Neuromotor development from 5 to 18 years. Part 2: associated movements

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Associated movements (AMs) are the most frequently assessed parameters of movement quality in children with motor dysfunctions. In this article, reference curves of duration and degree of AMs from 5 to 18 years are provided. In a cross-sectional study of non-disabled children (n=662) duration and degree of AMs were estimated at six specific ages while children performed repetitive finger, hand, and foot movements, alternating hand and foot movements, diadochokinesis, sequential finger movements, pegboard, stress gaits, and dynamic balance. Moderate-to-high intraobserver and interobserver reliability for the assessment of AMs were noted. Duration and degree of AMs displayed a non-linear developmental course that was a function of the motor task's complexity. AMs decreased most with age in repetitive movements, less in alternating and sequential movements, and least in the pegboard and dynamic balance. Reference curves demonstrated large interindividual variations for duration and degree of AMs. Both the variable developmental course and large interindividual variation need to be taken into account in the assessment of movement quality of school-age children. In contrast to timed performance, considerable sex differences for AMs were observed.

Movement quality is regularly examined in children suspected of having mild to moderate motor dysfunction. Although routine in daily clinical practice for many years, the assessment of movement quality is still a major methodological challenge. How reliably can movement quality be estimated? What amount and duration of associated movements can be regarded as 'normal' in a 7-year-old child? Interobserver and test–retest reliability have been investigated in only a few studies, and have been found to be moderate to low for some motor items, and even insufficient for others (Quitkin et al. 1976, Werry and Aman 1976, Vitiello et al. 1989). In children with motor problems, associated movements (AMs), in particular contralateral AMs, are the most frequently assessed parameters of movement quality. Due to the fact that AMs are not only present in children with motor problems, but may occur also in normally developing children, they ought to be quantified for a reliable judgement. Age-specific normative values for movement quality parameters are still lacking. In this article AMs are described in two dimensions: duration and degree. Duration of AMs during a defined time period was estimated on a 11-point scale (e.g. a score of 5 means there were AMs during half of the timed period). Degree, which refers to the extent to which AMs were expressed during the defined time period, was assessed on a 4-point scale (e.g. a score of 2=moderate AMs). In a cross-sectional study (N=662 participants), duration and degree of AMs were estimated by means of the Zürich Neuromotor Assessment (ZNA) at six specific ages while children performed repetitive finger, hand and foot movements, alternating hand and foot movements, diadochokinesis, sequential finger movements, pegboard, stress gaits, and dynamic balance tasks. The principal aim of this article was to provide a description of duration and degree of AMs between 5 and 18 years with respect to developmental course, interindividual variation, and sex differences. In a previous article, timed performance was analysed in a similar manner (Largo et al. 2001a).

Method

PARTICIPANTS

In a cross-sectional design, 662 children were tested at the mean ages of 5.8, 7.2, 9.3, 12.5, 15, and 18.1 years. The study population is described in detail in the companion paper to this one (Largo et al. 2001a).

NEUROMOTOR TESTING

In the ZNA 12 distinct motor tasks were assessed with regard to timed performance, duration, and degree of AMs of the contralateral and ipsilateral extremity, face, head, and body (Table I). Children's performances on all motor tasks were videotaped. Informed consent was obtained from children and their parents after the testing procedure and goals of the study had been fully explained.

The assessment of handedness and the testing procedure for repetitive, alternating, and sequential movements, pegboard, dynamic, and static balance are reported in the companion study to this one (Largo et al. 2001a). (A manual with detailed instruction from 5 to 18 years is available from the corresponding author upon request.)

Testing procedures for diadochokinesis and stress gaits are described. For each task, the examiner gives verbal instructions while demonstrating the expected performance. Brief untimed practice follows, without specifying which side the child should try first. No effort was made during the practice or timed trials to control whether the child looked at his/her own performing limb or spoke while carrying out the activity. To measure the task at full exertion, after practising with both extremities, the examiner said, 'When I say "go", do the same thing as fast as you can until I stop you.'

Diadochokinesis

Children stood with one arm relaxed at their sides and the other flexed at the elbow at an angle of 90°. The elbow touches the body. The head is centred, arms and shoulders are relaxed. Children were asked to quickly pronate and supinate the hand and forearm as fast as possible.

Stress gaits

The child was instructed to walk and return a distance of 3 metres on their (1) toes; (2) heels; (3) outer soles; and (4) inner soles of the feet, while arms and hands hang initially loosely at the sides.

SCORING OF AM

Duration and degree of AMs for contralateral and ipsilateral extremity, face, head, and body were scored from video recordings. In this article, data on duration and degree AMs of the contralateral extremity are presented for repetitive finger, hand, and foot movements, alternating hand and foot movements, diadochokinesis, sequential finger movements, and pegboard. For dynamic balance and stress gaits, duration and degree of AMs of the upper extremity are provided. In stress gaits, form-specific associated posture and movements were selectively scored. Form specific, as used here, indicates that movements and posture of the upper extremities mirrors that of the lower extremities: walking on toes (extension of arms and anteflexion of wrists in a backward direction); walking on heels (extension of arms and dorsiflexion of wrists in a forward direction); walking on outer soles (flexion of elbows, anteflexion of wrists and extension of fingers); walking on inner soles (adduction of arms, dorsiflexion of wrists and extension of fingers).

Scoring of duration and degree of AMs was carried out during the time period needed to perform the required number of movements.

Duration was defined as occurrence of AMs during the timed period estimated using a 11-point scoring system: 0, no AMs; 5, AMs during half of the timed period; and 10, AMs during the whole timed period. Degree was defined as the extent to which AMs were expressed during the timed period, using a 4-point scoring system: 0, no AMs; 1, barely visible AMs; 2, moderately expressed AMs; and 3, markedly expressed AMs. Each degree of scoring for each motor task was documented with pictures and video sequences.

ESTIMATION OF RELIABILITY

Intraobserver reliability was assessed by one examiner. Within an interval of 8 weeks, all motor tasks were timed twice using video recordings of 30 children. Interobserver reliability was assessed from videotapes by two examiners (AAM, JAC).

Table I: Motor tasks of the Zürich Neuromotor Assessment

Repetitive movements	Fingers
	Hand
	Foot
Alternating movements	Hand (pro-/supination in sitting position)
	Diadochokinesis (pro-/supination in standing position)
	Foot (heel-toe alternation)
Sequential movements	Fingers
Pegboard	
Dynamic balance	Side-to-side jumping
	Forward jumping
Static balance	
Stress gaits	Walking on toes
	on heels
	on outer soles of feet
	on inner soles of feet

Table II: Intraobserver and interobserver reliability for the estimates of duration and degree of AMs calculated by Spearman correlation coefficients

Motor task	*Intraobserver reliability*		*Interobserver reliability*	
	Duration	*Degree*	*Duration*	*Degree*
n	30	30	30	30
Repetitive finger movements	0.90	0.73	0.82	0.68
Sequential finger movements	0.80	0.82	0.83	0.67
Repetitive hand movements	0.78	0.74	0.71	0.75
Alternating hand pro-/supination	0.88	0.89	0.78	0.65
Diadochokinesis	0.73	0.65	0.60	0.51
Pegboard	0.83	0.75	0.70	0.57
Repetitive foot movements	0.77	0.74	0.55	0.55
Alternating foot movements	0.80	0.81	0.87	0.85
Side-to-side jumping	0.68	0.68	0.76	0.68
Forward jumping	0.55	0.61	0.78	0.68
Walking on toes	0.67	0.62	0.57	0.53
Walking on heels	0.54	0.82	0.73	0.77
Walking on outer soles of feet	0.74	0.57	0.51	0.57
Walking on inner soles of feet	0.66	0.62	0.54	0.55

$p<0.001$: $r>0.60$.

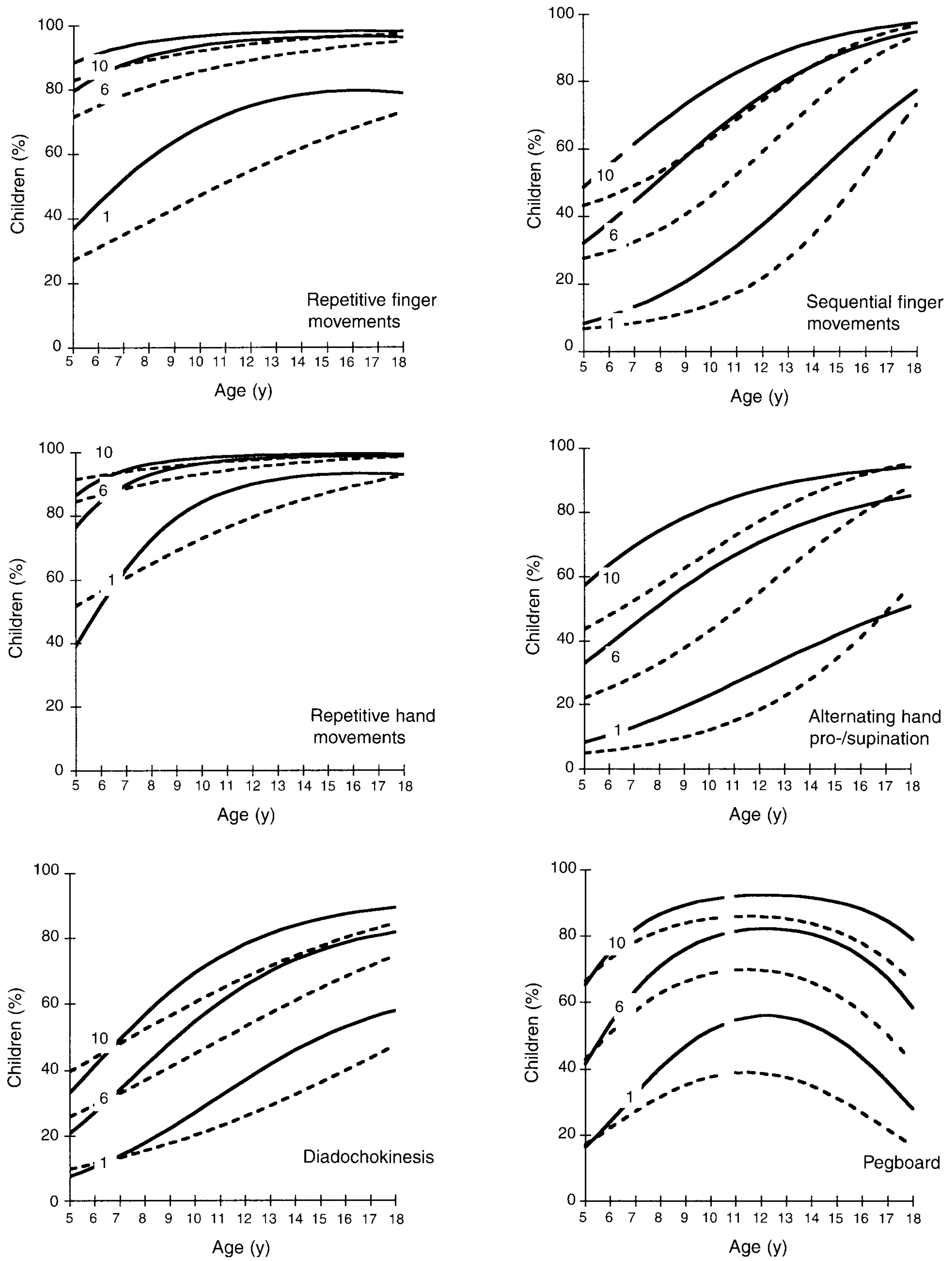

Figure 1: *Reference curves for duration of contralateral associated movements (AMs) of six motor tasks in females (—) and males (----) performing with their dominant upper extremity. Scoring of AM duration: below 1, no AMs; 1–5, AMs for up to half of timed period; 6–9, AMs for more than half of timed period; above 10, AMs during whole timed period.*

STATISTICAL ANALYSIS

Scores for degree and duration of AMs are discrete measurements. While degree was clearly assessed on an ordinal scale with four levels, duration was initially more finely graded on a percentage scale with 11 levels. It turned out, however, that not all levels were consistently used, so that the levels of duration were grouped into four ordered categories: 0, no AMs; 1 to 5, AMs for up to half of the timed period; 6 to 9, AMs for more than half of the timed period; 10, AMs during the whole timed period.

Owing to the fact that degree and duration are ordered measurements with few levels, the customary representation of the developmental course and variability by empirical, age-dependent centiles is not adequate. Instead we decided to calculate cumulative multinomial logits (Agresti 1990) and to represent the corresponding cumulative probabilities as a function of age. The cumulative logits were modelled as quadratic polynomials in age: for duration, different polynomials were required for males and females, while for degree an additive model, i.e. a shift on the logit scale, was sufficient to account for the sex differences. In the graphical representation chosen, the height of each curve gives the percentage of participants, as modelled by cumulative logits, having a score for duration below that indicated by the label of the curve. For example, the height of the curve labelled 1 represents the percentage of children, at a given age, without AMs, and the height above the curve labelled 10 indicates the percentage of those children who displayed AMs during the whole timed period. Thus, the reference curves indicate improvement of movement quality by a raising of curves corresponding to a low degree or a short duration of AMs. For the estimation of the reference curves only right-handed children were included.

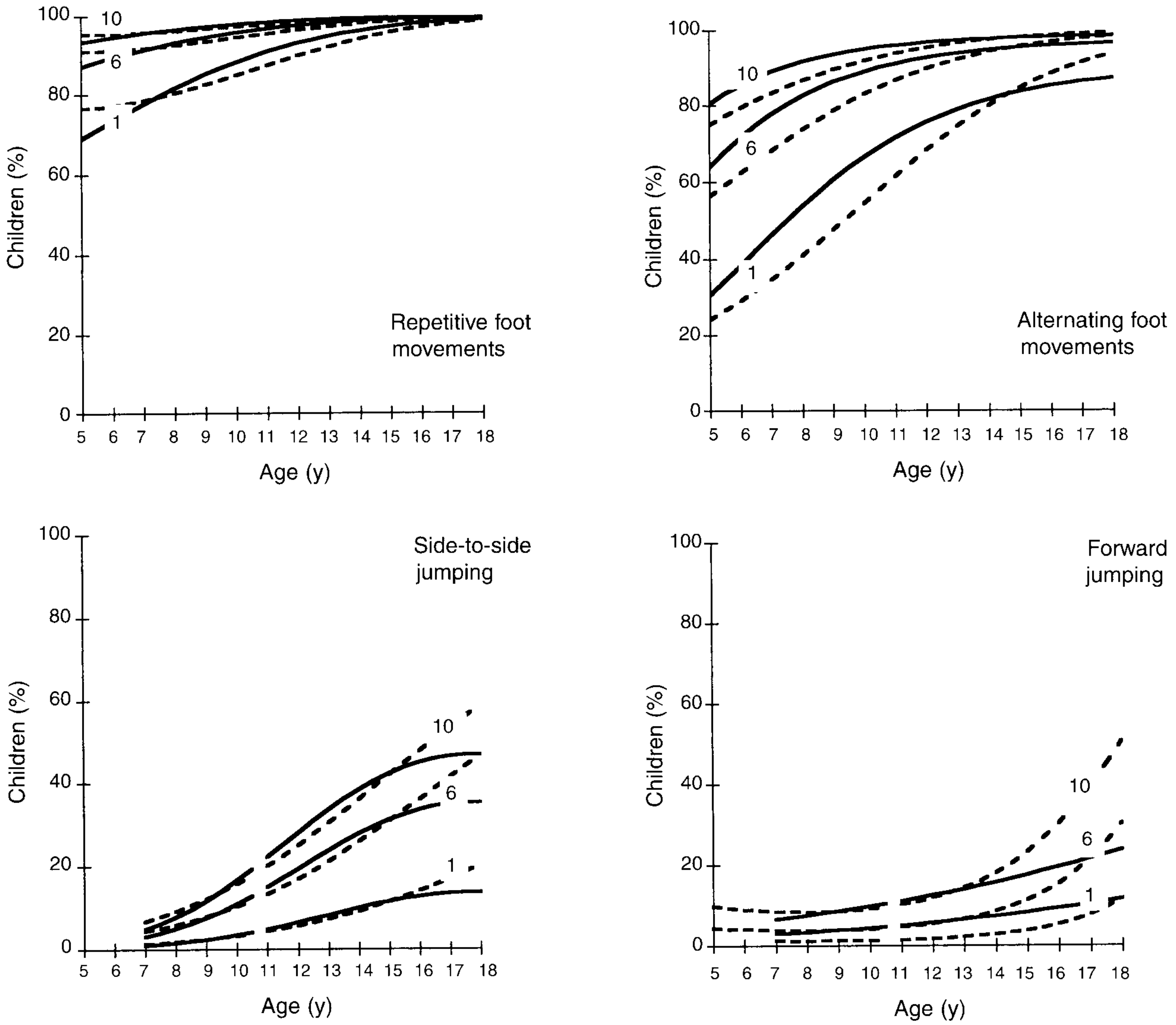

Figure 2: *Reference curves for duration of contralateral associated movements (AMs) in repetitive and alternating foot movements performed with dominant lower extremity and of AMs of upper extremities in side-to-side and forward jumping in females (—) and males (----). Scoring of AM duration: below 1, no AM; 1–5, AMs for up to half of timed period; 6–9, AMs for more than half of timed period; above 10, AMs during whole timed period.*

Spearman's rank correlations were used to estimate intraobserver and interobserver reliability.

Results

First, data on test reliability are presented, then reference curves of duration and degree of AMs for the various motor tasks are provided. For the sake of brevity, only reference curves of the active dominant extremity are shown. The following aspects of duration and degree of AMs will be addressed here: developmental course, interindividual variation, and sex differences. (Reference curves and normative data tables of duration and degree of AMs from 5 to 18 years are available from the first author upon request).

RELIABILITY

To estimate intraobserver and interobserver reliability Spearman's correlations for duration and degree of AMs were calculated (Table II).

With respect to intraobserver reliability, moderately to highly significant correlations for duration and degree of AMs were observed (r=0.54 to 0.90, and 0.57 to 0.89, respectively). Some of the correlations between observers tended to be lower, but most were comparable to the intraobserver correlations (r=0.51 to 0.87 for duration, and 0.53 to 0.85 for degree, respectively).

DURATION OF AMS

The duration of AMs in the upper extremity showed a nonlinear developmental course that was highly variable (Fig. 1). Timing and extent of reduction of duration were a function of the complexity of the motor task. Duration of AMs for repetitive hand and finger movements was largely reduced already at early school age, while those of alternating and sequential hand movements decreased considerably during

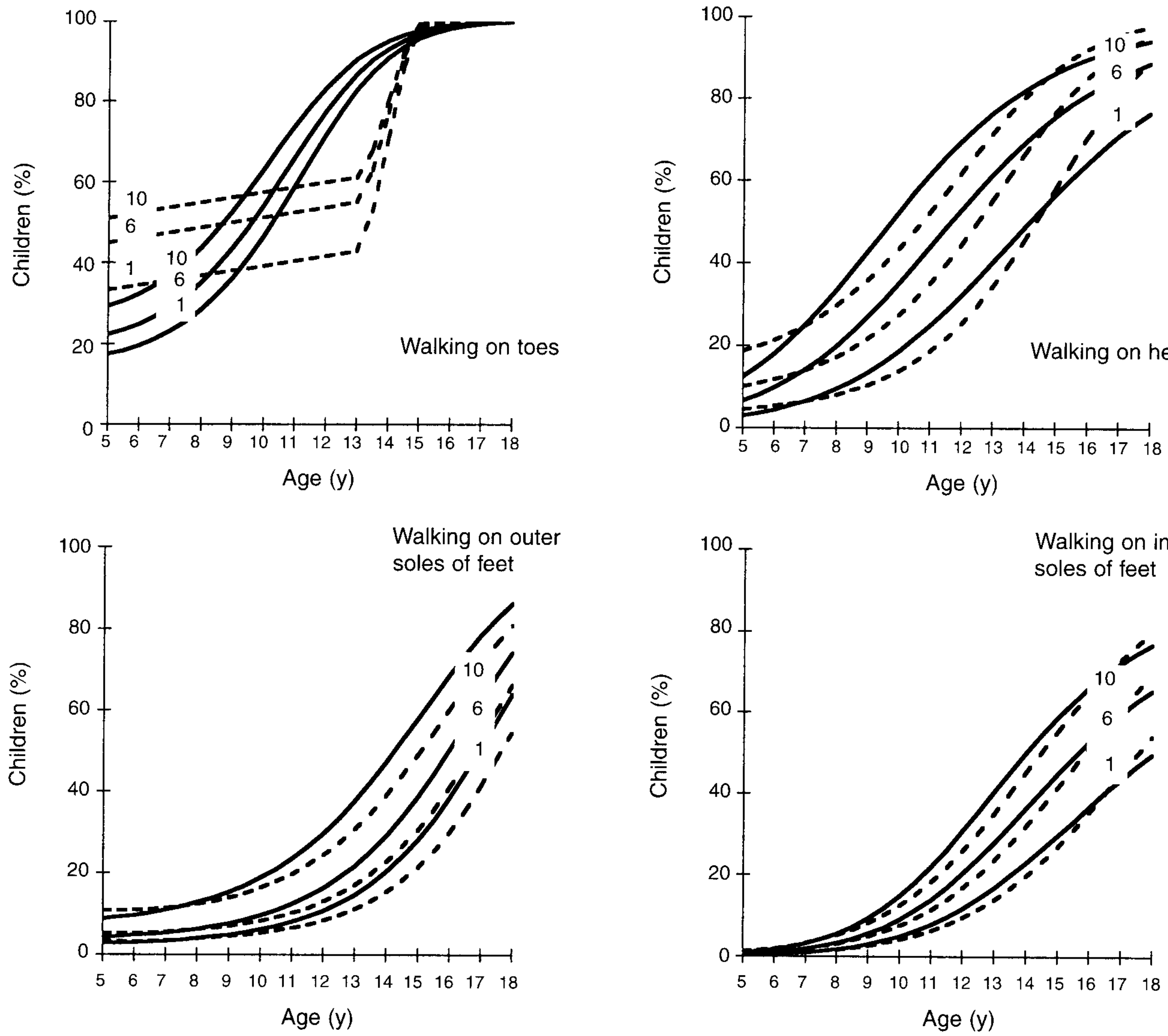

Figure 3: *Reference curves for duration of form-specific movements and posture (AMs) in upper extremities in females (—) and males (----) performing stress gaits. Scoring of AM duration: below 1, no AM; 1–5, AMs for up to half of timed period; 6–9, AMs for more than half of timed period; above 10, AMs during whole timed period.*

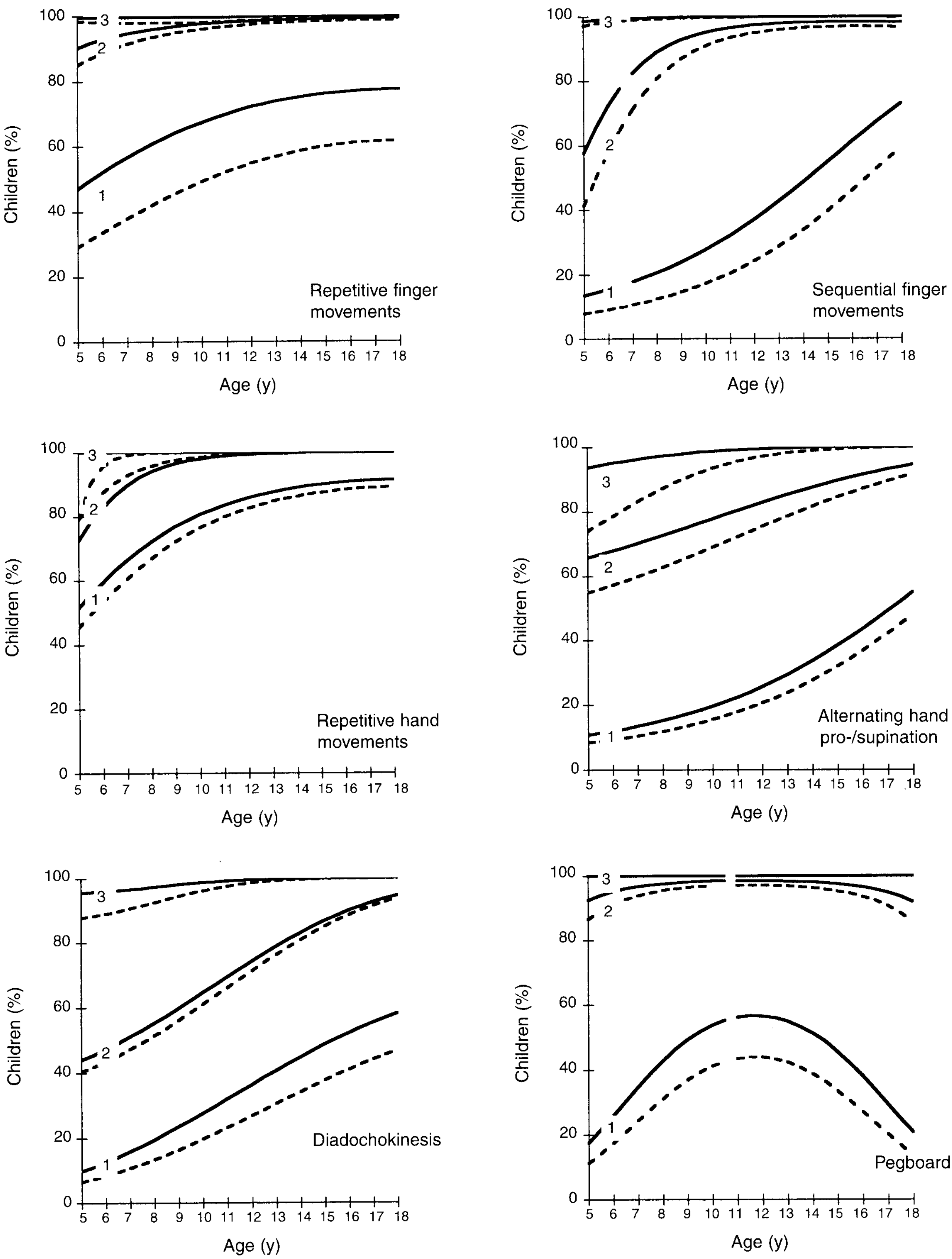

Figure 4: *Reference curves for degree of contralateral associated movements (AMs) of six motor tasks in females (—) and males (----) performing with dominant upper extremity. Scoring of AM degree: below 1, no AMs; 1–2, barely visible AMs; 2–3, moderate AMs; above 3, marked AMs.*

puberty. A major decrease of AMs duration was observed in the pegboard task between 5 and 10 years. However, thereafter AMs duration increased again.

Between 5 and 7 years, the interindividual variability was large in all motor tasks. During this age period, 30 to 40% of the children performing the repetitive finger movements showed no AMs, while 10 to 15% displayed AMs constantly. By 18 years, 70% of the adolescents had no AMs at all, while 10% showed AMs during the whole timed period. At kindergarten age, less than 10% of children did not display any AMs when performing sequential finger movements. At 18 years, no AMs were observed in 75% of the adolescents, and 5% displayed AMs during the whole timed period. The extent to which interindividual variability changed with age varied considerably among the motor tasks. In simple motor tasks, such as repetitive movements, AMs duration was markedly reduced at an early age, while it remained largely unchanged in alternating hand movements and the pegboard (Fig. 2).

With regard to the lower extremity, the developmental course and interindividual variation of AMs duration was again a function of the complexity of the movement pattern. AMs duration for repetitive foot movements decreased at early school age and displayed an increasingly narrow range, while for side-to-side and forward jumping, developmental course of AMs duration showed changes up to the age of 18 years, and variability increased with age.

In the four types of stress gaits, duration of form-specific posture and movements of the upper extremities also displayed a variable developmental course and a large interindividual variation (Fig. 3). Duration was shorter and decreased earliest when the children walked on their tip-toes. Long duration and least change was noted when the children walked on

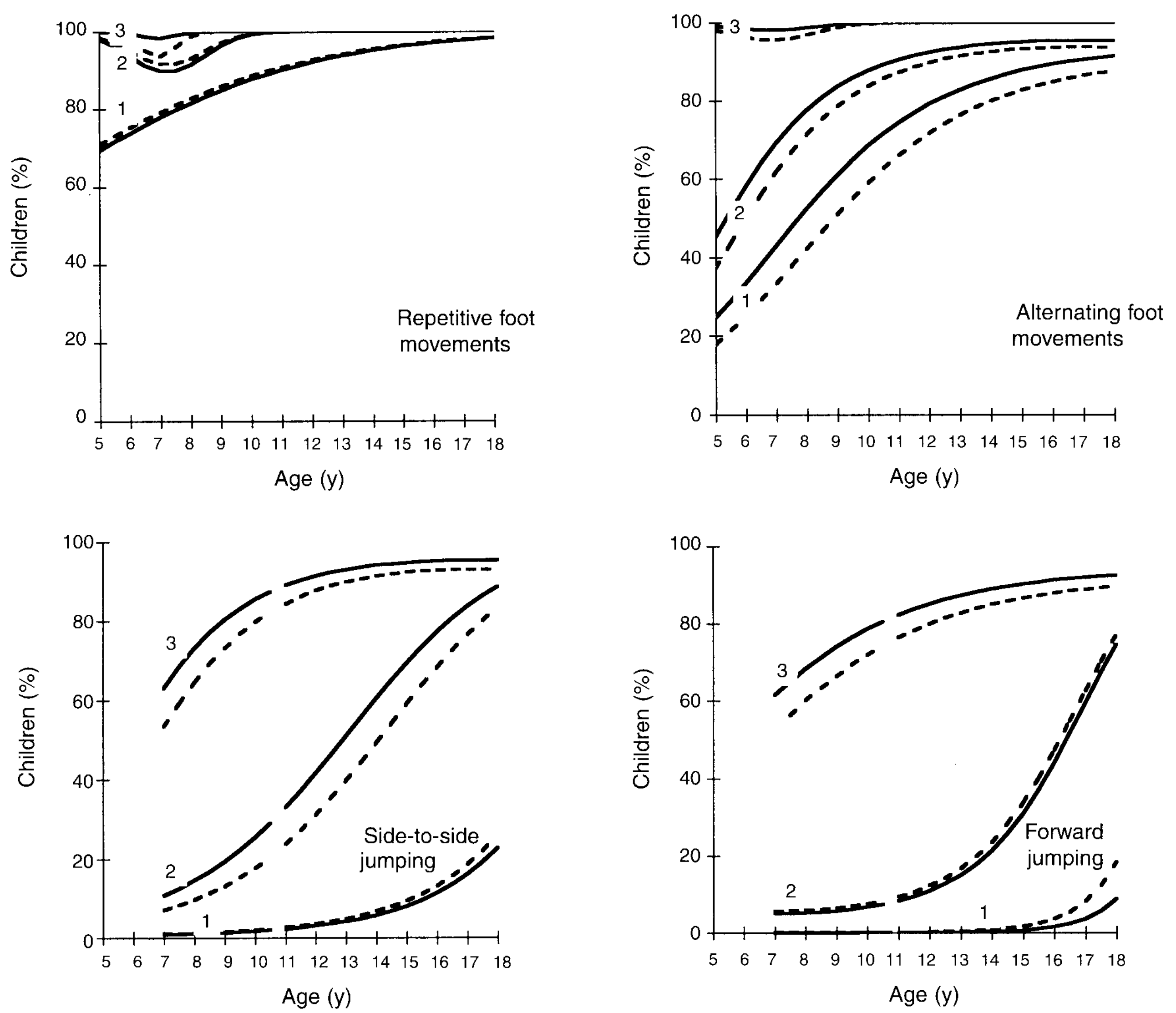

Figure 5: *Reference curves for degree of contralateral associated movements (AMs) in repetitive and alternating foot movements performed with dominant lower extremity and of AMs of upper extremities in side-to-side and forward jumping in females (—) and males (----). Scoring of AM degree: below 1, no AMs; 1–2, barely visible AMs; 2–3, moderate AMs; above 3, marked AMs.*

the inner or outer soles of their feet.

Sex differences for AMs duration were noted in two aspects: females tended to display less AMs at most ages; an exception was forward jumping during puberty. Second, reduction of AMs duration occurred earlier in females than in males. Sex differences of AMs duration were less pronounced for the lower than for the upper extremities. AMs duration for walking on toes showed a peculiar sex difference, not seen for any other parameter. While for females, it decreased gradually with age, for boys it remained fairly constant up to the age of 13 years, to abruptly shrink to practically 0 duration in the following 2 years. This prevented fitting a quadratic polynomial to the cumulative logits of males; a straight line was instead fitted to the logits for the age of 5 to 13 years.

DEGREE OF AMS

The AMs degree showed similar developmental characteristics as AMs duration. With regard to the upper extremity, the degree of AMs decreased up to the age of 18 years in all motor tasks, with the exception of the pegboard (Fig. 4). In the latter an increase of AMs degree was again noted beyond 11 years. As already observed for AMs duration, AMs degree displayed less interindividual variability in repetitive movements than in alternating and sequential movements, diadochokinesis, and particularly in the pegboard.

Developmental course and interindividual variability of degree of AMs for repetitive and alternating movements in the lower extremities were similar to those of the upper extremities (Fig. 5). Variability of AMs degree was lowest in repetitive and alternating foot movements while it was large and even increased during school age in side-to-side and forward jumping.

For the four types of stress gaits, a variable decline of form-specific movements and posture of the upper extremities

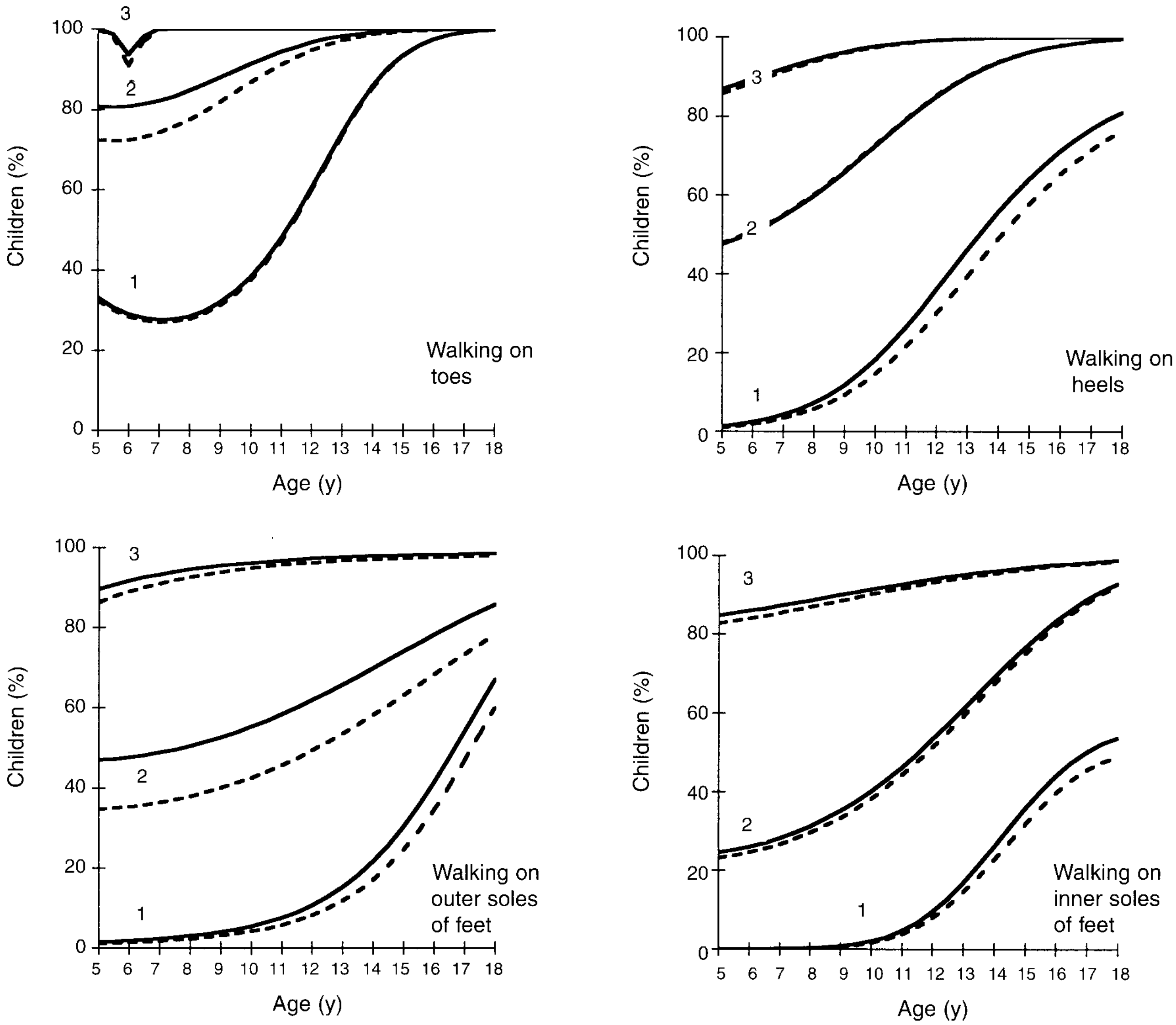

Figure 6: *Reference curves for degree of form-specific movements and posture AMs in upper extremities in females (—) and males (----) performing stress gaits. Scoring of AM degree: below 1, no AMs; 1–2, barely visible AMs; 2–3, moderate AMs; above 3, marked AMs.*

was observed (Fig. 6). Interindividual variability was large at all ages for all four types, particularly during kindergarten and early school age.

Sex differences in favour of girls were less pronounced for AMs degree than for AMs duration among most motor tasks; a few tasks showed even no sex differences. The differences were again smaller for the lower than for the upper extremities.

SOCIOECONOMIC STATUS (SES)

No significant correlations (Spearman) between SES and duration and degree of AMs were noted for any of the motor tasks.

Discussion

For the assessment of movement quality, well-standardized neurological test instruments have been developed (Touwen and Prechtl 1979, Denckla 1985). Although they have been widely used by clinicians and researchers, their reliability and validity were examined only in a few studies (Neeper and Greenwood 1987). Quitkin and coworkers (1976) found that some neurological soft signs indeed proved reliable (kappa coefficient >0.5) among examiners (e.g. finger–thumb mirror overflow, left-sided pronation–supination, foot-tapping), while others (e.g. finger–thumb opposition or pronation–supination mirror overflow) were unreliable. In the same study, very few signs were stable at retesting. Using the revised version of the Neurological Examination for Subtle Signs (NESS), Vitiello and colleagues (1989) analysed interobserver and test–retest reliability of neurological subtle signs. Reliability was sufficient for continuous variables, but was low for overflow movements and dysrhythmias, which were more dependent on subjective interpretation. Test–retest reliability at 2 weeks was unsatisfactory for most of the categorically scored items, including some classic subtle signs, such as overflow or dysrhythmias (kappa and intraclass correlation coefficients <0.50). The authors recommended that researchers and clinicians should rely more on subtle signs that can be assessed on continuous scales.

In our study, intraobserver and interobserver reliability for duration and degree of AMs was moderate to high for the majority of the motor tasks. In agreement with Vitiello and colleagues (1989) reliability for AMs was found to be lower than for timed performance (Largo 2001a). For comparison with previous studies Spearman's correlation coefficients were calculated, which are imperfect measures of reliability. In a forthcoming paper we will present a more sophisticated and detailed statistical analysis of reliability as well as validity. Given these methodological limitations, our results as well as those of previous studies indicate that acceptable reliability for movement quality can only be achieved when a highly standardized testing instrument is used and the examiners are well trained.

The significance of training was investigated recently by Kakebeeke and coworkers (1993). They estimated the interobserver and test–retest reliability of the well-standardized Touwen examination (1979). When the manual was the only reference for instruction, acceptable levels of reliability were not achieved. The reliability estimates for the total test scores were satisfactory, while interobserver reliability for the nine groups of items and the individual tasks within these groups was poor. When methodology and interpretation of performance was agreed among observers, these disagreements diminished. Short-term stability of the total scores was good, but reliability for group and individual item scores remained poor.

There is a general agreement that AMs decrease with age. Age related changes of contralateral AMs from kindergarten age to adolescence have been reported for various fine motor tasks. In the finger lifting method, ipsilateral and contralateral AMs were recorded when the child was asked to move a specified finger (Zazzo 1960, Abercrombie et al. 1964, Connolly and Stratton 1968). In the clip-pinching method, AMs in the contralateral hand were judged when the child exhibited a certain degree of pressure with the thumb (Abercrombie et al. 1964, Connolly and Stratton 1968). Touwen and Prechtl (1979) provided some semiquantitative data for AMs in children performing tasks such as finger opposition, diadochokinesis, or walking on heels. Wolff and colleagues (1983, 1985) reported on age-specific changes of AMs in distinct motor tasks. Vitiello and coworkers (1989) noted a dramatic decrease in the total score of subtle signs at about 6 years of age. They pointed out that this decrease occurs at the very age when children are expected to enter school and learn skills for which a higher level of coordination is required.

Our study provided two major insights in the development of AMs between kindergarten age and adolescence. First, duration and degree of AMs do not regularly decrease with age. A non-linear course of both duration and degree was observed that was a function of the complexity of the individual motor task, e.g. duration and degree of AMs decreased much earlier in repetitive than in alternating and sequential movements. A peculiar developmental course was observed in the pegboard. In contrast to timed performance which improved up to 18 years, duration and degree of AMs decreased up to 12 years of age and increased again between 12 and 18 years. Second, a large interindividual variation for duration and degree of AMs was found in all motor tasks at most ages. Variation again depended on the complexity of the individual motor task. It decreased rapidly in repetitive movements and increased in dynamic balance. For a reliable assessment of AMs in clinical practice and research, the non-linear course, the interindividual variation, and the variability among motor tasks need to be taken into consideration. Comparisons between motor tasks (e.g. between repetitive foot movements and forward jumping) indicate that developmental course and variation determine the clinical relevance of a specific motor task. Thus, depending on the age of the child, different motor tasks should be applied. There are more questions which need to be answered in order to improve sensitivity and specificity of a neuromotor assessment. For example, is duration or degree of AMs of higher clinical significance? Preliminary results suggest that neither duration nor degree, but the product of both is the most powerful indicator for movement quality.

In contrast to timed performance (Largo et al. 2001a), major sex differences for duration and degree of AMs were noted. Females displayed less frequent and less pronounced AMs and, therefore, appeared to be better coordinated than males. Females also exhibited the decrease in AMs earlier than males. A comparable sex shift has been reported in the development of mental abilities and somatic growth (Waber 1977). These sex differences most probably reflect the different maturation rate for females and males. A more detailed analysis of these differences, as well as of laterality and handedness will be presented in a forthcoming article. In conclusion, duration and degree of AMs between 5 and 18 years are characterized by a non-linear developmental course, a large interindividual variation, and considerable sex differences.

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References

Abercrombie MLJ, Lindon RL, Tyson MC. (1964) Associated movements in normal and physically handicapped children. *Developmental Medicine & Child Neurology* **6:** 573–80.

Agresti A. (1990) *Categorical Data Analysis.* New York: Wiley.

Connolly KJ, Stratton P. (1968) Developmental changes in associated movements. *Developmental Medicine & Child Neurology* **10:** 49–56.

Denckla MB. (1985) Revised neurological examination for subtle signs. *Psychopharmacological Bulletin* **21:** 773–800.

Kakebeeke TH, Jongmans MJ, Dubowitz LM, Schoemaker MM, Henderson SE. (1993) Some aspects of the reliability of Touwen's examination of the child with minor neurological dysfunction. *Developmental Medicine & Child Neurology* **35:** 1097–105.

Largo RH, Caflisch JA, Hug F, Muggli K, Molnar AA, Molinari L, Sheehy A, Gasser T. (2001a) Neuromotor development from 5 to 18 years. Part 1: Timed performance. *Developmental Medicine & Child Neurology.* **43:** 436–43.

Neeper R, Greenwood RS. (1987) On the psychiatric importance of neurological soft signs. In: Lahey BB, Kazdin AE, editors. *Advances in Clinical Child Psychology Vol. 10.* New York: Plenum Press. p 217–58.

Quitkin F, Rifkin A, Klein DF. (1976) Neurologic soft signs in schizophrenia and character disorder. Organicity in schizophrenia with premorbid asociality and emotionally unstable character disorders. *Archives of Genetic Psychiatry* **33:** 845–53.

Touwen BC, Prechtl HF. (1979) *The Neurological Examination of the Child with Minor Nervous Dysfunction. Clinics in Developmental Medicine, No. 38.* London: Spastics International Medical Publications (Mac Keith Press).

Vitiello B, Ricciuti AJ, Stoff DM, Behar D, Denckla MB. (1989) Reliability of subtle (soft) neurological signs in children. *Journal of American Academy of Adolescent Psychiatry* **28:** 749–53.

Waber DP. (1977) Sex differences in mental abilities, hemispheric lateralization and rate of physical growth at adolescence. *Developmental Psychology* **13:** 29–38.

Werry JS, Aman MG. (1976) The reliability and diagnostic validity of the physical and neurological examination for soft signs (PANESS). *Journal of Autism and Childhood Schizophrenia* **6:** 253–62.

Wolff PH, Gunnoe CE, Cohen C. (1983) Associated movements as a measure of developmental age. *Developmental Medicine & Child Neurology* **25:** 417–29.

——— (1985) Neuromotor maturation and psychological performance: a developmental study. *Developmental Medicine & Child Neurology* **27:** 344–54.

Zazzo R, editor. (1960) *Manuel pour l'Examen Psychologique de l'Enfant.* Neuchâtel, Switzerland: Delachaux Nestlé. (In French).

Mac Keith Meetings

Customary Consanguineous Marriage (Closed Meeting)
Royal Society of Medicine, London, UK. September 4, 2001.
Richard Morton and Bernadette Modell

Catatonia in Childhood (Closed Meeting)
Royal Society of Medicine, London, UK. September 26–27, 2001.
Michael Prendergast

Drugs in Pregnancy and their Consequences: Little Foundation Annual Open Meeting
Royal Society of Medicine, London, UK. October 24, 2001.
The Little Foundation with Martin Bax

Asperger Syndrome – Management in Children and Young People (Open Meeting)
Royal Society of Medicine, London, UK. January 18, 2002.
Christopher Gillberg and Roger Freeman

Customary Consanguineous Marriage (Open Meeting)
Royal Society of Medicine, London, UK. February 4, 2002.
Richard Morton and Bernadette Modell

Menstruation and Fertility in Disability (Open Meeting)
Royal Society of Medicine, London, UK. March 22, 2002.
Michael Prendergast and Claire Burns

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