Upsala J Med Sci 102: 49–60, 1997

Assessment of Cognitive Function

A study with the Swedish version of the Kaufman Assessment Battery for Children

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ABSTRACT

The Kaufman Assessment Battery for Children (K-ABC) is a test that measures cognitive function in children. A Swedish version has been produced for use as a research instrument in a longitudinal follow-up study of children that needed neonatal intensive care at the Uppsala University Children's Hospital, Sweden. A study using this Swedish version was carried out in 26 healthy children 10 years of age attending a primary school in Uppsala, Sweden. The results showed that the Swedish version of the K-ABC well discriminates cognitive function in children aged 10 years. The scores of all subtests were distributed over the scale and the mean scores mostly corresponded to near average or above average performance when compared with the mean values obtained in the standardization sample.

INTRODUCTION

The Kaufman Assessment Battery for Children (K-ABC) is a recently introduced individually administered test of intelligence and achievement, designed for use in assessments of children between the ages of 2.5 and 12.5 years (Kaufman, 1983a).

In the K-ABC, intelligence is defined in terms of a child's ability to process information in order to solve problems, and is based on the theory of neuropsychology and cognitive psychology. Intelligence - or problem solving ability - is measured with two Mental Processing Scales. One is the Sequential Processing Scale, which measures the child's capability of processing information serially or temporally in a stepwise fashion. The other one is the Simultaneous Processing Scale, in which the child is required to solve problems that are analogical, spatial and organizational in nature. A Mental Processing Composite Scale is a unification of the Sequential and Simultaneous Processing Scales and is intended for measuring total intelligence.

The Achievement Scale in the K-ABC provides an estimate of previous learning by using subtests that measure verbal intelligence, general knowledge and acquired school skills. In addition, the K-ABC includes a Non-verbal Scale which serves to estimate intellectual potential

in hearing-impaired or language-disordered children.

The theoretical basis of the test is related to recent advances in areas of cognitive development, learning theory and neuropsychology. These advances have been applied to various aspects of the test construction and validation, including modern stimulus materials (Kaufman, 1983b; Kamphaus & Reynolds, 1984).

The neuropsychological theory applied by Kaufman & Kaufman (1993b) derives from two lines: the information processing approach of Alexander R. Luria, and the cerebral specialization theory. According to Luria's model the sequential-simultaneous dichotomy corresponds to the successive (fronto-temporal) and simultaneous (occipito-parietal) modes of information processing. According to the cerebral specialization theory, sequential processing corresponds to the ability of problem solving associated with the left hemisphere and simultaneous processing is believed to take place in the domain of the right hemisphere. In the majority of individuals, the left cerebral hemisphere appears to be specialized for linguistic, propositional, serial and analytical tasks and the right hemisphere for more non-verbal, synthetic and holistic tasks. Identification of significant strengths and weaknesses among the Mental Processing subtests and among the Achievement subtests offers, then, additional information for purposes of diagnosis and remediation (Kaufman et al, 1987; Reynolds et al, 1989).

K-ABC is a test developed in the USA and standardized for use in American and German children (Kaufman, 1983a; Artner et al, 1989). It has also been adapted for British children, and at present it is the most commonly used cognitive test in international research on both normal and at-risk groups of children (Achenbah et al, 1993; Hack et al, 1994; Obrzut et al, 1987; Roth et al, 1994; Ulissi et al, 1989). A total of 43 validity studies of the K-ABC have been described by Kaufman & Kaufman (1983b). Additionally, the K-ABC has been reported to give more detailed information about children's cognitive function as compared with other standardized tests, for instance the Wechsler Intelligence Scale for Children-Revised (Hack et al, 1994; Roth et al, 1993; Roth et al, 1994).

The purpose of the present study was to translate the K-ABC into Swedish and to evaluate the Swedish version of the test in a group of healthy children. It is intended that the Swedish version of the K-ABC shall be used as a research instrument in an epidemiological follow-up study of children who needed neonatal intensive care at the Uppsala University Children's Hospital, Sweden, and were born between 1 January 1986 and 30 April 1989 (Eizirik et al, 1994; Eizirik at al, 1996; Persson & Strömberg, 1995). The cognitive function of these children will be assessed in the spring of the year of their tenth birthday, when the majority of them will be attending the fourth year of the junior level of compulsory school.

METHOD

Description of the K-ABC subtests

The K-ABC contains 16 subtests. Because of the age range of certain tasks, no child is administered more than 13 subtests. Some subtests are given at all ages and others are administered only to selected age groups. The battery takes about 35 minutes for administration in young children and about 75-90 minutes in older ones.

Sequential Processing Subtests:

* Hand Movement: requires the child to imitate the exact sequence of taps on the table made with the hand by the examiner. Ability required: motor reproduction of a sequence.

* Number Recall: requires the child to repeat in sequence a series of numbers presented orally by the examiner. Automatic auditory vocal memory is the ability required.

* Word Order: the child is required to point to silhouettes of objects in the same sequence as those objects named by the examiner. Abilities required: auditory-visual integration, auditory-motor memory, understanding and following directions and working productively despite distractions.

Simultaneous Processing Subtests:

* Magic Window: the child has to name a picture that is exposed, section at a time, through rotation behind a narrow slit. Ability required: integration of sequentially presented visual stimuli.

* Face Recognition: a picture showing one or two faces is presented briefly and the child is required to select the correct faces from a subsequently presented group picture. Abilities measured: visual search and scanning strategies, face perception and face recognition.

* Gestalt Closure: the child is shown a partially completed drawing and is required to name or describe the drawing. Perceptual closure, perceptual inference and conversion of abstract stimuli into a concrete object are the required abilities.

* Triangles: the child is provided with a set of rubber triangles and is required to duplicate an abstract design presented by the examiner within a time range. Abilities required: non-verbal concept formation and ability to work under time pressure.

* Matrix Analogies: the child is shown a 2 x 2 visual analogy in which the last element is missing, and then has to select from a set of seven pictures the one which correctly completes the abstract analogy. Analogic thinking is the required ability.

* Spatial Memory: the child is shown a set of randomly arranged pictures and then has to recall and indicate their location on a subsequently presented grid. Ability required: spatial localization.

* Photo Series: photographs showing a sequence of events are placed in a random order on the table and the child is required to order them in a correct sequence by handing them to the examiner. Abilities required: seriation, temporal relationships and time concepts.

Achievement Subtests:

* Expressive Vocabulary: the child is required to name the common objects depicted in photographs. The ability required is to recall verbal labels.

* Faces & Places: the child is required to name the fictional character, famous person or well-known place depicted. Ability required: general factual knowledge.

* Arithmetic: the child is required to count, compute and demonstrate his/her understanding of mathematical concepts. Abilities required: basic mathematical concepts and computational skills.

* Riddles: the child is given the attributes, functions and other general characteristics of a concrete or abstract concept and asked to infer its name. Abilities required: integration of sequentially presented auditory stimuli, conceptual inference and logical classification.

* Reading/Decoding: the child is required to identify letters and to read and pronounce words. Abilities required: letter naming, word recognition and pronunciation.

* Reading/Understanding: the child is required to perform written commands. Abilities required: reading comprehension and gestural communication.

Scaled Scores and Standard Scores

A mean value of 100 and a standard deviation of 15 were selected by Kaufman & Kaufman (1983b) to describe the standard scores for the Achievement subtests and for the Global Scales (Sequential, Simultaneous and Mental Processing Composite). In contrast, a mean of 10 and a standard deviation of 3 were used to define the scaled scores yielded by each separate Mental Processing subtest.

Regardless of the parameters selected, standard scores have a constant meaning when based on distributions that are normal or approximately normal. Scores that are plus or minus one standard deviation from the mean include about 68 per cent of the individuals in a given population, a range of 2 standard deviations below and above the mean includes 95 per cent, and nearly everyone (over 99 per cent) is included between 3 standard deviations below and above the mean. Therefore 68 per cent or about two-thirds of normal children will earn standard scores of between 85 and 115 and scaled scores of between 7 and 13. Similarly, 95 per cent will score between 70 and 130 and virtually all the children will obtain scores in the 55 to 145 range; for the scaled scores the corresponding values are 4 to 16 and 1 to 19 (Kaufman & Kaufman, 1983b).

Translation of the K-ABC into Swedish and adaptation of items

The translation of the K-ABC into Swedish was done in collaboration with a school teacher with long experience in teaching in primary school. Special attention was paid to the Achievement Subtest Faces and Places, where 35 pictures of famous persons or places had to be changed to suit the Swedish context. Instead of presenting, for example, a picture of

George Washington, we showed Gustav Vasa; instead of Hellen Keller, we showed Astrid Lindgren; instead of Ben Franklin, we showed Carl von Linné etc.

MATERIAL AND TEST PROCEDURE

A total of 26 children, 14 boys and 12 girls, participated in the study. The children were recruited from the junior level of compulsory school in Uppsala, Sweden, all of them attending the first term of the fourth year. Their ages varied between 9.06 and 10.06 years, with a mean of 9.08 years (median = 10.02 and mode =10.03 years). All children lived in the area close to the school.

The procedure for recruiting the children was as follows: First, contact with the school director and the teacher was established in order to explain the study procedures and to obtain their consent. Subsequently, the parents of all children in one class were informed by letter about the purposes of the assessment. As the participation in the study was voluntary, it was requested that the children should return the letter to the school teacher with the parents' decision regarding agreement to take part. Of a total of 29 children, 19 (65%) agreed to participate. Finally, 10 additional parents of children from another class, selected by a draw, were contacted and seven answered positively. No data on background characteristics of participants and non-participants are available.

All the assessments were performed in a quiet room at the school and on schedules defined in agreement with the children's parents. The assessment lasted about 90 minutes and the children were offered some juice and biscuits prior to the testing. The subtests Magic Window, Face Recognition and Expressive Vocabulary were not administered, as they are never included in assessments of children between 7.0 and 12.5 years of age (Kaufman & Kaufman, 1983a).

RESULTS

Global Scales

The scores of the Sequential Processing, Simultaneous Processing and Mental Processing Composite ranged between 2 standard deviations below and 2 above the mean of the American standardization sample, while the Achievement Scale showed scores within 1 standard deviation below and 3 standard deviations above the same mean (Table 1). The mean score of the Sequential Processing in the study corresponded to average performance and the mean scores of the remaining Global Scales to above average performance.

Table 1. Standard Scores for the Global Scales (n=26)

	Sequential Processing	Simultaneous Processing	Mental Processing Composite	Achievement
Mean	106.5	112.9	111.8	119.4
SD	11.3	12.3	11.4	11.1
Median	107.0	115.0	114.0	122.0
Mode	95.0	121.0	118.0	129.0
Min	81.0	82.0	86.0	99.0
Max	124.0	129.0	128.0	134.0

Sequential Processing Subtests

The scaled scores for the Sequential Processing subtest Number Recall ranged within 2 standard deviations below and 2 above the mean of the American standardization sample (Table 2). The scores for the remaining subtests, Hand Movement and Word Order, ranged between 1 standard deviation below and 2 standard deviations above the mean of the standardization sample. The mean score for all sequential subtests of the study lay at the level of average performance.

Table 2. Scaled Scores for the Sequential Processing Subtests (n=26)

	Hand Movement	Number Recall	Word Order
Mean	11.1	10.5	11.5
SD	2.3	2.4	2.1
Median	11.0	10.0	11.5
Mode	14.0	13.0	11.0
Min	7.0	6.0	7.0
Max	15.0	14.0	16.0

Simultaneous Processing Subtests

The scores of the Simultaneous Processing subtest Photo Series ranged between 2 standard deviations below and 2 above the mean of the American standardization sample (Table 3).

The scores of the Matrix Analogies subtest ranged between 2 standard deviations below and 3 above that mean, and the remaining subtests Gestalt Closure, Triangles and Spatial Memory showed scores between 1 standard deviation below and 2 standard deviations above the mean of the American standardization sample. The mean score for the subtests corresponded to a performance above average, except for Gestalt Closure and Spatial Memory, which were classified as average.

Table 3. Scaled Scores for the Simultaneous Processing Subtests (n=26)

	Gestalt Closure	Triangles	Matrix Analogies	Spatial Memory	Photo Series
Mean	10.3	12.8	12.5	11.5	12.0
SD	1.7	2.4	3.3	2.4	2.5
Median	10.0	13.0	13.0	11.0	12.0
Mode	10.0	16.0	8.0	10.0	14.0
Min	7.0	7.0	6.0	8.0	6.0
Max	14.0	16.0	17.0	16.0	16.0

Achievement Scale

The scores for the Achievement subtests Arithmetic, Reading/Decoding and Reading/ Understanding ranged between 1 standard deviation below and 3 standard deviations above the mean of the American standardization sample (Table 4). For the remaining subtests, Faces and Places and Riddles, the scores were within 2 standard deviations below and 2 above that mean and corresponded to average performance. The mean score of the Arithmetic subtest was above average; the mean score of Reading/Understanding, well above average; and that of Reading/Decoding corresponded to upper extreme performance.

As the Achievement subtest Reading/Decoding measures the child's ability to identify letters and to read and pronounce words, it is possible that the upper extreme performance in this subtest was related to a use of less complex Swedish words in the translation than those presented in the American version. A speech pathologist, with large experience in testing children, reviewed the Swedish words and made new suggestions, taking into account the numbers of syllables, word endings, common and uncommon words and also both phonetic and non-phonetic pronunciations, as suggested by Kaufman & Kaufman (1983b). The new words were tested in another 16 children who were attending the fourth class of the junior level, 13 of them from the same school as the children tested with the whole K-ABC. It was found that the mean score of the new version of the Reading/Decoding subtest was lower than that obtained earlier (Table 5), but was well above the average performance in the US

standardization sample. The scores varied between 1 standard deviation below and 3 standard deviations above the mean of the American standardization sample.

Table 4. Standard Scores for the Achievement Subtests (n=26)

	Faces and Places	Arithmetic	Riddles	Reading/ Decoding	Reading/ Understanding
Mean	104.1	114.5	106.3	135.8	120.0
SD	9.7	11.8	13.7	10.4	12.0
Median	106.0	117.5	111.0	140.0	123.5
Mode	109.0	109.0	97.0	140.0	128.0
Min	80.0	90.0	74.0	102.0	96.0
Max	121.0	133.0	126.0	144.0	136.0

Table 5. Standard Score for the Achievement Subtest Reading/Decoding (n=16)

	Reading/Decoding
Mean	127.1
SD	11.7
Median	127.5
Mode	143.0
Min	108.0
Max	143.0

DISCUSSION

The present study was undertaken to translate the K-ABC into Swedish and to test the Swedish version in a group of healthy children at the age of 10 years. The K-ABC is a recently introduced test (Kaufman & Kaufman, 1983b) which measures cognitive function in children. Its construction has a strong theoretical and research basis and it distinguishes acquired factual knowledge from the ability to solve unfamiliar problems. Additionally, the K-ABC includes novel tasks and has been reported to give more detailed information about children's cognitive function compared with other standardized tests (Hack et al, 1994; Roth et al, 1993; Roth et al, 1994).

The Swedish version of the K-ABC is intended for use as a research instrument in a longitudinal follow-up study of children who needed neonatal intensive care at the Uppsala

University Children's Hospital, Sweden. The translation of the K-ABC into Swedish was focused not only on grammatical rules but also on changes of stimulus necessary to suit the Swedish context.

The results of the study showed that the scores of all K-ABC subtests were distributed over the scale, demonstrating that the Swedish version of the K-ABC discriminates cognitive function in children at the age of 10 years. The mean scores of the K-ABC subtests were mostly close to average or above average performance as compared with the mean scores of the American standardization sample.

The tendency to higher performance among the Swedish children in comparison with American children might be due to differences in background characteristics of the sample. Although it was not the intention in the present study to collect demographic variables regarding the children, the sample might have differed, especially in socio-economic background, from the American national standardization sample (more than 2.000 children, tested at 34 test sites in 24 states). Parental education, for instance, might have been higher in the present study, as 19.2% of the parents from the standardization sample had less than high-school education, whereas in Sweden there is a nine-year compulsory school. Additionally, 27.5% of the American sample consisted of children from minority groups of Blacks, Hispanics, Native Americans, Asians, Alaskan Natives and Pacific Islanders, in contrast to our sample, which included mostly Swedish caucasian children. Another aspect is that since many of the K-ABC subtests, especially those from the achievement scale, are a function of richness of early environment, cultural opportunities at home, availability of magazines and newspapers and school learning (Kaufman & Kaufman, 1983b), the supposed differences in socio-economic background between the two samples might have contributed to the observed differences in performance. In addition, it is difficult to say whether the sample from a central part of Uppsala, a university city, is fully representative for the performance of Swedish ten-year old children as a whole.

The K-ABC needs to undergo all the steps for standardization and validation for Swedish children as proposed by Kaufman & Kaufman (1983b) before it can become a generally available test in Sweden. Our impression, however, is that the K-ABC is an important innovation in the practice of cognitive assessment and a major contribution to neuro-psychology and education.

CONCLUSION

The present study showed that the Swedish version of the K-ABC well discriminates cognitive function in a small selected sample of children at the age of 10 years. The scores of all subtests were distributed across the scale and the mean scores mostly corresponded to near average or above average performance when compared with the mean scores of the American

standardization sample. The Swedish version of the K-ABC would thus seem to be a suitable research instrument for use in the planned follow-up study of children who needed neonatal intensive care and a group of healthy control children.

ACKNOWLEDGEMENTS

This study was financially supported by grants from the Swedish Medical Research Council (19X-04998, 19M-7544), Sävstaholm Association, Sven Jerring Foundation and Gillbergska Foundation, and Förstamajblommans Riksförbund, Sweden. The author wishes to thank Marianne Edström, Assistant Lecturer at the Deparrtment of Education, Uppsala University, for collaboration in the translation of the test, Margareta Jennische, Speech Pathologist, for reviewing the reading words and Professor Gunnar Sedin, co-ordinator of the follow-up study.

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