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Gross motor development in children adopted from orphanage settings

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Abstract

AIM—This study sought to examine the effect of environmental enrichment on the motor skills of children adopted from orphanage settings. We investigated balance and bilateral coordination skills in 33 internationally adopted postinstitutionalized children (16 males, 17 females; age range 8y 5mo–15y 10mo; mean age 10y 9mo; SD 2y 2mo) and compared them with 34 non-institutionalized children (21 males, 13 females; age range 8y 3mo–14y 10mo; mean age 11y 2mo; SD 2y 1mo) being raised in their birth families.

METHOD—The children were individually administered the balance and bilateral coordination subtests of the Bruininks–Oseretsky Test of Motor Proficiency in a research laboratory. Parents completed questionnaires about developmental history, family environment, and orphanage care.

RESULTS—Postinstitutionalized children showed motor system delays compared with the non-institutionalized comparison children (postinstitutionalized balance mean 9.44, SD 5.92, comparison children balance mean 14.12, SD 4.39; postinstitutionalized bilateral coordination mean 11.97, SD 5.43, comparison children mean 19.97, SD 3.97). The length of time that children remained institutionalized before adoption predicted balance delays ($b=-1.57$, $t=-2.33$, $p=0.027$) and the severity of caregiving deprivation the children experienced correlated with bilateral coordination ($r=-0.44$, $p=0.013$).

INTERPRETATION—These findings suggest that institutionalized settings do not provide the early life experiences needed for the development of age-level motor skills later in childhood and that simple environmental enrichment following adoption is not enough to remediate skills. Children who have experienced early institutional care may benefit from early identification and targeted intervention.

Many children adopted internationally have had less than optimal early life experiences, often suffering severe deprivation frequently associated with institutional care. Such deprivation is known to affect skill acquisition negatively across a wide range of developmental areas.[1] Longer periods of institutionalization have been linked to increased difficulties in specific areas, including memory, attention, learning, and inhibitory control,[2] as well as internalizing and externalizing behavioral problems.[3] Identifying motor deficits in internationally adopted, postinstitutionalized children is important given the evidence that children with motor problems are often stigmatized, with poor motor performance leading to exclusion from social activities. As a result, motor delays are implicated in a cycle of decreasing participation in peer play, decreasing social competence, and low self-esteem.

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Furthermore, exercise and motor development are closely related to physical and mental health.[4–7]

Institutional (also called orphanage) environments usually afford inadequate opportunities for motor activity. Rutter[8] emphasized that children adopted from Romanian orphanages were more severely deprived than almost any other group of children previously studied. Romanian orphans were mainly confined to cribs or cots with few if any toys. A time use study by Tirella et al.[9] found that children in a Russian orphanage spent 50% of their time alone. Additional factors such as high child-to-caregiver ratios and regimented schedules contribute to limited opportunities for children to participate in gross motor play with caregivers or peers.[10,11]

Most extant studies of the motor skills of institutionalized children were conducted before or just after children were adopted into family settings, rather than following a period in the enriched environment. A study by Sweeney and Bascom[12] is one that assessed children before adoption. Participants in that study, who resided in nine orphanages across Romania, were screened to be free of overt neurological impairments. These children scored below the 4th centile in motor skills using the Peabody Developmental Motor Scales. One of the first studies of international adoptees at entry into the USA reported gross motor delays in 33% of the children.[13] These authors suggested future studies would be necessary to examine any possible reversibility of the delays after adoption into a family environment.

Developmental `catch-up' in children adopted from institutional settings is often attributed to radical improvement in the child's environment, shorter time in an institution, and/or younger age at adoption. Some studies also emphasize the length of time spent in the enriched environment. One such study of children from Eastern Europe who had been in their adoptive homes for an average of 5 years found that 34% of the participants were identified with developmental coordination disorder even after exposure to an enriched environment.[14] However, 90% of this sample was also diagnosed with neurological and/or neurodevelopmental disorders. A study by Pomerleau et al.[15] examined the development of 123 children adopted before 18 months of age from China, East Asia (Vietnam, Taiwan, Thailand, South Korea, Cambodia), and Eastern Europe (mainly Russia). Rapid gains in motor development were observed postadoption, especially for those children with a shorter length of institutional experience or those who were younger at the time of adoption. Lin et al.[16] examined the motor/sensory skills of children also adopted from Eastern Europe. Using the Sensory Integration and Praxis Tests, they evaluated 60 children aged from 4 to 9 years who had been living with their adoptive families for an average of 3 to 5 years. Half of the children had spent an average of 34 months in an institution and half had spent an average of 3 months in an institution. Children with longer periods of institutionalization displayed higher levels of problems with sensory discrimination, praxis, and sensory modulation.

The present study was designed to assess and then compare the gross motor development of children raised in orphanages before adoption with age-matched peers being reared in their birth families. Tests of gross motor development used in this study were selected based on a preliminary study in our laboratory of 18 9-year-old children adopted from orphanages in Romania. These children showed delays in balance and bilateral coordination that appeared to persist over time.[17] Therefore, tests of balance and bilateral coordination were selected for the present study. None of the children who participated in the preliminary study was included in the study reported here. Our aim was to select children without overt neurological problems who had been living in a family environment for a number of years following adoption from an institutionalized setting. We sought to assess motor skill `catch-up' once children had spent time in an enriched environment. We also tested to determine if longer histories of institutionalization, or more severely deprived settings, would be associated with gross motor development. Our primary hypothesis was that internationally adopted postinstitutionalized children would display weaker balance and bilateral coordination skills than their peers even after years in an enriched environment, with longer periods of institutionalization and more severe deprivation leading to more significant delays.

METHOD

Participants

Sixty-seven children participated in this study. The target group included 33 internationally adopted postinstitutionalized children (17 females, 16 males; mean age 10y 9mo; SD 2y 2mo; range 8y 5mo–15y 10mo). These children were compared with 34 non-institutionalized children being raised in their birth families (13 females and 21 males; mean age 11y 2mo; SD 2y 1mo; range 8y 3mo–14y 10mo). The adopted children were born in Romania (*n*=23) and Russia (*n*=10). These children spent a mean of 3.1 years in an orphanage before adoption (SD 1.77; range 3mo–8y 4mo) and had been living in the USA for a mean of 6.2 years at the time of testing (SD 2.36; range 2y 9mo–12y 6mo). Demographic characteristics of the sample are summarized in Table I.

Adopted children were recruited through flyers distributed by parent support groups, pediatricians, and schools soliciting families who had an interest in participating in adoption research. Comparison children were recruited through flyers distributed at local public elementary schools. All children had IQs screened in the normal range and were without diagnoses of neurological disease, significant developmental challenges or delays, or autism spectrum disorder. In addition, comparison children were not included if they had a history of abuse or neglect in a state or county registry, or were domestically adopted. As recommended by other researchers in international adoption,[18] we recruited comparison families who were similar to the adoptive families in maternal level of education and median family income to ensure similar current family environments. To assess whether adoptive and comparison families provided similar opportunities for motor development, we asked parents to indicate, from a possible list of 26 items, what had been made available to their child over the previous year. The list included common items/activities such as swing sets or jungle gyms in the yard, swimming lessons outside of school, sending the child to a camp, etc. Out of a possible range of zero to 26 opportunities for such environmental enrichment, the mean number of opportunities endorsed for comparison children was 19.5 (SD 2.8) and for adopted children was 18.6 (SD 3.5). We created a rudimentary scale that queried adoptive parents about what they observed in the orphanage when they went to bring their child home. Questions included issues of cleanliness, visible toys, responsiveness of caregiving, crowding, etc. Items were scored on a Likert-type scale (with 1=good care and 5=extremely neglectful). These responses were summed to create a very rough index of likely deprivation experienced by the children (mean 5.03, SD 3.32, range 0–12).

Procedures

This study was reviewed and approved by the University of Wisconsin-Madison's institutional review board. All parents provided informed consent. Demographic information as well as information about children's past and current environments was gathered through parent questionnaires. Children were individually administered the balance and bilateral coordination subtests of the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP),[19] a standardized test used to evaluate the motor functioning of children. All testing was done in a university research laboratory by two trained examiners with advanced degrees. Interrater reliability for the scale was 0.90 to 0.98. The balance test included eight items assessing static and dynamic balance. The bilateral coordination test included eight items assessing sequential and simultaneous coordination of arms and legs. The scores on the balance subtest had a possible range from 0 to 32, while scores on the bilateral coordination subtest had a possible range from 0 to 20 (mean 15, SD 5).

RESULTS

Following the descriptive analyses to characterize the sample, we used Student *t*-tests to compare the two groups of children's results on the gross motor tests. We next examined correlations between assessment results and characteristics of the children. Finally, regression analyses were completed to determine predictors of gross motor performance. The distributions of the balance and bilateral coordination scores were suitable for the proposed analyses (Table II).

On the balance test, adopted children had a mean score of 9.44 (SD 5.92) compared with a mean score for the non-adopted children of 14.12 (SD 4.39), a difference in means of −4.68 (t[64]=−3.66, p=0.001; 95% CI=[−7.23, −2.13]; Cohen's d=−0.90). This large effect size signified nearly 1SD difference between the two groups of children. On the bilateral coordination test, adopted children had a mean score of 11.97 (SD 5.43) compared with a mean score for the non-adopted children of 19.97 (SD 3.97), a difference in means of −8.00 (t[64]=−6.859, p<0.001; 95% CI=[−10.33, −5.67]; Cohen's d=−1.68). Here, the very large effect size signified a difference of 1.68SD between the two groups of children. Forty-six percent (15 out of 33) of the adopted children scored more than 1SD below the BOTMP mean in balance and 36% (12 out of 33) scored more than 1SD below the mean in bilateral coordination. In the comparison group, 15% (5 out of 34) of the children scored more than 1SD below the BOTMP mean in balance and none scored more than 1SD below the mean in bilateral coordination. Simple correlation analyses were used to investigate associations between the gross motor scores and the severity of deprivation experienced by the children in the institution as well as the length of time spent in the institution. A correlation was established between severity of deprivation and bilateral coordination among the adopted children (r=−0.44, p=0.013). No significant correlation was found between severity of deprivation and balance scores. Furthermore, there was no significant correlation between time spent in the institution and either of the gross motor scores.

To evaluate the differences better between the children's balance and bilateral coordination scores, regression analyses were performed in which the effects of additional covariates could be controlled for. The first set of regression analyses focused on the adopted children only. The variables `age at testing' and `time living in the USA' were entered as covariates along with the predictor of `time in an institution'. Separate regression models were fitted using the balance and bilateral coordination scores respectively, as outcomes. Controlling for covariates, the results revealed that the amount of time a child spent in an institution was a significant predictor of balance (b=−1.57, t=−2.33, p=0.027), implying that balance scores fall on average 1.57 points for every year in an institution (Table III). However, time spent in an institution was not a significant predictor of bilateral coordination. When severity was entered as an additional covariate for each outcome, the effect of the amount of time spent in an institution remained significant for balance scores (b=−1.54, t=−2.31, p=0.029), and non-significant for bilateral coordination (b=0.07, t=0.19, p=0.910), although severity did significantly predict bilateral coordination (b=−0.81, t=−3.05, p=0.005).

A second set of regression analyses included both groups of children. The models entered `age at testing' as a covariate, as well as a dummy coded predictor related to adoption status, and an interaction between adoption status and age at testing. In these analyses, the age variable was centered about its mean (11y). The results suggest a significant main effect related to adoption status for both the balance and bilateral coordination outcomes. For example, by age 11 the experience of institutionalization led to a −4.63 point difference in balance scores (t=−3.57, p=0.001; 95% CI=[−7.23, −2.04]) and a −7.74 point difference in bilateral coordination scores (t=−6.68, p<0.001; 95% CI=[−10.06, −5.43]) when compared with the comparison group (Table IV). These scores reflect only slight reductions from the unadjusted effects reported using independent Student t-tests mentioned earlier. In neither of the regression analyses were the age at testing or interaction effects found to be statistically significant. Finally, although as noted earlier the adopted and comparison groups were identified so as to possess similar distributions with respect to age, maternal education, and family income, the matching was not exact. In order to confirm that the group differences seen above were not a consequence of subtle differences in covariates, we also ran the models above with maternal education and family income as additional covariates. The results suggested a slight increase in the adjusted mean difference to −7.85 for the balance scores (t=−2.98, p=0.005; 95% CI=[−13.21, −2.48]) and −8.77 for bilateral coordination (t= −3.86, p=0.001; 95% CI=[−13.40, −4.15]), although it is important to note that in both of these analyses the sample was reduced because of missing observations on the maternal education and/or family income variables for certain participants.

DISCUSSION

Although institutional caregiving may provide children with rudimentary food and shelter, these environments often do not afford all that is required to promote optimal child development.[20] Early experiences of movement and exploration are critical mechanisms underlying neurobehavioral development and these are often lacking in institutional environments. The data reported here suggest that motor system delays associated with early environmental deprivation do not fully remediate simply with change to an enriched environment later in development. Children who were deprived of motor activity and opportunities for exploration are not `catching up' to the performance levels of their age-matched peers, with scores on tests of balance and coordination below those of their peers, even after an average of more than 6 years with their adoptive families in the USA. Many of these children scored more than one standard deviation below the mean on these tests, which could qualify them for intervention with occupational or physical therapy services. This is surprising given that these children have been in an enriched family environment that provides ample opportunities for promoting motor development.

One possible explanation for these findings is that the common presentation of delayed motor skills at the time of adoption leads to exclusion from activities by peers, which then creates a cycle of decreasing participation and decreasing competence. Another possibility is that children who experienced institutional environments were not afforded key aspects of experience that are tied to behavioral plasticity. Both suggestions are consistent with other studies of postinstitutionalized children, one reporting heightened reactivity to sensation tied to the dopamine system[21] as well as neuroimaging studies showing structural and functional differences in relevant brain regions, including the cerebellum.[22–24] This correlation between a lack of early experience and behavioral plasticity does not suggest that the motor delays are fixed, only that they do not appear to remediate merely through changes in environment and may require targeted interventions. Similarly, the findings in studies of developmental coordination disorder (DCD) also highlight the need for structured intervention rather than just increased opportunity. DCD, affecting 5 to 6% of school-aged children, is characterized by motor performance substantially below that expected for age and intelligence, and which significantly interferes with academic achievement or activities of daily living. A small number of children with DCD do improve as they develop, but most often the motor difficulties continue unless there is structured intervention.[25] Indeed, based on our results, many of the internationally adopted children who participated in this study would qualify for intervention services in schools. Of note, only 15% (5 out of 33) of our adopted children had contact with a physical therapist (i.e. an evaluation or intervention) before participating in the study.

We had expected to find that children who spent longer periods in institutions would have lower scores on tests of both balance and bilateral coordination. However, in this sample, the length of time the child spent in an institution predicted delays in balance scores, but not bilateral coordination scores. We also had expected to find that children who experienced more severe deprivation would have lower scores on tests of both balance and bilateral coordination. However, more severe orphanage deprivation was associated with lower bilateral coordination scores, but not with balance scores. Given the difficulty of objectively quantifying each orphanage setting, this association between more severe orphanage deprivation and bilateral coordination should be interpreted with some caution. Finding these inverse patterns may suggest different neural sensitivities to the timing of experiences across these two motor skills. It is also possible that our sample size was not sufficient to detect a group effect across both balance and bilateral coordination. These ideas may be empirically tested through future research. One unexpected finding in our study was the percentage of comparison children with low balance scores. This finding suggests that the comparison group was not biased towards children with especially high motor skills. It is possible that parents of comparison children having motor difficulties chose to participate in this particular study because of the focus. Comparison children were accepted into the study from a community sample if they met the criteria and had none of the exclusion factors previously mentioned.

Future longitudinal studies assessing the full range of motor skills in children adopted from around the world, with varying lengths of institutional care and levels of deprivation, would help to continue to clarify the impact of early institutionalization. Perhaps most importantly, controlled studies of the effects of intervention efforts would address both practical issues for supporting the development of children adopted from orphanage settings while also addressing basic science issues about the plasticity of the motor system. It is likely that early identification of motor problems and targeted interventions to promote motor development could enhance the developmental trajectories of children who begin their lives in unfavorable circumstances.

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What this paper adds

- Motor system delays associated with early environmental deprivation do not fully remediate simply with change to an enriched environment later in development.
- Longer periods of institutionalization and more severe deprivation are associated with decreased balance and bilateral coordination skills.
- Children who have experienced early institutional care should receive periodic motor skill evaluations, and intervention to address residual motor delays.

Table I

Demographic characteristics of study participants

	Adopted children (*n*=33)	Comparison children (*n*=34)
Mean (SD) age	10y 9mo (2y 2mo)	11y 2mo (2y 1mo)
Range	8y 5mo–15y 10mo	8y 3mo–14y 10mo
Sex, F /M	17 / 16	13 / 21
Mean (SD) time in institution, y	3.12 (1.77)	NA
Range	3mo–8y 4mo	
Mean (SD) time in USA	6.26 (2.36)	NA
Range	2y 9mo–12y 6mo	
Mean level of education (maternal)	Bachelor's degree	Bachelor's degree
Median family income (US$)	51 000–75 000 per year	51 000–75 000 per year

NA, not applicable.

Table II

Bruininks–Oseretsky Test of Motor Proficiency, standard scores

	Adopted children (*n*=33)	Comparison children (*n*=34)
Balance		
Mean (SD)	9.44 (5.92)	14.12 (4.39)
Range	1–24	4–21
Bilateral coordination		
Mean	11.97 (5.43)	19.97 (3.97)
Range	1–22	12–29

Table III

Multiple regression analysis for variables predicting balance scores (*n*=33) and bilateral coordination scores (*n*=33)

	Unstandardized regression		Standardized regression	
Variable	***B***	**SE *B***	**β**	***p* value**
Balance				
Intercept	18.36	4.67		0.001
Age at testing	1.04	58	0.38	0.082
Time spent in an institution	−1.57	67	−0.48	0.027
Time living in the USA	−0.61	50	−0.24	0.238
Bilateral coordination				
Intercept	12.51	4.53		0.010
Age at testing	0.743	0.55	0.30	0.185
Time spent in an institution	0.09	0.66	0.03	0.897
Time living in the USA	−0.09	0.49	−0.04	0.850

Table IV

Multiple regression analysis for variables predicting balance scores (*n*=66) and bilateral coordination scores (*n*=66)

	Unstandardized regression		Standardized regression	
Variable	***B***	**SE *B***	**β**	***p* value**
Balance				
Intercept	14.13	0.90		<0.001
Adoption status	−4.63	1.30	−0.41	0.001
Age at testing	−0.072	0.44	−0.03	0.870
Adoption status × age at testing	0.400	0.62	0.105	0.520
Bilateral coordination				
Intercept	19.94	0.81		<0.001
Adoption status	−7.74	1.16	−0.63	<0.001
Age at testing	0.16	0.39	0.05	0.691
Adoption status × age at testing	0.577	0.55	0.14	0.294