The assessment of children with Developmental Coordination Disorders in the Netherlands: The relationship between the Movement Assessment Battery for Children and the Körperkoordinations Test für Kinder

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Abstract

The Movement Assessment Battery for Children (Movement ABC; Henderson, S.E., Sugden, D.A., 1992. Movement Assessment Battery for children: Manual. Psychological Corporation, London.) is used throughout the world in the evaluation of children with movement difficulties. Within Europe, another test commonly used for the same purpose is the Körperkoordinations Test für Kinder (KTK; Kiphard, B.J., Schilling F., 1974 Körperkoordinations Test für Kinder. Beltz Test Gmbh, Weinheim.). The aims of this study were: (i) to take a preliminary look at the suitability of the published norms of these two tests for use with Dutch children, (ii) to examine the correlations between scores on the two tests and, (iii) to examine the concordance between the tests in detecting cases of impairment among children believed to be poorly coordinated. Two hundred and eight children completed both tests. The results suggested that the current norms for the Movement ABC are satisfactory for Dutch children but for the KTK, they may require adjustment. The overall correlation between the two tests was

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0.62. Although there were children who failed one test and passed the other, the degree of con-
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1. Introduction

Motor competence is an important determinant of a child's educational
progress as well as more general development. In most cultures, for example,
learning in the early years is based on exploratory play which in turn involves
movement. As the child gets older, the ability to write legibly and with ade-
quate speed becomes a prerequisite for note taking and examination perfor-
mance as well as being a component of more general literacy skills. In
addition, lack of movement skill may exclude a child from playground
games, leading to social isolation, loneliness, and even depression (Gillberg
and Gillberg, 1989; Losse et al., 1991; Hellgren et al., 1994).

Within the school population, it is estimated that approximately 5% of the
children fail to acquire sufficient movement skill to allow normal progress in
school. This state of affairs is reflected in recent editions of the formal diag-
nostic manuals of the World Health Organisation, (WHO, 1992) and the
American Psychiatric Association (APA, 1987, 1994) which attempt, for
the first time, to identify a developmental disorder of movement skill. Such
recognition has not only raised awareness of the potential consequences of
''clumsiness'' but has also increased the demand for information on the most
effective way to identify, diagnose and treat the children concerned. In the
area of assessment, however, no single perceptuo-motor test is yet considered
to be the ''gold standard'' and professionals use a variety of procedures rang-
ing from very informal checklists to fully standardised tests.

The work described in this paper forms a part of an international collab-
orative programme concerned with the use of the Movement Assessment Bat-
tery for Children (henceforth Movement ABC) (Henderson and Sugden,
1992) to assess coordination difficulties in children. The Movement ABC
comprises a teacher's checklist, a standardised test and a set of guidelines
for intervention. The standardised test and its predecessor, the Test of Motor
Impairment (Stott et al., 1984) were founded on normative data collected in

the UK, Canada and the USA, with the final version being standardised on over 1000 American children. A database containing information on the performance of more than 5000 children now exists and an annotated bibliography of studies employing the Movement ABC is currently in press (Barnett and Henderson, in press). The test manual has recently been translated into Swedish, Danish, Italian, Chinese and Japanese. A Dutch translation, including a full standardisation of the test, will be published later this year (Smits-Engelman, 1998).

In this preliminary study, we were concerned with the suitability of the Movement ABC for use with Dutch children and its comparison with another assessment instrument commonly used in the Netherlands, the *Körperkoordinations Test für Kinder* (literally translated as the Body Coordination test for Children and henceforth referred to by the acronym KTK). This test, constructed and standardised in Germany by Kiphard and Schilling (1974), was also designed to identify and diagnose problems of motor development in children. However, it differs from the Movement ABC in that it focuses exclusively on gross motor coordination whereas the Movement ABC contains both gross and fine motor tasks.

Our specific aims in the study were threefold. Our first objective was to take a preliminary look at the suitability of the published norms of the Movement ABC and the KTK for use with Dutch children. Our second objective was to examine the relationship between the constituents of the two tests. Our third objective was to examine the concordance between the tests in detecting cases of impairment among children believed to be poorly coordinated by parents or teachers.

2. Method

2.1. Subjects

Two hundred and eight Dutch children participated in this study. They comprised two groups, as follows. A *non-referred* group of 134 children were randomly selected from normal mainstream schools throughout the Netherlands. None of the children had any known physical or neurological handicap. The age range of this sample was 5–13 years and 55% were boys.

A *referred* group of 74 children ranging in age from 5 to 12 years of whom 62% were boys. All of these had been referred to a physical therapist because they were suspected of having motor problems.

2.2. Procedure

For each child, both tests were administered and scored by the same physical therapist (or pair of therapists), using the criteria described in their respective manuals. All the participating testers were experienced physical therapists who had previously received training by the first author in the use of both tests. Order of testing was counterbalanced within groups, with half the children being tested on the Movement ABC first and half on the KTK. Depending on the age and performance level of the individual child, test duration ranged from 20 to 30 min for the Movement ABC and 15 to 20 min for the KTK.

The tests used and method of scoring: The two tests employed in this study are different both in format and in the way they are scored.

The Movement ABC test is designed for use with children aged 4–12+ years. A total of 32 items are divided into four sets of eight, each intended for use with children of specific ages. The first set of items, labelled Age Band 1 (AB1) is designed for use with 4–6 year old children, the second set, AB2 for 7 and 8 year old children, the third for 9 and 10 year olds and the fourth for children 11 years and older. Within each age band, the structure of the test is identical. All children complete three items involving the use of the hands, two items which require the child to catch or throw a bean bag or small ball and three items which assess static and dynamic balance.

Scoring: A child's performance on the test can be scored in several ways. Raw scores, such as the number of seconds taken to complete a task, the number of catches made etc. are always noted. These raw scores are then converted into scaled scores in order to ascertain where the child's performance lies in relation to the standardisation sample. This can be done at the level of individual items, on which children receive a score of 0–5, sub-scores (manual dexterity, ball skills and balance) or for the total score (maximum possible 40). In the present paper, we focus on the children's scaled scores dealing exclusively with the totals for the test as a whole and for the three sub-sections.

In the Movement ABC manual, the test authors suggest that total scores falling below the fifth percentile should be considered as indicative of a definite motor problem, while scores between the fifth and 15th percentile suggest a degree of difficulty that is borderline, but needs further monitoring.

The Körperkoordinations Test für Kinder was first produced in Germany by Kiphard and Schilling in 1970 then revised in 1974. From an initial pool of

150 movement tasks, a set of six was chosen on the grounds that they differentiated best between normal and pathological movement performance. Factor analysis of the six item test showed that all but one item loaded on the same factor called total body coordination. This outlier and one other item, which required a very large piece of equipment, were discarded leaving the following four tasks, which are completed by all children between the ages of five and 15:

- *Walking backwards along a balance beam:* the number of successful steps are recorded.
- *Hopping for height:* the child hops on one foot over a pile of foam squares; if successful the height is increased by adding another foam square. The height of the final successful jump is recorded.
- *Jumping sideways as fast as possible:* the child is required to make 15 consecutive sideways jumps as fast as possible, time taken in seconds is recorded.
- *Moving sideways on boxes:* the child begins by standing on one box holding a second in his/her hand. The second box is then placed alongside the first and the child steps on to it. The first box is then lifted up, transferred to the other hand and placed down, the sequence continues and the number of correct movements are measured.

Scoring: From the KTK, a number of different estimates of performance are also available. For each item, a raw score (e.g. number of steps, number of times etc.) and a scaled score are recorded. The test manual provides norms for children at yearly intervals and for three of the four items (hopping, jumping sideways and moving sideways on boxes) different norms are available for boys and girls. The scores can be transformed into a motor quotient (mean 100, SD 15) and into percentiles. Tables with normative data are available for three reference groups (normal, learning disabled, and children with ''brain dysfunction''). A score of 85 or less represents a motor performance level below the 15th percentile, less than 70 below the third percentile.

2.3. Statistical analyses

Both parametric and non-parametric statistics were employed as appropriate. Pearson's product moment correlations were used to examine the relationships between the tests. Chi square tests were used to compare the proportion of children passing and failing the two tests.

Table 1
The range of scores obtained for the randomly selected Dutch sample ($N = 134$) on each test, along with the percentage of children falling below the 50th and 15th percentile points established from the standardization samples

	Movement ABC	KTK
Range of total scores	0–21 [a]	44–130 [a]
Below 50th percentile	50%	68%
Below 15th percentile	16%	29%

[a] On the Movement ABC high scores indicate impairment, on the KTK the opposite is the case.

3. Results and discussion

3.1. Performance of the randomly selected children on the two tests

Although the 134 non-referred children in this study form only a small part of the full Dutch Movement ABC standardisation sample, the sampling procedure was rigorous and allowed us to make some preliminary comparisons with the normative data presented in the test manuals. In the case of the Movement ABC, these norms are based on the performance of 1234 American children. In the case of the KTK, norms are based on the performance of 1228 German children. Since very detailed item by item comparisons will be presented in the Dutch Movement ABC manual, in this paper we have confined ourselves to the children's total scores [1] on the two tests.

Table 1 shows three characteristics of the score distributions for the 134 randomly selected children in the study: the range of total scores, the proportion falling below the 50th percentile and the proportion falling below the 15th percentile, the last being the point below which both sets of test authors suggest that concern for a child's motor competence is warranted.

As can be seen from Table 1, the children obtained a satisfactory range of scores on both tests, indicating some sensitivity to both good and poor

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[1] No significant differences between boys and girls were found on any of the Movement ABC test items. There was a tendency for girls to be better than boys on the balance sub-total but this did not reach even the 0.05 level of significance ($p < 0.09$). On the KTK item ''Walking backwards on balance beam'' girls scored significantly better than boys ($t = 3.8$, $p < 0.001$). Surprisingly, this is the item for which the KTK-manual provides no separate scaling for boys and girls. On the item ''Jumping sideways as fast as possible'' there was a trend towards boys performing better ($p < 0.06$). However, we are confident that none of these effects alter the results reported here. No differences between right and left handed children were obtained on either test.

performances. However, the proportions of children falling below the two marker points were quite different. Whereas, the percentage of Dutch children falling below the 15th and 50th percentile points on the Movement ABC came very close to those obtained for the standardisation sample of American children, the percentages on the KTK were substantially higher than those for German children, especially at the 15th percentile. So far, therefore, these results suggest that the norms for the Movement ABC need little adjustment for use with Dutch children, whereas those for the KTK are likely to overestimate the number of children with difficulties.

3.2. The relationship between the tests

Table 2 shows the correlations between the four component items of the KTK, the three sub-sections of the Movement ABC and the total scores obtained by the 134 randomly selected children on each test. As the table indicates, the overall correlation between the Movement ABC and KTK is 0.62 ($p < 0.0001$; 38% of shared variance). This can be interpreted in two ways. One possibility is that the correlation obtained is simply a reflection of the overlap in the content of the two tests. Both contain items that might broadly be described as ''gross motor'', requiring the child to control the body while in motion (for example, the ability to hop and jump is assessed in both tests). Another possibility is that the degree of shared variance supports the idea that there is a general ''motor ability'' factor which underlies motor tasks of all types.

A closer look at the pattern of correlations between the components of the two tests provides marginal support for the second of these alternatives, the idea that there is such a thing as a general motor ability factor. While we might have predicted that the correlations between the four items in the

Table 2
The correlation matrix for the three sub-sections and total scores for the Movement ABC and the four items and total for the KTK ($N = 134$)

	Manual dexterity	Ball skills	Balance	Movement ABC total score
Walking backwards	0.47	0.37	0.48	0.59
Hopping on one leg	0.28	0.29	0.33	0.40
Jumping sideways	0.39	0.30	0.30	0.44
Moving sideways	0.39	0.30	0.23	0.42
KTK total score	0.52	0.43	0.45	0.62

All significant at 0.0001 level.

KTK and the Balance section of the Movement ABC would have been significantly higher than between the KTK and the Manual Dexterity section, this proved not to be the case. In fact, it was almost the opposite. For the KTK task, Walking backwards along a balance beam, the correlation with the Manual Dexterity and Balance sections of the Movement ABC was equal (0.47 and 0.48) and on the third and fourth tasks, both involving sideways movements, the correlations with Manual Dexterity were actually higher than with Balance (0.39 vs. 0.30 and 0.39 vs. 0.23 respectively). Clearly, this pattern of correlations needs further investigation.

An identical analysis of the relationship between the two tests using the data from the 74 referred children produced a very similar outcome. The overall correlation between these children's total scores on the two tests was 0.65 ($p < 0.0001$). The correlations between Walking backwards along a beam and the Manual Dexterity and Balance sections of the Movement ABC were 0.42 and 0.59 respectively (values which do not differ statistically from each other), and the pattern of correlation for the other KTK tasks and the Movement ABC sections exactly mirrored that described for the randomly selected children in the paragraph above.

3.3. The detection of impairment by the two tests

In the Netherlands, referral for physiotherapy has to be instigated by a physician. A parent or teacher, who is concerned about a child's difficulties must first seek the opinion of their doctor who then takes responsibility for the formal referral. In this study, 74 children were referred to physiotherapists for assessment, which included the Movement ABC and KTK. Sixty one of these children were boys, a finding which is almost invariably obtained in studies of this kind.

There are a number of ways of examining the extent to which the two tests are "sensitive" to the problems these children are believed to have. Although crude, a useful beginning might simply be to use the same three markers as we have used to describe the performance of the randomly selected children, the range of total scores, the proportion of children falling below the 50th percentile and the proportion falling below the 15th. The relevant data on the referred children's scores on the two tests are shown in Table 3.

Obviously, we would expect, overall, that the performance of a sample of children referred as potentially motor impaired to be poorer than that of a sample randomly drawn from the population at large. The data in Table 3 provide some reassurance that this is so. In the case of the Movement

Table 3
The range of scores obtained by the referred sample ($N = 74$) on each test, and the percentage of children falling below the 50th and 15th percentile points established from standardisation sample

	Movement ABC	KTK
Range of total scores	0.5–31 [a]	46–130 [a]
Below 50th percentile	84%	85%
Below 15th percentile	59%	68%

[a] On the Movement ABC high scores indicate impairment, on the KTK the opposite is the case.

ABC, for example, the percentage of children falling below the 15th percentile in this sample was 59%. However, the very fact that not all of these children fell below the 15th percentile suggests that on both tests there were children "passing" who someone has expected to "fail". There are two possible explanations of this outcome. The first is that some of these children do not actually have a true developmental disorder of coordination, but do appear "clumsy" in everyday life because they are distractible, hyperkinetic or too occupied by other difficulties to concentrate on motor tasks. The second possibility is that the children do indeed have difficulties but that these are not picked up by these particular tests. For instance, neither the Movement ABC nor the KTK would be likely to detect a child whose difficulties were confined to the graphomotor domain. Problems with handwriting, drawing diagrams etc. can occur in isolation and may cause a child such distress that referral to a physiotherapist is a sensible course. It might also be worth contemplating the possibility that true cases are not detected because of deficiencies in the tests!

Another way of looking at the extent to which these two tests are sensitive to impairment is to look at the concordance between them – using the 15th percentile as a cut-off point for pass or fail in each case. By combining the

Table 4
Number of children meeting the pass/fail criteria of the Movement ABC and KTK, using the 15% as a cut-off point, including all 208 children

KTK	MABC	
	>15%	<15%
>15%	106	13
<15%	32	57

(χ^2 (1) = 64.4; $p = 0.001$); Cramer's $V = 0.56$).

data from both the randomly selected and the referred samples for this analysis, we were able to achieve a large number of cases of widely differing performance levels ($n = 208$). The agreement between the two tests with respect to pass/fail criteria is shown in Table 4.

In situations like this it is difficult to know whether to celebrate the 78% of occasions on which the two tests agreed about whether a child should pass or fail or to lament the remainder of occasions on which they did not agree. On the positive side, this level of agreement in which 106 of the 208 children passed both tests and 57 failed both is statistically highly significant ($X^2 = 64.4$, $p < 0.001$). On the negative side, however, there were 45 children who failed one test but passed the other. We have already established that the KTK is "oversensitive" to impairment when applied to the Dutch population, whereas the Movement ABC was almost precisely coincident with the proportions based on the norms. This would lead us to expect that a preponderance of the disjunctive cases should be ones in which the KTK verdict was "fail" and the Movement ABC "pass" and this does appear to be the case. The 13 individuals whom KTK deemed to have "passed" and Movement ABC deemed to have failed serves as a reminder that not all the issues of test construction can be resolved by adjusting cut-off points. In the end, no one instrument may be able to provide a clear view of the underlying realities. However, this cannot be decided until we have a gold standard against which to validate individual decisions.

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