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Health status, cognitive and motor development of young children adopted from China, East Asia, and Russia across the first 6 months after adoption

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We compared health status, anthropometric and psychological development of 123 children adopted before 18 months of age from China, East Asia (Vietnam, Taiwan, Thailand, South Korea, Cambodia), and Eastern Europe (mostly Russia). Data were collected close to the time of arrival, and 3 and 6 months later. Anthropometric measures included weight, height, and head circumference percentiles, and weight/height and height/age ratios (indices of acute and chronic malnutrition, respectively). We assessed cognitive (MDI) and motor (PDI) developments with the Bayley Scales of Infant Development (Bayley, 1993). At time of arrival, children presented physical, cognitive, and motor delays, as well as health problems. Growth parameters improved with time, but differently among the groups. East Asian children, in a better physical state at time of arrival, changed less than the others did across time. Children adopted from Russia globally had lower MDI than the others, while children adopted from East Asia had the highest PDI. Hierarchical linear modelling indicated that initial MDI was related to height/age ratio (index of chronic malnutrition), while its change over time was related to age at time of arrival. PDI was also related to height/age ratio, as well as to presence/absence of neurological signs at time of arrival. Infants with a higher risk index had lower MDI and PDI initial scores.

The number of children adopted from abroad has been steadily increasing during the last decade in Western countries. Worldwide, more than 75,000 international adoptions are realised each year (Chicoine, 2001). Because of the importance of international adoption in our societies, it appeared crucial to document the state of the children at the moment of their adoption and to follow their development across multiple domains of functioning, such as physical growth and cognitive and socio-emotional development (Gunnar, Bruce, & Grotevant, 2000). This information is instrumental to the offer of adequate counselling to the adoptive families and to provide efficient care to their adopted children. On a theoretical level, this study participates in the understanding of early environmental and experiential impacts on child development. It shows how certain specific variables early in the life of children, especially those associated with a deprived environment, may have an effect on the quality of their development, both present and future. It also indicates how changes in environmental conditions can modify their developmental trajectory and alleviate the impacts of these early variables (O'Connor, Rutter, Beckett, Keaveney, Kreppner, & the English and Romanian Adoptees [ERA] Study Team, 2000; Rutter, O'Connor, & the English and Romanian Adoptees [ERA] Study Team, 2004; Schaffer. 2000).

Research has shown that, at the time of their arrival in their adoptive country, many children are in precarious physical and psychological conditions (Gunnar et al., 2000; Johnson, 2000; Johnson et al., 1992; Miller, 2000; Miller, Kiernan, Mathers, & Klein-Gitelman, 1995; Proos, Hofvander, Wennqvist, & Tuvemo, 1992a; Tizard, 1991). Their weight, stature, and head circumference are often below the norm for their age. These measures indicate deficits in the children's nutritional status as well as psychosocial deprivation. Researchers also report frequent medical problems in adopted children, such as respiratory diseases, hepatitis B, intestinal parasites, foetal alcohol syndrome, congenital anomalies, and neurological organic diseases (Chicoine, 2001; Hostetter, 1999; Johnson et al., 1992; Miller et al., 1995; Tizard, 1991). When assessed for cognitive, motor and socio-emotional development, standardised evaluations usually indicate delays. Researchers explain children's poor condition at their arrival mostly by deficits in their pre-adoption life (Ames & Chisholm, 2001; Gunnar et al., 2000).

Some researchers have reported relations between the physical and the psychological conditions of adopted children. Miller et al. (1995) followed 129 children adopted in the United States from 22 different countries (mostly from

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Romania, China, Korea, Paraguay). Between 6 and 18 weeks after arrival, children's weight, height, and head circumference were positively related to their cognitive, motor, and language developmental scores. According to the authors, children's physical and psychological status at time of arrival reflect the pre-adoption context, particularly malnutrition conditions and psychosocial deprivation. In predictive studies, no relations were found between initial growth failure and subsequent cognitive development (Benoit, Jocelyn, Moddemann, & Embree, 1996), or only a moderate relation between weight at entry and cognitive development at 6 years of age (O'Connor et al., 2000). The contemporary and predictive relations between children's physical and psychological conditions need to be further investigated.

When children arrive in their adoptive family, their life changes radically. We can relate the important improvements generally observed in children's physical and psychological development to the nurturing context of their adoptive environment (Benoit et al., 1996; Morison, Ames, & Chisholm, 1995; Morison & Ellwood, 2000; Proos, Hofvander, Wennqvist, & Tuvemo, 1992b; Rutter & the ERA study team, 1998). However, we still need to specify the profile and speed of this developmental trajectory, as well as the specific variables associated with it. Gunnar et al. (2000) stated that longitudinal research with internationally adopted children permits the provision of accurate information on their developmental outcomes. It also allows the identification of the variables associated with different qualities of development.

Researchers have put forward variables explaining children's physical and psychological states at the time of adoption, as well as predicting the quality of their development after adoption. Among these variables are children's age at time of adoption, the pre-adoption context and its duration (inevitably linked to children age), and the country of origin (Kim, 1995; Marcovitch et al., 1997; Tizard, 1991; Verhulst, Althaus, & Versluis-Den Bieman, 1992).

Children adopted at younger ages are in better condition at arrival than those adopted later; they also make more progress in the first months after adoption (Ames, 1997; Benoit et al., 1996; Johnson, 2000; Le Mare, Vaughan, Warford, & Fernyhough, 2001; Marcovitch et al. 1997; O'Connor et al., 2000; Rutter & the ERA study team, 1998). Castle et al. (1999) proposed that this relation between age at time of adoption and subsequent development would only hold for children who experienced poor quality pre-adoption context. For these children, being adopted at a later age predicts poorer outcomes. Thus, when considering age at time of adoption as a predictive variable of development, it appears essential to take the pre-adoption living conditions into account.

Two studies on children adopted from Romania reporting a relation between age at arrival and developmental outcomes support this argument. In the first study (Morison & Ellwood, 2000), the older adopted children, with poorer outcomes, were living in an orphanage before adoption. By contrast, the younger ones, with better outcomes, who were also destined for an orphanage, were luckily adopted before they got there. The authors concluded that the pre-adoption context, not age, was the main factor associated with subsequent development. In the second study (Benoit et al., 1996), most of the children who were 6 months of age or younger at the time of adoption were adopted from their birth home rather than from an orphanage, while the reverse was true for the older adopted children. Again, the pre-adoption context appears to explain the differences in developmental outcomes. Data on a subsample of Romanian children who had not lived in an institution before adoption, reported by Castle et al. (1999), permit the substantiation of this interpretation. Children assessed at 6 years of age had no cognitive deficit regardless of their age at the time of entry into the adoptive country. On the other hand, for children with similar living experiences in orphanages, age at time of adoption comes out as the explicative variable (Le Mare et al., 2001).

The pre-adoption context varies according to the country of origin. Although it may also vary within countries, studies indicate that pre-adoption environmental conditions are, on average, better in some countries than in others. For instance, it has been reported that a high proportion of children adopted from Romania and Russia had lived in institutions offering minimal care and stimulation (Albers, Johnson, Hostetter, Iverson, & Miller, 1997; Morison et al., 1995; O'Connor et al., 2000). These children generally arrived in poor physical, medical, and psychological states, especially those adopted after 6 or 8 months of age. After 11 months in their adoptive homes, the majority of children adopted from Romania remained delayed in two or more areas of development (Morison et al., 1995). On the other hand, in Korea, most children waiting for adoption were cared for by foster parents rather than in large group child-rearing settings (Miller, 2000). Korean children usually presented fair physical and psychological conditions at the time of adoption and showed good adjustment within their adoptive families (Kim, Shin, & Carey, 1999). Under the best conditions, foster care can prevent many problems. Thus, the variable "country of origin" may reflect the children's pre-adoption living conditions. As such, it permits the prediction, in part, of their subsequent development.

To sum up, studies on international adoption indicate that, in order to understand children's status and development, we have to take into consideration their country of origin and the duration of pre-adoption experiences (Castle et al., 1999; Fischer, Ames, Chilsholm, & Savoie, 1997; Lien, Knarig, & Winick, 1977; Morison & Ellwood, 2000). The former variable is related to many variations in the pre-adoption experiences of children. The duration of pre-adoption experiences is confounded with children's age at the time of adoption.

The present study is part of a longitudinal research on health status, physical, cognitive, motor, and psychosocial development of children adopted in the province of Québec before 18 months of age. Among the 2000 yearly adoptions in Canada, close to 1000 occur in Québec. In this research, we assess the children and their adoptive families from the time of their arrival until the children reach the age of 3 years. In our sample, children were adopted at an early age, within a relatively small range of ages at time of adoption. We follow them at specific moments after adoption (3 and 6 months later), as well as when they reach identical ages (2 and 3 years). First, this allows us to compare, after identical amounts of time in their adoptive families, children's physical and psychological evolution. Second, our research permits us to document their evolution at identical ages, later in time.

In this report, we present data on the children's health status, anthropometric, cognitive, and motor development: at time of arrival, and 3 and 6 months later. We describe and compare the evolution of three groups of children adopted from China, East Asia, and Russia. Most of the children adopted in Québec originate from these countries. According to Tessier, Moss, Nadeau, Larose, and Tarabulsy (2005), children adopted from China represent 42.6%, East Asia 12.8%, and Russia 5.4% of all international adoptions in Québec between 1985 and 2002. As the pre-adoption conditions are reported to be more extreme in Russia than in China or East Asia, we expected that Russian children would display a more difficult developmental trajectory than the others. We also analyse among all children the relations between anthropometric, medical, and developmental measures, and their links with infants' age at time of arrival. Finally, we identify which factors permit the prediction of children's cognitive and motor development across the first few months after adoption. The factors considered are infants' age at time of arrival, their medical and physical conditions at this time, and their country of origin.

Method

Participants

At its inception, the study included 123 children adopted before the age of 18 months from China (C, $n = 58$), East Asia (A, $n = 39$; 20 from Vietnam, 8 from Taiwan, 7 from Thailand, 3 from South Korea, and 1 from Cambodia), and Russia (R, $n = 26$; 25 from Russia and 1from Belarus). According to the *Secrétariat à l'adoption internationale du Québec* database, our samples represent 32%, 55%, and 65%, respectively, of all children of these countries adopted before the age of 18 months in the greater Montréal area during our recruiting period. We also collected data on their 121 Québécois (119 French-speaking and 2 English-speaking) adoptive families (there were twins adopted in the C and R groups). Girls formed 100% of the Chinese group, 38.5% of the Asian group, and 54% of the Russian group. At the time of their arrival in Québec, children from China were older than children from East Asia, $F(2, 120) = 10.82$, $p < .001$ (mean ages in days: C = 360.9 [11.26 months], $SD = 67.2$; A = 266.6, [8.23 months], $SD = 127.5$; R = 317.8 [10.13 months], $SD = 105.3$). Thirty-three per cent of children in the A group were less than 6 months of age at the time of their arrival, while 100% of children in the other groups were 6 months or older. In the whole sample, 52.8% of children were between 6 and 12 months of age (C = 55.2%, A = 41.0%, R = 65.4%), and 36.6% between 12 and 18 months (44.8%, 25.6%, and 34.6%, respectively). Children had been less than 1 month in the adoptive country at the first assessment (mean in days: C = 19.1, $SD = 8.4$; A = 21.4, $SD = 7.8$; R = 22.9, $SD = 6.6$). They had been in contact with their adoptive parents for approximately 1 month (mean in days: C = 31.2, $SD = 9.3$; A = 30.1, $SD = 9.0$; R = 26.1, $SD = 7.8$).

International adoption agencies (accredited by the *Secrétariat à l'adoption internationale du Québec*) sent information on the project to adopter families. During meetings organised by the agencies before adoption, one member of the research team explained to the parents the details of the project and of their eventual commitment. If interested in participating, parents were invited to contact the International Pediatric Clinic (IPC) of the Hôpital Ste-Justine in Montréal and to book an appointment close to the time of arrival. A few parents were recruited directly at their first visit at the IPC for a medical evaluation of their adopted child. Parents who agreed to participate signed a letter of consent that described the project, indicated that they could stop their participation at any time, and assured them of the confidentiality of the data. Seven per cent of the families ($n = 9$, C = 4, A = 1, R = 4) stopped their participation during the course of the project (between time of arrival and 3 years of age), and 3% ($n = 4$, C = 2, R = 2) between time of arrival and the 6-month measure.

Pre-adoption conditions

According to the information given to the parents by adoption agencies in the children's native country, most children had been given for adoption at birth (C = 50.0%, A = 69.2%, R = 57.7%) or between birth and 3 months of age (C = 41.4%, A = 20.5%, R = 34.6%). This information is unknown for 5% of children ($n = 6$; 3, 2, and 1, in C, A, and R groups, respectively). They were adopted from an orphanage (C = 77.6%, A = 84.6%, R = 96.2%) or a family setting (C = 6.9%, A = 7.7%). A few had had both types of placements (C = 15.5%, A = 7.7%, R = 3.8%). The reported adult/infant ratio varied from 1/1 to 1/2–4, and 1/6–10. The 1/1 ratio was more frequent in Asia (23 children), the 1/2–4 ratio more frequent in Russia (5 children). However, these data are unknown for 70.7% of children (84.5%, 35.9%, and 76.9% of C, A, and R groups, respectively).

We have information on infant health at birth for only a small proportion of children. Seven Russian children and two Asian children were preterms (unknown: C = 98.3%, A = 64.1%, R = 23.1%). Low birthweight (< 2500g) was reported for eight Russian and two Asian children (unknown: C = 100%, A = 66.7%, R = 19.2%). More Russian children had reported perinatal complications and were hospitalised before adoption than Chinese and Asian ones. A smaller proportion of them had received complete immunisation. It is to be noted, however, that except for immunisation, health information was obtained more frequently from Russia than from China and Asia. Five Russian mothers were reported as drug addicts (unknown: C = 98.3%, A = 89.7%, R = 73.1%).

Sociodemographic characteristics of the adoptive family

Table 1 presents sociodemographic characteristics of the adoptive families of each group. Parents were older, on average, than biological parents of children of that age (see Desrosiers, 2000). Their schooling levels and annual family incomes were representative of middle and high socioeconomic status. Most families were dual-earner. More than 80% of parents in each group were married; some formed reconstituted families (9%, 3%, and 8%, in C, A, and R groups). Less than 1% of families were mother-headed ($n = 5$, 2, and 1). On average, 45% had other children; 62% of these families had other adopted children. Most of the families spoke only French or English at home and to the adopted child (93%, 90%, and 84%, in C, A, and R groups). A few parents were born in countries other than North America (5%, 5%, and 12% in C, A, and R groups). There were no significant differences between groups on all these variables.

Measures and procedure

Measures bore on the child (growth, health status, cognitive and motor development), on the adoptive family (socio-

Table 1
Sociodemographic characteristics of the adoptive families of each group of children

	Group		
	China	*E. Asia*	*Russia*
n	57	39	25
Age (in years, *M* & *SD*)			
Mothers	37.8 (5.2)	37.0 (4.6)	37.9 (4.6)
Fathers ($n = 113$)	39.1 (5.4)	39.6 (5.5)	38.5 (5.6)
Schooling (in years, *M* & *SD*)			
Mothers	14.9 (2.4)	15.9 (2.7)	14.8 (2.0)
Fathers ($n = 113$)	15.4 (2.6)	15.6 (3.5)	14.8 (2.6)
Family income (CDN$, %)			
< 30,000	0	0	4.2
30,000–60,000	20.4	26.4	4.2
> 60,000	79.6	73.7	91.7
Civil status (% married)	87.7	94.9	84.0
Siblings (% yes)	45.6	53.8	32.0
Adopted (% yes)	53.8	85.7	25.0

demographic characteristics), and, when available, on the pre-adoption context (orphanage or home environment, adult/child ratio). Measures were taken close to the child arrival, and 3 and 6 months later. At each moment, the child and his/her parents participated in two visits, one to the Laboratory of Infant Studies (LIS) at the university department of psychology (psychological data), the other to the university hospital (child health status).

Mean ages (in days) at time of the psychological evaluation at the first visit were 379.4 (12 months 13 days, $SD = 68.02$) in the C group, 288.1 (9 months 14 days, $SD = 129.19$) in the A group, and 340.9 (11 months 5 days, $SD = 101.60$) in the R group; at the 3-month visit mean ages were: 459.8 (15 months 2 days, $SD = 71.74$), 361.9 (11 months 27 days, $SD = 124.93$), and 426.7 (13 months 30 days, $SD = 106.64$), respectively; at the 6-month visit, 556.8 (18 months 8 days, $SD = 74.59$), 459.5 (15 months 2 days, $SD = 133.65$), and 523.5 (17 months 5 days, $SD = 102.99$), respectively.

Health status. Measures of the child health status included anthropometrical (weight, height, and head circumference percentiles—North American norms, Hamill et al., 1979—and, as other indices of acute and chronic malnutrition, weight/height ratio and height/age ratio) and medical data (infectiology, cranio-facial anomaly, nondermatologic organic disease, neurological sign, nutritional status). These data were collected at the IPC. At the first visit, a paediatrician made a complete medical examination of the child and necessary follow-up laboratory tests (Aronson, 2000). At the subsequent visits, the usual anthropometric measures were taken, while medical measures were adapted to the health condition of each child. The paediatricians produced a grid where all anthropometric and medical information appeared. Medical information was indexed within seven categories and one subcategory (see Appendix A). These data were then transferred to a computer for subsequent analyses. We obtained percentages of children presenting medical problems in each category and subcategory. Percentiles for weight, height, and head circumference were coded in seven categories (see Hamill et al., 1979): (1) < 5th, (2) 5th–9th, (3) 10th–24th, (4) 25th–49th, (5) 50th–74th, (6) 75th–90th, (7) > 90th.

Cognitive and motor development. We used the Bayley Scales of Infant Development (Bayley, 1993) to evaluate child cognitive and motor development at each time. The scales give normalised developmental indexes ($M = 100$, $SD = 15$), from 1 to 42 months, of mental (MDI) and psychomotor development (PDI). Internal consistency of the scales varies from .78 to .93. As the adopted child may present particular language difficulties, especially at the first evaluation, we took care to give simple instructions or to accompany verbal instructions with considerable mimes and gestures in order to attenuate the language barrier.

Sociodemographic characteristics. At the end of the visit to the LIS, we noted the sociodemographic characteristics of the adoptive family indicated above.

Results

Results are reported in four sections. First, we compare the three groups on measures of health status, cognitive and motor development at the time of arrival, then 3 and 6 months later. Second, we analyse the relations between anthropometric, medical, and developmental measures. We divide children according to their nutritional status—normal or subnormal—and we compare the two subgroups. Moreover, as specific medical problems can be related to child development, we contrast subgroups of children with and without neurological signs observed at time of arrival. These subgroups were formed on the basis of the consensual medical diagnoses at the children's first visit. Some of these children did not present neurological signs at subsequent visits. Their number decreased from 15 at time of arrival, to 10 at the 3-month assessment, and to 6 at the 6-month assessment (see Table 2). No new cases were diagnosed at these later visits. We also compare the developmental scores of the six children with a confirmed diagnosis over time to the nine whose neurological signs disappeared subsequently. Third, we examine the links between age at time of arrival, anthropometric and developmental measures. Finally, we determine predictors of cognitive and motor development by hierarchical linear modelling

Table 2
Medical problems observed in the three groups of children at time of arrival and 3 and 6 months later (%)

	Arrival			*3m*			*6m*		
Problem	*C*	*A*	*R*	*C*	*A*	*R*	*C*	*A*	*R*
Infection:									
Respiratory	*65.5*	*43.6*	*57.7*	27.3	22.2	66.7	23.6	38.2	21.7
Gastrointestinal	*10.3*	*17.9*	*30.8*	7.3	13.9	8.3	3.6	5.9	9.3
Cutaneous (total)	60.3	48.7	42.3	38.2	36.1	29.2	34.5	23.5	8.7
Eczema	37.9*	33.3*	7.7*	23.6	27.8	12.5	23.6*	17.6*	0.0*
Cranio-facial anomaly	46.6*	28.2*	15.4*	30.9	16.7	16.7	25.5	8.8	13.0
Nondermatologic organic disease	19.0*	20.5*	50.0*	30.9	27.8	29.2	*34.5*	*14.7*	*17.4*
Neurological sign	6.9*	5.1*	34.6*	*3.6*	*5.6*	*25.0*	1.8*	2.9*	17.4*
Anaemia/rickets	13.8	5.1	11.5	0.0	5.6	0.0	0.0	2.9	0.0

C = China; A = E. Asia; R = Russia.
Significant differences between groups are asterisked (*); marginal differences ($p < .10$) are in italics.

(HLM), taking into consideration indices of nutritional status (height/age ratio) and brain growth (head circumference percentile), presence of neurological signs at the first visit, age at time of arrival, as well as country of origin. We also examine part of the variance in cognitive and motor development related to a risk index attributed to each child on the basis of medical data and age at time of arrival.

Due to missing data, the number of participants may change from one time period to the next. Numbers of participants appear in all tables.

Health status, cognitive and motor development, at time of arrival and 3 and 6 months later

Health status: Anthropometric measures. Repeated analyses of variance (ANOVAs) of child anthropometric measures with group (3) as a between-subject factor, and time (3) as a within-subject factor, indicated time effects for each measure: weight and height percentiles, $F(2, 210) = 61.55$ and 8.44, $ps < .001$; head circumference percentile, weight/height and height/age ratios, $F(2, 198) = 12.26$, 14.43, 7.35, $ps < .001$. All measures showed an increase from one moment to the other. Group × Time interaction effects and follow-up tests indicated that the anthropometric variables changed differently among the three groups: weight and height percentiles, $F(4, 210) = 12.10$ and 7.34, $ps < .001$; head circumference percentiles, $F(4, 198) = 5.19$, $p < .001$; weight/height and height/age ratios, $F(4, 198) = 5.05$ and 10.07, $ps < .001$. East Asian children had, at time of arrival, higher percentiles for weight and height than Chinese and Russian children, $F(2, 120) = 5.46$ and 4.99, $ps < .01$. Accordingly, increases in percentiles with time were higher in the Chinese and Russian groups than in the Asian group (see Figure 1). Weight/height ratio considerably increased in the Chinese and the Russian groups, but not in the East Asian group (see Figure 2). At the first measure, height/age ratio was higher in the Asian group than in the others, $F(2, 120) = 4.47$, $p < .05$. It did not change across time in this group. The highest increase appeared in the Russian group.

Spearman (percentile categories) and Pearson (ratios) correlations indicated stability of all anthropometric measures across time. Correlations varied from .42 to .88 in the whole

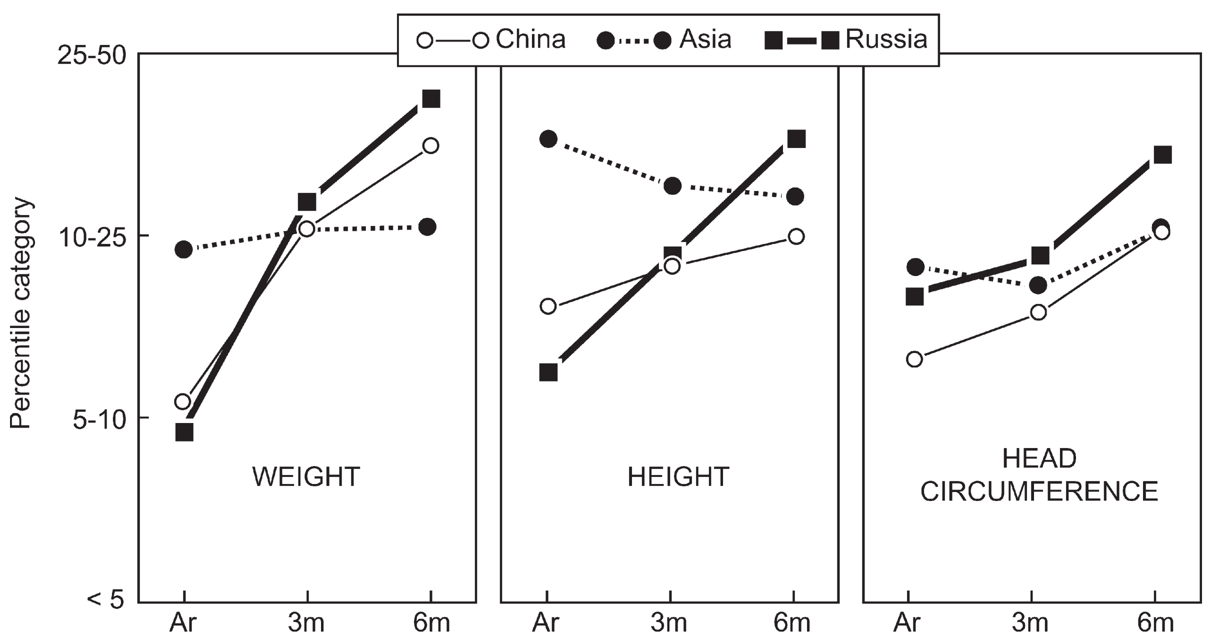

Figure 1. Percentile category for weight, height, and head circumference in the three groups, at time of arrival and 3 and 6 months later.

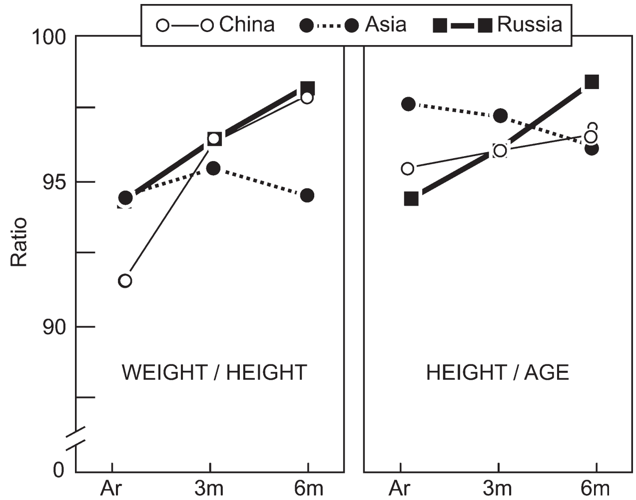

Figure 2. Weight/height and height/age ratios in the three groups, at time of arrival and 3 and 6 months later.

sample. There were also significant correlations between all anthropometric measures at each time (except for two at one time: between height and weight/height ratio at arrival, between head circumference and height/age ratio at the 6-month measure) (*r*s from .17 to .94).

Health status: medical data. Percentages of children with medical problems are indicated in Table 2. Generally, the percentages decreased from the first evaluation to the 6-month measure. Cochran's Q tests indicated that the change was significant for respiratory infections in C, $Q(2) = 23.72$, $p < .000$, and R groups, $Q(2) = 11.46$, $p < .003$; for gastrointestinal infections in R, $Q(2) = 6.00$, $p < .05$; for cutaneous infections in the three groups, $Q(2) = 15.92$, 8.13, and 7.00, $p < .000$, .02, and .03: C, A, and R groups respectively; for eczema in C, $Q(2) = 6.75$, $p < .04$; for cranio-facial anomaly in C, $Q(2) = 9.70$, $p < .008$, and A groups, $Q(2) = 11.14$, $p < .004$; for nondermatologic organic disease in R, $Q(2) = 9.46$, $p < .009$; and for anaemia/rickets in C, $Q(2) = 16.00$, $p < .000$, and R groups, $Q(2) = 6.00$, $p < .05$.

Although the differences did not reach the traditional level of significance, fewer Asian than Chinese and Russian children showed respiratory infections, $\chi^2(2, N = 123) = 4.58$, $p = .10$, at time of arrival, while a larger percentage of Russian children had gastrointestinal infections, $\chi^2(2, N = 123) = 5.32$, $p = .07$. Eczema was significantly more frequent in the Chinese and Asian groups than in the Russian group at time of arrival, $\chi^2(2, N = 123) = 8.09$, $p < .05$, and 6 months later, $\chi^2(2, N = 112) = 6.45$, $p < .05$. More Chinese children presented cranio-facial anomalies at time of arrival, $\chi^2(2, N = 123) = 8.65$, $p < .01$. At this same moment, more Russian children had nondermatologic organic diseases, $\chi^2(2, N = 123) = 9.88$, $p < .01$. At the 6-month measure, these diseases were more frequent in the Chinese group, $\chi^2(2, N = 112) = 5.30$, $p = .07$. Neurological signs were more frequent in the Russian group. The difference between groups was significant at time of arrival, $\chi^2(2, N = 123) = 15.54$, $p < .001$, and at the 6-month measure, $\chi^2(2, N = 112) = 8.32$, $p < .05$, and was marginally significant 3 months after arrival, $\chi^2(2, N = 115) = 10.26$, $p = .06$. The presence of neurological signs (muscular hypotonia, hypertonia and lower limb hyper-reflexive responses, retarded growth, physical indices, microcephaly, etc.) at time of arrival indicates potential organic problems. These signs may also reflect the cumulative effects of severe nutritional and sensorimotor deficiencies. The presence of these signs at arrival represents highly problematic health conditions, whatever their causes. That is why we selected them as an important factor in the analyses on cognitive and motor development. An early medical diagnosis of neurological signs triggered immediate corrective actions. Adequate diet, exercise, stimulation, and professional supervision are among the environmental factors that might explain the clinical improvement of certain children over time and the disappearance of some of these signs. The only signs to remain present are those linked to confirmed anomalies, such as hemiparesia, cerebral motor deficit, or alcoholic foetal syndrome.

In short, more Chinese and Asian children presented eczema and cranio-facial anomalies, while more Russian children had nondermatologic organic diseases, and, most importantly, neurological signs.

Cognitive and motor development. A repeated-measure ANOVA of child MDI with group (3) as a between-subject factor, and time (3) as a within-subject factor, indicated significant differences between groups, $F(2, 111) = 3.12$, $p < .05$, and across time, $F(2, 222) = 10.59$, $p < .001$. As shown in Figure 3, children from Russia had lower scores than children from China and East Asia. With a Bonferroni correction for the number of ANOVAs on MDI or PDI, this result becomes marginal. However, as we had hypothesised that children from Russia would show a more difficult developmental trajectory than the others, such marginal group difference may be informative. Globally, the mental development scores were higher after 3 and 6 months in the adoptive country than at time of arrival (significant linear and quadratic trends).

A repeated ANOVA of PDI indicated also significant differences between groups, $F(2, 110) = 6.14$, $p < .001$, and across time, $F(2, 220) = 17.74$, $p < .001$ (see Figure 3). Children from East Asia had higher motor development scores than the others. Motor scores increased across time on a linear and quadratic trend.

Pearson correlations indicated positive relations between children's MDI and PDI, in the whole sample (*r*s from .42 to .65). Correlations across time showed a relative stability of developmental scores from the time of arrival to the 6-month measure (*r*s from .52 to .75).

Relations between health status and developmental measures; comparison of subgroups of children

We calculated Spearman (percentile categories) and Pearson (ratios) correlations between anthropometric measures at time of arrival and developmental scores, at the three time periods. As indicated in Table 3, there were significant relations between MDI and height percentile, head circumference percentile, and height/age ratio, at the three moments. There were also relations between PDI and weight percentile, height percentile, and height/age ratio, at time of arrival and 3 months later for the first two anthropometric measures, and at the three points in time for the latter. These data indicate that better nutritional status at time of arrival, as shown by anthropometric measures, is moderately related to better cognitive or motor scores up to 6 months after.

In order to compare developmental scores of children of

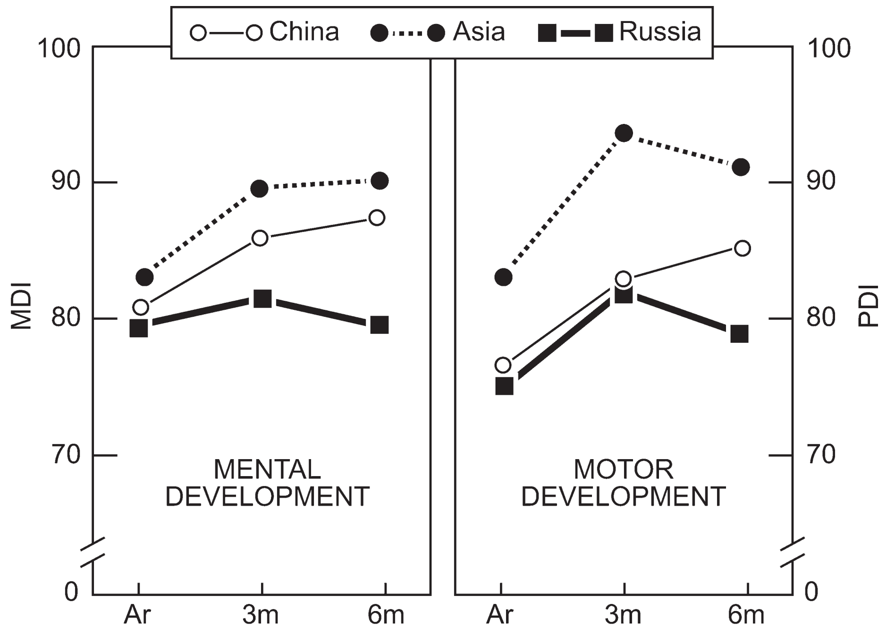

Figure 3. Mental (MDI) and motor development index (PDI) in the three groups, at time of arrival and 3 and 6 months later.

different brain growth and nutritional status at time of arrival, we formed subgroups of children according to head circumference percentiles, weight/height and height/age ratios: children below the 5th percentile for head circumference versus children above, children in the subnormal range of weight/height ratio ($< .90$) or height/age ratio ($< .95$) versus children in the normal range. Repeated measures ANOVAs of MDI and PDI with group (3) and subgroup (2) as between-subject factors, and time (3) as a within-subject factor, indicated, as previously, group and time effects and also subgroup effects. Children below the 5th percentile for head circumference at time of arrival had lower MDI (79.11 vs 86.45) and PDI (79.00 vs 85.16) than children above, $F(1, 108) = 10.03$, $p < .01$ and $F(1, 107) = 5.06$, $p < .05$, respectively. Children in the subnormal range of height/age ratio had lower PDI than children in the normal range (79.35 vs 85.82), $F(1, 102) = 5.52$, $p < .05$. A subgroup by time interaction effect, $F(2, 204) = 3.78$, $p < .05$, indicated that the difference in PDI was important at the first evaluation and this diminished later on. There were no differences in developmental scores between the subgroups formed according to weight/height ratios. Thus, head circumference percentile and height/age ratio appear to be important indices of anthropometric status related to cognitive or motor development.

We also compared subgroups of children with or without neurological signs at arrival. Repeated measures ANOVAs of MDI and PDI with subgroup (2) as a between-subjects factor, and time (3) as a within-subject factor, indicated time effects as previously and significant differences between subgroups. Children with neurological signs at arrival ($n = 15$) had lower MDI (76.64 vs 86.08) and PDI (71.11 vs 85.62) than children without signs, $F(1, 112) = 10.33$, $p < .01$ and $F(1, 111) = 18.43$, $p < .001$, respectively. We also ran repeated measures ANOVAs on the developmental scores of children whose neurological signs disappeared over time ($n = 9$) and of children whose neurological signs persisted ($n = 6$). Globally, MDI scores did not significantly change from time to time (77.4, 75.4, and 77.1). MDI scores were higher for children without persistent diagnosis of neurological signs than for those

Table 3
Correlations between anthropometric measures (at time of arrival) and developmental indexes (at time of arrival and 3 and 6 months later), in the whole sample

	MDI			*PDI*		
Measure	*Arrival*	*3m*	*6m*	*Arrival*	*3m*	*6m*
N	123	118	116	123	118	116
Percentile categories (Spearman)						
Weight	.17~	.16~	.24**	.36***	.22*	.07
Height	.19*	.21*	.30***	.36***	.28**	.12
Head circumference	.20*	.24**	.29**	.11	.14	.09
Ratios (Pearson)						
Weight/height	.13	.09	.13	.16~	.10	–.06
Height/age	.30***	.31***	.30***	.44***	.25*	.23*

* $p < .05$; ** $p < .01$; *** $p < .001$; ~ $p < .10$.

Table 4

Correlations between children's age at time of arrival, and anthropometric measures and developmental indexes (at time of arrival and 3 and 6 months later) in the whole sample

Measure	*Arrival*	*3m*	*6m*
Anthropometric measures			
N	123	115	112
Percentile categories (Spearman)			
Weight	–.26**	–.13	–.01
Height	–.17~	–.14	.002
Head circumference	–.34***	–.32*** (n = 114)	–.12 (n = 106)
Ratios (Pearson)			
Weight/height	–.33***	–.23*	–.01
Height/age	–.25**	–.14	.02
Developmental indexes			
N	123	118	116
MDI	–.15~	–.38***	–.36***
PDI	–.11	–.16~	–.11 (n = 115)

* $p < .05$; ** $p < .01$; *** $p < .001$; ~ $p < .10$.

with persistent diagnosis (81.9 vs 68.8), although the difference did not reach level of significance ($p = .069$). The interaction Subgroup × Time was not significant ($p = .519$). The PDI scores were both significantly different across time (64.2, 75.6, and 73.6, at $p = .014$) and between groups (78.9 vs 59.5, at $p = .016$). The interaction was not significant ($p = .269$). It appears that neurological signs disappearing from one assessment to the other, thus hypothetically reflecting severe pre-adoption deficiencies, were associated with better developmental measures than neurological signs that were confirmed over time. These results also revealed that children with neurological signs at arrival could make gains on motor scores with adequate follow-up interventions, but not on their cognitive scores. However, the small number of children in that condition precludes firm conclusions.

Relations between children's age at time of arrival and anthropometric and developmental measures

Analyses revealed significant negative correlations between weight percentile and age at time of arrival, as well as between head circumference percentile and age at time of arrival at the first and second times of measure (see Table 4). We also found correlations between age at time of arrival and weight/height ratios at the same two moments, and between age and height/age ratios at time of arrival. MDI at the 3- and 6-month measures was negatively related to children's age at time of arrival. As a whole, these results indicate that younger children at time of arrival showed generally better physical and psychological conditions when they were evaluated close to time of arrival and later on.

Predictors of cognitive and motor development

We retained five variables, children's state of nutrition (height/age ratio), brain growth (head circumference percentile), presence/absence of neurological signs at arrival, age at time of arrival, and country of origin (dummy variable), in order to examine, by hierarchical linear modelling (HLM, Raudenbush & Bryk, 2002), their relative weight in the evolution of cognitive and motor scores. HLM was used to take advantage of the longitudinal structure of the data. It estimates individual growth curves for each child. The slopes of these curves become the dependent variable that can be predicted by the five variables above.

First, we analysed by HLM the scores at time of arrival and their evolution in an unconditional model. This model provides empirical evidence for determining a proper specification of the individual growth equation and baseline statistics for evaluating a subsequent, more complex model. Table 5

Table 5

Linear model of evolution in MDI and PDI (unconditional model)

	MDI				PDI			
Fixed effect	*Coefficient*	*Standard error*	*t*	*p*	*Coefficient*	*Standard error*	*t*	*p*
Mean score at arrival	81.46	1.27	64.25	.000	78.56	1.57	50.03	.000
Mean growth rate	1.01	0.33	3.09	.002	1.48	0.41	3.64	.000
Random effect	*Variance component*	*df*	χ^2	*p*	*Variance component*	*df*	χ^2	*p*
Score at arrival	112.30	119	311.82	.000	199.04	119	293.15	.000
Growth rate	1.14	119	150.47	.027	0.52	119	121.16	ns
Level-1 error	58.97				104.79			

presents the results for the MDI and PDI analyses. The average MDI at time of arrival was estimated to be more than 1 *SD* below the mean. Children were gaining an average of 1.01 points from one month to the next. There was significant individual variation in MDI at time of arrival and in its evolution (see Table 5: random effect). The estimated correlation between change in MDI and initial score was –.38. Children who had lower scores at time of arrival tended to gain more thereafter. As shown in Table 5, similar results were obtained for PDI: average PDI at time of arrival was more than one standard deviation below the mean, scores increased by 1.48 point from month to month, there was significant individual variation in PDI at time of arrival, but not in its evolution. The estimated correlation between change in PDI and initial score was –.96.

The more complex model with five predictors indicated that MDI at time of arrival was best explained by height/age ratio, while the evolution of MDI scores from time of arrival to the 6-month measure was predicted by age at time of arrival (see Table 6). A better height/age ratio, an index of chronic state of nutrition, was associated with better scores at time of arrival. Children who were adopted at younger ages tended to gain more 3 and 6 months after adoption. Height/age ratio and absence of neurological signs at arrival explained PDI scores at time of arrival, while height/age ratio negatively predicted their evolution (see Table 7). This last result is probably explained by the positive link between height/age ratio and PDI at time of arrival, as well as the strong negative correlation between PDI at time of arrival and its evolution. In other words, children with lower height/age ratio have lower initial motor development scores and children who have lower initial scores (thus also lower height/age ratio) gain more thereafter. When considered along with these variables, country of origin did not contribute to the variance of MDI or PDI scores.

Table 6
Linear model of evolution in MDI: Statistical effect of height/age (H/A) ratio, age at time of arrival, head circumference (HC) percentile, neurological signs (absence/presence), and group (A vs C, A vs R)

Fixed effect	*Coefficient*	*Standard error*	*t*	*p*
Dependent variable: Score at arrival				
Intercept	81.84	2.26	36.20	.000
H/A ratio	0.90	0.35	2.58	.010
Age	–0.01	0.01	–0.88	*ns*
HC percentile	–0.01	0.87	–0.02	*ns*
Neuro signs	–3.40	3.90	–0.87	*ns*
Group A vs C	–0.69	3.00	-00.23	*ns*
Group A vs R	0.03	3.62	0.01	*ns*
Dependent variable: Growth rate				
Intercept	0.84	0.41	2.07	.038
H/A ratio	–0.09	0.06	–1.47	*ns*
Age	–0.01	0.002	–2.33	.020
HC percentile	0.12	0.16	0.76	*ns*
Neuro signs	–0.70	0.70	–1.00	*ns*
Group A vs C	0.64	0.54	1.18	*ns*
Group A vs R	–0.76	0.67	–1.13	*ns*

Random effect	*Variance component*	*df*	χ^2	*p*
Score at arrival	104.60	113	283.43	.000
Growth rate	0.94	113	136.98	.062
Level-1 error	58.09			

Table 7
Linear model of evolution in PDI: Statistical effect of height/age (H/A) ratio, age at time of arrival, head circumference (HC) percentile, neurological signs (absence/presence), and group (A vs C, A vs R)

Fixed effect	*Coefficient*	*Standard error*	*t*	*p*
Dependent variable: Score at arrival				
Intercept	81.04	2.77	29.24	.000
H/A ratio	1.87	0.43	4.37	.000
Age	–0.002	0.02	–0.11	*ns*
HC percentile	–1.39	1.07	–1.31	*ns*
Neuro signs	–12.80	4.78	–2.68	.008
Group A vs C	–4.87	3.68	–1.32	*ns*
Group A vs R	–0.14	4.44	–0.03	*ns*
Dependent variable: Growth rate				
Intercept	1.82	0.50	3.61	.001
H/A ratio	–0.23	0.08	–2.87	.005
Age	0.00	0.003	0.09	*ns*
HC percentile	0.05	0.20	0.23	*ns*
Neuro signs	0.26	0.87	0.29	*ns*
Group A vs C	–0.23	0.67	–0.34	*ns*
Group A vs R	–1.33	0.83	–1.60	*ns*

Random effect	*Variance component*	*df*	χ^2	*p*
Score at arrival	137.05	113	229.78	.000
Growth rate	0.30	113	111.76	*ns*
Level-1 error	103.86			

When we compare the estimated variances for the random effects in the five factors model with those from the unconditional model (looking at the difference between the total parameter variance, estimated from the unconditional model, and the residual parameter variance, based on the more complex model, relative to the total parameter variance), we observe that height/age ratio accounts for 6.9% of the variance in MDI initial scores and that age accounts for 43.5% of the variance in MDI evolution; height/age ratio and neurological signs at arrival account for 31.1% of the variance in PDI initial scores, while height/age ratio accounts for 40.9% of the variance in PDI evolution.

In order to take into account the multiplicity of risk factors that individual children could present, we created a risk index including medical data as well as age at time of arrival. Each child was given a score form 0 (*no risk*) to 7 (*high risk*). The risk index was based on the presence or absence of the following: subnormal height/age ratio, head circumference below the 5th percentile, neurological sign at arrival, severe respiratory or gastrointestinal infection, cutaneous infection, cranio-facial anomaly, arrival after 12 months of age. The HLM model indicated that the risk index accounted for 15.3% of the variance in MDI and for 23.5% of the variance in PDI initial scores. A higher risk index was related to lower initial scores. It was not related, however, to MDI nor PDI evolution (see Table 8).

Discussion

This study aimed to compare anthropometric, cognitive, and motor development measures of children adopted from China,

Table 8
Linear model of evolution in MDI and PDI: Statistical effect of risk index and group (A vs C, A vs R)

	MDI				PDI			
Fixed effect	*Coefficient*	*Standard error*	*t*	*p*	*Coefficient*	*Standard error*	*t*	*p*
Dependent variable: Score at arrival								
Intercept	89.40	2.55	35.07	.000	91.99	3.30	27.85	.000
Risk	–3.02	0.82	–3.70	.000	–4.36	1.06	–4.11	.000
Group A vs C	–0.73	2.77	–0.26	*ns*	–4.09	3.59	–1.14	*ns*
Group A vs R	–2.44	3.30	–0.74	*ns*	–5.95	4.28	–1.39	*ns*
Dependent variable: Growth rate								
Intercept	1.25	0.48	2.61	.009	0.95	0.59	1.61	*ns*
Risk	–0.06	0.15	–0.41	*ns*	0.30	0.19	1.56	*ns*
Group A vs C	0.22	0.52	0.42	*ns*	–0.08	0.64	–0.13	*ns*
Group A vs R	–1.10	0.63	–1.75	*ns*	–0.84	0.78	–1.07	*ns*
Random effect	*Variance component*	*df*	χ^2	*p*	*Variance component*	*df*	χ^2	*p*
Score at arrival	95.06	116	272.66	.000	152.25	116	235.10	.000
Growth rate	1.05	116	144.41	.038	0.48	116	115.48	*ns*
Level-1 error	105.22				105.22			

East Asia, and Russia, and their evolution from the time of their arrival in Québec up to 6 months later. Its objective was to determine which variables predicted children's cognitive and motor development after adoption. Variables considered were anthropometric measures, medical problems, children's age at time of arrival, and country of origin. Results indicated differences between groups in health status and developmental scores. They also revealed relations between each of these variables and cognitive and motor development measures 6 months after adoption. When we considered together five specific variables related to developmental outcomes, height/age ratio (MDI-PDI), age at time of arrival (MDI) and absence of neurological signs (PDI) stood as the best predictors of MDI or PDI. A risk index measure was related to MDI and PDI initial scores. As our comparative analyses have shown, country of origin is associated with anthropometric measures, health status, and cognitive and motor development. When anthropometric and health variables are included in HLM analyses, the variable ''country of origin'' does not add to the explanation of scores' variance.

Other studies have shown that the children's country of origin determines in part their general status at time of arrival and its subsequent evolution. Variations in the pre-adoption context across countries most probably explain the contribution of this variable to developmental measures. Children have been differently subjected to deprivation, such as nutritional deficiency, lack of adequate stimulation, especially linguistic privation, lack of affection, lack of opportunities to play, lack of opportunities for developing attachments to others, etc. We tried to document the conditions in which children were living before adoption. The little information we had indicated that, compared to children adopted from China or Russia, more children adopted from Asia had been living in an orphanage or a family setting with an adult/child ratio of 1/1. We know that such a ratio underlines a condition of adequate care for infants. Most children had been living in orphanages before adoption. Orphanages vary in type, scope, purpose, and awareness of the emotional, physical, and educational needs of children. Financial resources, staff-to-child ratios, and staff training all vary considerably. As noted by Gunnar et al. (2000), the conditions experienced in institutions are complex, varying over time and across institutions, and are probably not uniform even within an institution (i.e., some children receive better care than others).

Early malnutrition is generally associated with pre-adoption experiences. Research shows that anthropometric indicators of undernutrition during infancy predict cognitive performance in middle childhood and adolescence (Pollitt et al., 1996). Poor nutrition has been related to impaired brain growth and cognitive development (Sigman, Espinosa, & Whaley, 1998; Wachs, 1995; Wachs & McCabe, 2001; Winick & Rosso, 1969). In the present sample, anthropometric measures indicated early malnutrition among children, more in the Chinese and Russian groups than in the East Asian group. Among all children, whatever their country of origin, head circumference percentiles and height/age ratios, measures of brain growth and chronic state of nutrition, were correlated with cognitive and motor development. Children who had, at time of arrival, head circumferences below the 5th percentile or subnormal height/age ratios had lower MDI and PDI than the others. Among the variables related to cognitive and motor development, height/age ratio was the most important one to explain MDI and PDI scores at time of arrival. Children who presented better indices of nutritional status displayed better developmental scores. This result underlines again the importance of nutrition in the early stages of development. It shows that deprivation related to pre-adoption experiences relates to physical as well as psychological needs. When we create a risk index taking into consideration nutritional status in addition to other medical problems at time of arrival (neurological sign, infection, cranio-facial anomaly) and later adoption, the analysis shows that the risk index predicts lower developmental scores at arrival. An accumulation of risks probably reflects an accumulation of depriving experiences that globally affects children. These cumulated risk factors do not, however, explain subsequent cognitive and motor development, while more specific variables do.

Besides their probably better pre-adoption living conditions, children from East Asia were younger at the time of adoption than children from China and Russia. Children's age at time of arrival was related to health and developmental status. When examined conjointly with other variables, age at time of arrival was the variable explaining variance in cognitive development up to 6 months after adoption. As previously reported (Ames, 1997; Morison et al., 1995; Morison & Ellwood, 2000; O'Connor et al., 2000; Rutter & the ERA study team, 1998), children adopted at younger ages show better developmental scores at time of arrival and better improvement after adoption than children adopted at older ages. In the present study, whatever the country of origin or the pre-adoption conditions, age at time of arrival appears to be important. It is to be noted that, in our sample, the older adopted children were only 18 months of age. Thus, even among young children adopted before their second birthday, age at time of adoption is related to their developmental gains.

We may hypothesise that the effect of the change in the children's environment after adoption appears more rapidly when children are younger, or that the impact of the adoptive environment is stronger for younger children. Thus age per se would be the relevant factor. Younger organisms have more potential for brain plasticity and learning than older ones (Thomas, 2003). Otherwise, the cumulated deprivation associated with the pre-adoption environment is not as important in younger children; they experienced their pre-adoption conditions for a shorter time, thus facilitating the counter-effect of the adoptive family context. We cannot reach a clear conclusion on that matter. Is it the extent of institutional experience per se or the children's age at the time they leave an understimulating environment (pre-adoption conditions) and join a stable and stimulating one (post-adoption conditions) that is important, or an interaction between the extent of experience and age? However, such results relating age at time of adoption to cognitive development later on strengthens what others have already suggested (Morison & Ellwood, 2000): Adoption policies should emphasise removing children from inadequate conditions as early as possible.

On the other hand, as Morison and Ellwood (2000) report for children adopted from Romania, there is continuity in cognitive functioning. In the present sample, we observe continuity in cognitive and motor functioning. Besides age at time of adoption, or extent of pre-adoption experiences, and health status at time of arrival, the first developmental evaluation allows us to predict how well children will be doing 6 months later. Thus, developmental level attained after months in the adoptive family will be partly delimited by developmental level at time of arrival. On the age of adoption question, one could argue that better developing children or children in better health are adopted earlier than children who are developing poorly or who present health problems. Our data do not permit us to entirely reject this hypothesis. However, HLM analyses indicated that age at arrival does not explain MDI initial scores, but part of the variance in MDI evolution over time. Age at arrival appears as a factor making possible, or not, a true catch-up effect. At later ages of adoption, the cumulated negative impact of prolonged physical and psychological deprivations can be more difficult to erase or attenuate than at younger ages, with shorter conditions of deprivation. Our data permit us to conclude that later adopted children have more difficulty in improving, or improve more slowly, than children adopted earlier. To further discard the hypothesis that children with problems are adopted later, we also looked at the ages at arrival of the 15 children with neurological signs at the first assessment. In the Chinese group, three of the five children with neurological signs were adopted at younger ages than their group mean age. Among these three was the only child in this group with a persistent diagnosis across time. In the Russian group, the majority (five out of eight) were also adopted at younger ages than their group mean age. Among these five were three of the four children in this group with a persistent diagnosis. On the other hand, the two children with neurological signs at arrival in the Asian group were adopted at older ages than their group mean age, and among these two was the only child in this group with a persistent diagnosis. From our findings, selective adoption does not appear to be a likely explanation.

To sum up, our study assessed the development of adopted children up to 6 months after the time of arrival in their adoptive country. It revealed that, on average, the anthropometric and developmental measures (except for children showing presence of neurological signs at arrival) improved after a few months with their adoptive families. However, even 6 months post-adoption, cognitive and motor scores were not in the normal range for all children. As underlined by Miller et al. (1995), lack of experience with play objects, such as the ones regularly used in most developmental scales, may have contributed to the poor testing results of many children. But these results most probably reflect the deprived environment in which the children lived before adoption and how difficult it was for some of them to catch up rapidly after adoption. We will continue to follow these children until they reach 3 years of age. We expect other improvements for all children, especially for those who did not catch up in the first 6 months after adoption. The fact that initially lower scores (anthropometric and developmental measures) were related to greater gains could be interpreted as regression to the mean instead of genuine catch-up. However, as specific factors, such as age at time of arrival or nutritional status, explain part of the variance in developmental gains, we consider that we have observed a real change in the developmental trajectory of these children. Our subsequent measures will show if the gains persist or are even greater, thus indicating genuine improvements associated with a drastic change in the children's environmental conditions.

Overall, the study of adopted children makes it possible to investigate to what extent the eventual damaging effects of negative early experiences can be mitigated by a more favourable environment (Verhulst et al., 1992). Our research indicates that improvement may be observed when certain conditions are met. A better nutritional status, a shorter length of pre-adoption experience or a younger age at time of adoption, and the absence of neurological signs allow us to expect rapid gains in cognitive and motor development. Thus, it appears possible to change a deficient developmental trajectory associated with negative early experiences when medical signs are not extreme and when the depriving conditions are not sustained for a very long period. The qualities of the adoptive environment, including good parental schooling level, high family financial resources, and adequate parental practices, should also be considered as determinant factors when assessing the global improvement of the adopted children.

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References

Albers, L. H., Johnson, D. E., Hostetter, M. K., Iverson, S., & Miller, L. L. (1997). Health of children adopted from the former Soviet Union and Eastern Europe: Comparison with preadoptive medical records. *Journal of the American Medical Association, 278,* 922–924.

Ames, E. W. (1997). *The development of Romanian orphanage children adopted to Canada*. Burnaby, Canada: Simon Fraser University.

Ames, E. W., & Chisholm, K. (2001). Social and emotional development in children adopted from institutions. In D. B. Bailey, Jr, J. T. Bruer, F. J. Symons, & J. W. Lichtmans (Eds.), *Critical thinking about critical periods*. Baltimore: Paul H. Brookes.

Aronson, J. (2000). Medical evaluation and infectious considerations on arrival. *Pediatric Annals, 29,* 218–223.

Bayley, N. (1993). *Bayley Scales of Infant Development* (2nd ed.). San Antonio, TX: The Psychological Corporation.

Benoit, T. C., Jocelyn, L. J., Moddemann, D. M., & Embree, J. E. (1996). Romanian adoption: The Manitoba experience. *Archives of Pediatric and Adolescent Medicine, 150,* 1278–1282.

Castle, J., Groothues, C., Bredenkamp, D., Beckett, C., O'Conner, T., Rutter, M., & the English and Romanian Adoptees (ERA) Study Team (1999). Effects of qualities of early institutional care on cognitive attainment. *American Journal of Orthopsychiatry, 69,* 427–437.

Chicoine, J.-F. (2001). Adoption étrangère: le point de vue du pédiatre. *Médecine thérapeutique/pédiatrie, 4,* 342–357.

Desrosiers, H. (2000). Milieux de vie: la famille, la garde et le quartier. In *Étude longitudinale des enfants du Québec* (ELDEQ 1998-2002), *Vol. 1*, no. 2. Québec: Institut de la Statistique du Québec.

Fisher, L., Ames, E. W., Chilsholm, K., & Savoie, L. (1997). Problems reported by parents of Romanian orphans adopted to British Columbia. *International Journal of Behavioral Development, 20,* 67–82.

Gunnar, M. R., Bruce, J., & Grotevant, H. D. (2000). International adoption of institutionally reared children: Research and policy. *Development and Psychopathology, 12,* 677–693.

Hamill, P. V. V., Drizd, T. A., Johnson, C. L., Reed, R. B., Roche, A. F., & Moore, W. M. (1979). Physical growth: National Center for Health Statistics percentiles. *American Journal of Clinical Nutrition, 32,* 607–629.

Hostetter, M. (1999). Infectious diseases in internationally adopted children: Findings in children from China, Russia, and Eastern Europe. *Advances in Pediatric Infectious Diseases, 14,* 147–161.

Johnson, D. E. (2000). Long-term medical issues in international adoptees. *Pediatric Annals, 29,* 234–241.

Johnson, D. E., Miller, L. C., Iverson, S., Thomas, W., Franchino, B., Dole, K., Kiernan, M. T., Georgieff, M. K., & Hostetter, M. K. (1992). The health of children adopted from Romania. *Journal of the American Medical Association, 268,* 3446–3451.

Kim, W. J. (1995). International adoption: A case review of Korean children. *Child Psychiatry and Human Development, 25,* 141–154.

Kim, W. J., Shin, Y.-J., & Carey, M. P. (1999). Comparison of Korean-American adoptees and biological children of their adoptive parents: A pilot study. *Child Psychiatry and Human Development, 29,* 221–228.

Le Mare, L., Vaughan, K., Warford, L., & Fernyhough, L. (2001, April). *Intellectual and academic performance of Romanian orphans 10 years after being adopted to Canada*. Poster presented at the Biennial meeting of the Society for Research in Child Development, Minneapolis, MN.

Lien, N. M., Knarig, K. M., & Winick, M. (1977). Early malnutrition and "late" adoption: A study of their effects on the development of Korean orphans adopted into American families. *The American Journal of Clinical Nutrition, 30,* 1734–1739.

Marcovitch, S., Goldberg, S., Gold, A., Washington, J., Wasson, C., Krekewich, K., & Handley-Derry, M. (1997). Determinants of behavioural problems in Romanian children adopted in Ontario. *International Journal of Behavioral Development, 20,* 17–31.

Miller, L. C. (2000). Initial assessment of growth, development, and the effects of institutionalization in internationally adopted children. *Pediatric Annals, 29,* 224–232.

Miller, L. C., Kiernan, M. T., Mathers, M. I., & Klein-Gitelman, M. (1995). Developmental and nutritional status of internationally adopted children. *Archives of Pediatric and Adolescent Medicine, 149,* 40–44.

Morison, S. J., Ames, E. W., & Chisholm, K. (1995). The development of children adopted from Romanian orphanages. *Merrill-Palmer Quarterly, 41,* 411–430.

Morison, S. J., & Ellwood, A.-L. (2000). Resiliency in the aftermath of deprivation: A second look at the development of Romanian orphanage children. *Merrill-Palmer Quarterly, 46,* 717–737.

O'Connor, T. G., Rutter, M., Beckett, C., Keaveney, L., Kreppner, J. M., & the English and Romanian Adoptees (ERA) Study Team (2000). The effects of global severe privation on cognitive competence: Extension and longitudinal follow-up. *Child Development, 71,* 376–390.

Pollitt, E., Golub, M., Gorman, K., Grantham-McGregor, S., Levitsky, D., Schurch, B., Strupp, B., & Wachs, T. (1996). A reconceptualization of the effects of undernutrition on children's biological, psychosocial, and behavioral development. *Social Policy Report of the Society for Research in Child Development, 10,* 1–24.

Proos, L. A., Hofvander, Y., Wennqvist, K., & Tuvemo, T. (1992a). A longitudinal study on anthropometric and clinical development of Indian children adopted in Sweden. I. Clinical and anthropometric condition at arrival. *Upsala Journal of Medical Science, 97,* 79–92.

Proos, L. A., Hofvander, Y., Wennqvist, K., & Tuvemo, T. (1992b). A longitudinal study on anthropometric and clinical development of Indian children adopted in Sweden. II. Growth, morbidity and development during two years after arrival in Sweden. *Upsala Journal of Medical Science, 97,* 93–106.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models* (2nd ed.). *Advanced quantitative techniques in the social sciences series*. Newbury Park, CA: Sage.

Rutter, M., & the English and Romanian Adoptees (ERA) Study Team (1998). Developmental catch-up, and deficit, following adoption after severe global early privation. *Journal of Child Psychology and Psychiatry, 39,* 465–476.

Rutter, M., O'Connor, T. G., & the English and Romanian Adoptees (ERA) Study Team (2004). Are there biological programming effects for psychological development? Findings from a study of Romanian adoptees. *Developmental Psychology, 40,* 81–94.

Schaffer, H. R. (2000). The early experience assumption: Past, present, and future. *International Journal of Behavioral Development, 24,* 5–14.

Sigman, M., Espinosa, M., & Whaley, S. (1998). Mild malnutrition and the cognitive development of Korean school children. In *Nutrition, health and child development. Pan American Health Organization Scientific Monograph No. 566* (pp. 91–103). Washington, DC: PAHO.

Tessier, R., Moss, E., Nadeau, L., Larose, S., & Tarabulsy, G. M. (2005). L'adoption internationale au Québec de 1985 à 2002. L'adaptation sociale des enfants nés à l'étranger et adoptés par des familles du Québec. Research report addressed to the *Secrétariat à l'adoption internationale du Québec, Ministère de la Santé et des Services Sociaux*.

Thomas, M. S. C. (2003). Limits on plasticity. *Journal of Cognition and Development, 4,* 99–125.

Tizard, B. (1991). Intercountry adoption: A review of the evidence. *Journal of Child Psychology and Psychiatry, 32,* 743–756.

Verhulst, F. C., Althaus, M., & Versluis-Den Bieman, H. J. M. (1992). Damaging backgrounds: Later adjustment of international adoptees. *Journal of the American Academy of Child and Adolescent Psychiatry, 31,* 518–524.

Wachs, T. D. (1995). Relation of mild to moderate malnutrition to human development. *Journal of Nutrition, 125 (Suppl),* 2245S–2254S.

Wachs, T. D., & McCabe, G. (2001). Relation of maternal intelligence and schooling to offspring nutritional intake. *International Journal of Behavioral Development, 25,* 444–449.

Winick, M., & Rosso, P. (1969). Head circumference and cellular growth of the brain in normal and marasmic children. *The Journal of Pediatrics, 74,* 774–778.

Appendix A

List of medical problems: Categories and subcategory

Categories

1. Respiratory infection (otitis media and externa, rhinoconjunctivitis, bronchiolitis, pneumonia).
2. Gastrointestinal infection (ascariasis, giardiasis and other parasites, bacterial gastro-enteritis as salmonellosis and campylobacter infection, viral gastro-enteritis).
3. Cutaneous infection (pyogenic dermatitis, furonculosis and other cutaneous infections, scabies, head lice) and eczema.
4. Cranio-facial anomaly (plagiocephaly, platybasia).
5. Nondermatologic organic disease (strabismus and other ophthalmologic problems, other ENT/audiologic problems, asthma, congenital hip dysplasia and other locomotor problems, congenital cardiopathy, umbilical hernia, inguinal hernia, and other surgical problems).
6. Neurological signs (epilepsy, cerebral palsy, hemiplegia, overt or possible foetal alcohol syndrome).
7. Anaemia/rickets.

Subcategory

1. Cutaneous infection: Eczema.