55	1,430	1	- 1,829.45	- 9,602.13
3	1,030.43	1,429	1	- 1,827.57	- 9,594.81
1 versus 3	2.67	2	0.26	–	–
2 versus 3	0.12	1	0.73	–	–
	Misleading Situation				
	L ²	df	p	AIC	BIC
Model					
1	1,248.19	1,427	1	- 1,605.81	- 9,362.18
2	1,248.04	1,426	1	- 1,603.96	- 9,354.89
3	1,247.95	1,426	1	- 1,604.05	- 9,354.98
1 versus 3	0.24	2	0.89	–	–
2 versus 3	0.09	1	0.76	–	–

1. Given that the partial non-response rate was higher than 5% namely 8.43%, these results are for information purposes only

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

Table A.5

Type of Family and Mental-Attentional Capacity of 5-Month-Old Infants, 1998

	Facilitating Situation				
	L ²	df	p	AIC	BIC
Model					
1	517.67	689	1	- 860.33	- 4,663.40
2	517.23	688	1	- 858.77	- 4,656.32
3	515.55	687	1	- 858.45	- 4,650.48
1 versus 3	2.12	2	0.3466	–	–
2 versus 3	1.68	1	0.1953	–	–
	Misleading Situation				
	L ²	df	p	AIC	BIC
Model					
1	581.43	683	1	- 784.57	- 4,554.52
2	579.96	681	1	- 782.04	- 4,540.95
3	579.50	680	1	- 780.50	- 4,533.89
1 versus 3	1.93	2	0.38	–	–
2 versus 3	0.46	1	0.50	–	–

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

Table A.6

Income Sufficiency Status and Mental-Attentional Capacity of 5-Month-Old Infants, 1998

	Facilitating Situation				
	L ²	df	p	AIC	BIC
Model					
1	427.57	441	0.7	- 454.43	- 2,883.08
2	420.26	440	0.7	- 459.74	- 2,882.88
3	420.25	439	0.7	- 457.76	- 2,875.39
1 versus 3	7.33	2	0.03	–	–
2 versus 3	0.02	1	0.90	–	–
	Misleading Situation				
	L ²	df	p	AIC	BIC
Model					
1	491.60	436	0.03	- 380.40	- 2,781.51
2	478.60	434	0.07	- 389.40	- 2,779.50
3	470.12	434	0.11	- 397.88	- 2,787.98
1 versus 3	21.48	2	0	–	–
2 versus 3	8.48	1	0.004	–	–

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

Table A.7

Number of Brothers/Sisters and Mental-Attentional Capacity of 5-Month-Old Infants, 1998

	Facilitating Situation				
	L ²	df	p	AIC	BIC
Model					
1	762.43	937	1	- 1,111.57	- 6,287.08
2	751.40	936	1	- 1,120.61	- 6,290.58
3	750.45	935	1	- 1,119.55	- 6,284.00
1 versus 3	11.97	2	0.003	–	–
2 versus 3	0.94	1	0.33	–	–
	Misleading Situation				
	L ²	df	p	AIC	BIC
Model					
1	810.99	932	1	- 1,053.01	- 6,200.89
2	791.74	931	1	- 1,070.26	- 6,212.62
3	791.64	930	1	- 1,068.36	- 6,205.20
1 versus 3	19.35	2	0	–	–
2 versus 3	0.10	1	0.76	–	–

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

Table A.8

Mother's Immigrant Status and Mental-Attentional Capacity of 5-Month-Old Infants, 1998

	Facilitating Situation				
	L ²	df	p	AIC	BIC
Model					
1	445.59	689	1	- 932.41	- 4,737.34
2	433.91	688	1	- 942.09	- 4,741.50
3	432.72	687	1	- 941.28	- 4,735.17
1 versus 3	12.87	2	0.002	–	–
2 versus 3	1.18	1	0.28	–	–
	Misleading Situation				
	L ²	df	p	AIC	BIC
Model					
1	533.38	684	1	- 834.62	- 4,611.94
2	511.09	682	1	- 852.91	- 4,619.19
3	510.97	681	1	- 851.04	- 4,611.79
1 versus 3	22.42	2	0	–	–
2 versus 3	0.13	1	0.72	–	–

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

Table A.9

Mother's Age at Birth of Firstborn and Mental-Attentional Capacity of 5-Month-Old Infants, 1998

	Facilitating Situation				
	L ²	df	p	AIC	BIC
Model					
1	420.78	441	0.75	- 461.22	- 2,896.83
2	419.31	440	0.75	- 460.69	- 2,890.79
3	413.52	438	0.79	- 462.48	- 2,881.53
1 versus 3	7.27	2	0.03	–	–
2 versus 3	5.79	1	0.02	–	–
	Misleading Situation				
	L ²	df	p	AIC	BIC
Model					
1	443.01	436	0.40	- 428.99	- 2,836.99
2	442.71	435	0.39	- 427.29	- 2,829.77
3	442.48	434	0.38	- 425.52	- 2,822.48
1 versus 3	0.53	2	0.77	–	–
2 versus 3	0.86	1	0.35	–	–

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

7.1 Association Between Mother's Age and the Growth Rate of Mental-Attentional Capacity in 5-Month-Old Infants in the Québec population

For the facilitating (misleading) situation, 5-month-old infants whose mother was a given age were 4.6 (5.0) times more likely to be in a given latent class than in the next lower one, compared to those whose mother was in the next higher age group (see Figures 3.1a and 3.1b).

7.2 Association Between Father's Age and the Growth Rate of Mental-Attentional Capacity in 5-Month-Old Infants

For the facilitating (misleading) situation, 5-month-old infants whose father was of a given age were 3.9 (4.1) times more likely to be in a given latent class than in the next lower one, compared to those whose father was in the next higher age group (see Figures 3.2a and 3.2b).

7.3 Association Between Household Income Sufficiency Status and the Growth Rate of Mental-Attentional Capacity in 5-Month-Old Infants

For the facilitating situation, 5-month-old infants whose family income was below the low-income cut off, were 9.3 times less likely to be in a given latent class rather than the next lower one (see Figure 3.3a). For the misleading situation, 5-month-old boys whose family income was below the low-income cut off, were 29.0 times less likely to be in a given latent class than the next lower one (see Figure 3.3b). However, this stimuli was only 2.1 for 5-month-old girls (see Figure 3.3b).

7.4 Association Between Number of Brothers and Sisters and the Growth Rate of Mental-Attentional Capacity in 5-Month-Old Infants

For the facilitating (misleading) situation, 5-month-old infants who had a given number of brothers and sisters were 5.6 (8.0) times more likely to be in a given latent class than in the next lower one, compared to those who had an additional brother or sister (see Figures 3.4a and 3.4b).

7.5 Association Between Mother's Immigrant Status and the Growth Rate of Mental-Attentional Capacity in 5-Month-Old Infants

For the facilitating (misleading) situation, 5-month-old infants whose mother was not an immigrant (European immigrant origin) were 8.7 (13.7) times more likely to be in a given latent class than in the next lower one lower, compared those whose mother was of European immigrant origin (non-European immigrant origin) (see Figures 3.5a and 3.5b).

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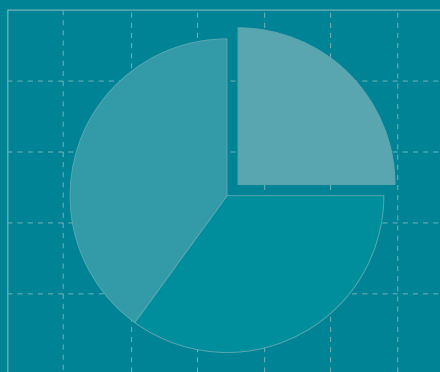
<i>Centre de la petite enfance</i>	Child-care centre
<i>Commission d'accès à l'information du Québec – CAI</i>	Québec Access to Information Commission
<i>Conseil québécois de la recherche sociale</i>	Social Research Council of Québec
<i>Direction de la méthodologie et des enquêtes spéciales, ISQ</i>	Methodology and Special Surveys Division, ISQ
<i>Direction de la santé publique de la Régie régionale de la Santé et des services sociaux de Montréal-Centre</i>	Public Health Department, Montréal-Centre, Regional Health Board
<i>Direction de la technologie et des opérations statistiques, ISQ</i>	Technology and Statistical Operations Division, ISQ
<i>Direction des normes et de l'information, ISQ</i>	Standards and Information Division, ISQ
<i>Direction Santé Québec, ISQ</i>	Health Québec Division, ISQ
<i>Étude des jumeaux nouveaux-nés au Québec – ÉJNQ</i>	Québec Study of Newborn Twins
<i>Fichier maître des naissances</i>	Master Birth Register
<i>Fonds de la recherche en santé du Québec (FRSQ)</i>	Health Research Fund of Québec
<i>Fonds pour la formation de chercheurs et l'aide à la recherche (FCAR)</i>	Researcher Education and Research Assistance Fund
<i>Groupe de recherche sur l'inadaptation psychosociale chez l'enfant – GRIP</i>	Research Unit on Children's Psychological Maladjustment
<i>Institut de la statistique du Québec</i>	Québec Institute of Statistics
<i>La Politique Familiale</i>	Policy on Families
<i>Le Rapport Bouchard (1991)</i>	The Bouchard Report, 1991: A Québec
<i>« Un Québec fou de ses enfants »</i>	In Love with its Children
<i>Les Priorités nationales de santé publique</i>	Priorities for Public Health
<i>ministère de l'éducation</i>	Ministry of Education
<i>ministère de la Famille et de l'Enfance</i>	Ministry of Family and Child Welfare
<i>ministère de la Justice</i>	Ministry of Justice
<i>ministère de la Recherche, Science et Technologie</i>	Ministry of Research, Science and Technology
<i>ministère de la Santé et des Services sociaux du Québec (MSSS)</i>	Ministry of Health and Social Services of Québec
<i>ministère de la Sécurité publique</i>	Ministry of Public Security
<i>ministère de la Solidarité sociale</i>	Ministry of Social Solidarity – formerly Income Security (Welfare)
<i>Personne qui connaît le mieux l'enfant (PCM)</i>	Person Most Knowledgeable (PMK)
<i>Politique de la santé et du bien-être</i>	Policy on Health and Well-Being
<i>Service la recherche</i>	Research services
<i>Service de support aux opérations de la Régie de l'assurance-maladie du Québec – RAMQ</i>	Operations Support Section of the Québec Health Insurance Board

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A child's level of motor and social development during infancy is associated with a number of indicators of adjustment later on in life. Although the sequence and the timing of the stages appear to be universal, various factors account for differences in development among infants. The first part of this section examines the motor and social development of infants in Québec. Information provided by mothers allows us to present an overview of the motor and social development of infants who were about 5 months old when data were first collected for the Longitudinal Study of Child Development in Québec (ÉLDEQ 1998-2002). Furthermore, we examine if certain characteristics of the infant's sociodemographic and family context are associated with the fact that he/she has already manifested certain abilities.

The Longitudinal Study of Child Development in Québec (ÉLDEQ 1998-2002) also provides an exceptional opportunity to assess, on an annual basis, early cognitive development in a very large representative sample of five-month-old Québec children. The main objective of this second section is to evaluate the mental capacity of infants at the age of five months. Of specific interest is the developmental pace of mental capacity: 1) Does this pace differ among infants, and 2) Are there links between certain aspects of socioeconomic status and the development pace of mental capacity?



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