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ANALYSIS OF FINE MOTOR TESTS IN FIVE- TO SIX-YEAR-OLD CHILDREN

ANALIZA TESTOV FINE MOTORIKE PRI PET- DO ŠESTLETNIH OTROCIH

Abstract

The purpose of this research was to state the condition of clumsiness in five- to six-year-old children, track down those whose results differ significantly from the average, and to find out whether there exist statistically significant differences in fine motor tests with regard to the children's sex. The data were obtained from eight fine motor tests performed on a sample of 30 five- to six-year-old girls and boys from four Slovenian kindergartens. The battery of tests was simple, the time needed for testing of each participant was 8 to 10 minutes. Data were processed using the frequencies analysis and the t-test. Within our sample, we established that the results children achieved were far below the average, as follows: 7% of children in at least three tasks, 28% of children in one task, and 13% of children in two tasks. Only 52% of children achieved the expected, normal results in all the tasks. This research has shown that the results do not statistically differ in terms of children' sex.

Key words: pre-school child, fine motor task, clumsiness, measuring procedure

Izvleček

S pomočjo raziskave smo želeli ugotoviti, kakšna je raven okornosti pet- do šestletnih otrok, izslediti otroke, katerih rezultati se bistveno razlikujejo od normalnega povprečja otrok in ugotoviti, če obstajajo statistično značilne razlike v rezultatih testov fine motorike glede na spol. Podatke smo zbrali s pomočjo osmih testov fine motorike. Baterija testov je preprosta, testiranje enega merjenca je potekalo 8 do 10 minut. Vzorec je vseboval 30 deklic in 30 dečkov, starih pet do šest let iz štirih slovenskih vrtcev. Podatke smo analizirali s frekvenčno analizo, razlike med spoloma pa smo ugotavljali s t-testom. Ugotovili smo, da je v našem vzorcu 7 % otrok, pri katerih so rezultati pri vsaj treh nalogah močno pod ravnjo povprečnih rezultatov, 28 % je otrok, ki imajo takšne rezultate pri eni nalogi in 13 % pri dveh nalogah. Le 52 % otrok pa je doseglo pri vseh nalogah povsem normalne rezultate. Raziskava je pokazala, da se rezultati glede na spol statistično značilno ne razlikujejo.

Ključne besede: predšolski otrok, fina motorika, okornost, merski postopek

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INTRODUCTION

The overall development of a child is oriented towards final maturity. Motor development is successive and relates to acquirement and completion of motor behaviour. In the course of his/her development a person progressively becomes capable of controlling and performing successfully various movements as well as any kind of more demanding work (Hadders-Algra & Touwen, 1992).

Passing through different stages he/she finally reaches the highest one, that of complete control over and performance of fine movements. Precise fine motor movements demand harmonious functioning of sensorial perception, central processes via information from the brain and coordination with a high executive plan, as well as final execution of a certain motion pattern. If one of these systems does not function properly, the result of the planned movement is unsatisfactory, the consequence of which is uncoordinated, less harmonious and less fluent movement (Landy & Burridge, 1999).

In normal children the development of motor coordination is shown a growing speed of performance of (especially) fine movements. Individual differences in timed performance of fine motor tasks within given age groups can be considerable. In a clinical framework these differences are usually interpreted as indicators of minimal brain dysfunctions (Denckla, 1985). Motor dysfunctions are presented as abnormal movements without localized neurological damage. Clumsy children most frequently do not suffer from any formal neurological deficits or motion difficulties connected with neurological diseases.

The designation "talent" or "clumsiness" is not just an unbiased statement concerning the condition of a child"s motor abilities and development of skills: it is estimated also within social integrations. Clumsiness also has an indirect negative effect on the state in other fields, such as communication and social interaction with other people. Clumsy children with bad coordination and bodily response are less successful in motion games than their playmates, which leads to an inappropriate estimation of themselves. Nowadays motor abilities of pre-school children hold a key position within the development of their personalities. They are comprehended as an integral part of the cognitive and emotional field (Kremžar, 1998).

There are two characteristics in the motor behaviour of clumsy children: reduced timed performance of fine and gross movements and poor motion quality (Wolff, Gunnoe & Cohen, 1985). The most critical time regarding the appearance of clumsiness is late pre-school and early school period: in this time the pathological motor plasticity is most expressive. Nevertheless, clumsiness can appear at any stage of a child's development.

Although a poor performance of skills can hardly be presented as a serious problem, clumsiness is one of the major difficulties with children and requires a multidisciplinary procedure. Problems in the performance of movements thus arise in more extensive motor activities such as running, jumping etc., as well as in minor tasks such as writing, drawing and other daily activities (Largo, 2001). Quite a few experts in this field (Denckla, 1985; Largo, 2001) have developed special tests for disclosing barely noticeable signs of mild brain dysfunctions which are the causes of clumsiness. The tests can help us state the level of efficiency and eventual disturbances in balance, rhythm and coordination of movements. But it should be emphasized that most experts have established no precise norms for testing children of defined ages which would give parents, teachers, sport pedagogues the possibility of a quick and simple test in case of suspected minor brain dysfunctions.

The purpose of our research was to establish the state of clumsiness with five- and six-year-old children, track down children whose results differ significantly from the average, and to find out whether there are statistically significant differences in the results of fine motor tests with regard to the children's sex. We wished to determine the border results for certain motor tasks: our results were obtained on a relatively limited sample, but even so they offer a possibility of comparison with those defined as critical and thus point out certain neuromotor disturbances.

METHOD

Participants

The research included 30 girls and 30 boys from four Slovenian kindergartens. Their average age is 5.5 years. They live in Ljubljana and do not do any sport activities outside kindergarten. The kindergartens have their own playgrounds for children's daily activities. According to their teachers the children are healthy and normally developed, with no visible neuromotor dysfunctions. Among the participants in the test there were 93.5% right-handers and 6.7% left-handers.

Instruments

The variables were chosen on the basis of a Zurich Neuromotor Assessment research (ZNA; Largo, 2001). ZNA is a standardized testing procedure where motor tasks are estimated as to timed performance. Metrical characteristics of the tests are satisfactory. Reliability of the metrical procedures was verified by test-retest (Largo, 2001). The tests include measurements which are components of normal motor ability with children and only get a clinical sign when the results drop quite far below the expected age limit. The tasks include repetitive, alternating, sequential movements for fingers, hands and feet and tasks in balance and pegboard skills; they follow Largo's pattern (2001). The tests are performed very quickly, the examiner observes the quality of the child's movements and measures time, most often of 20 repetitions of each task. A test of lateral dominance has to be carried out prior to these tests, since it has been established that children with undetermined lateral dominance already have minimal neurological dysfunctions (Denckla, 1985). Therefore these children must be excluded from the research.

Verification of left-handedness and right-handedness

The child who was tested was asked to draw something, to cut a sheet of paper, and to show us how it brushes its teeth and combs its hair. With regard to its dominant side it later performed the tasks with its left or right hand. The children who used their left and right hand alternatively were excluded from the research.

ZNA comprises eight brief tests:

A. Placing of pegs in a board with holes

At the sign "go" the child began putting the pegs as fast as possible into a board with twelve holes; the pegs could be picked up in any order, but only one at a time; transfer of pegs from one hand to the other was not permitted.

Time was measured from the moment the first peg was picked up to the moment when the last one was put into its hole.

B. Static balance

The child was holding its position on one leg, holding a 30 cm long stick behind its head, its elbows bent. We measured the time from the moment when the child lifted its foot from the ground to the moment when it put it down again, or when 60 seconds had elapsed.

C. Repetitive, alternating and sequential movements

The tests had to be carried out in the shortest time possible and were recorded by camera.

- *repetitive finger movements* (20 taps between thumb and index finger; the child was in sitting position with arms held up sideways and bent in elbows at a 90° angle)
- *repetitive hand movements* (20 light pats of one hand, while the wrist is resting on the thigh; the idle hand was resting under the forearm of the active one, its palm turned upwards)
- *repetitive foot movements* (20 light taps of the foot; the heel was resting on the floor throughout the task)
- *alternating pronation-supination movements* (10 pairs of alternating movements of pronation and supination; the forearm of the active arm was resting on the child's thigh; the idle arm was resting under the forearm of the active one, its palm turned upwards)
- *alternating foot movements* (10 pairs of alternating heel-toes rocking movements; part of the idle foot must be in contact with the ground all the time)
- *sequential finger movements* (3 sets of sequential movements: all fingers in turn must touch the thumb; each set comprised the following contacts: index finger – thumb, middle finger – thumb, third finger – thumb, little finger – thumb; the active arm was stretched out and bent in the elbow at a 90° angle).

Procedure

For the children included in the research we obtained permission from their parents, who were also briefly informed about the purpose and the procedure of measuring timed performance.

The test took place in a special, quiet room with sufficient light, which the participants entered one by one. The children wore comfortable clothes that did not impede their movements. Each participant took us eight to ten minutes. The examiner counted the child's repetitions and took the time simultaneously. He/she began measuring the time after a few repetitions, when the child had already formed its rhythm, and stopped it after the necessary number of repetitions. In order to secure the reliability of the obtained results the time required for most tasks was measured by means of viewing the recordings of a video camera.

Data were processed using the frequencies analysis and the t-test.

RESULTS

Table 1 shows the differences between the results of boys and girls. We hypothesised that there are no significant differences in timed performances of fine motor tasks with the regard to sex. Results

showed that the differences between the results of male and female children are not statistically significant (hypothesis was accepted with a 1% risk). Nevertheless, the greatest differences may be observed with the tests repetitive finger movements (RFM) and repetitive hand movements (RHM) as well as with the static balance test (ST). The girls performed the ST test better than the boys, while the latter performed better the repetitive movements of fingers, hands and feet. Their timed performance of the alternating pronation-supination hand movements (AHM) test was more or less equal.

Table 1: Differences between boys and girls

Task	F	Sig	Mean(G)	SD	Mean(B)	SD
RFM	4.575	0.037	7.9	1.07	7.4	0.79
RHM	2.298	0.135	6.8	0.98	6.5	0.74
RFM	0.742	0.392	9.5	1.89	9.0	2.15
AHM	0.057	0.812	7.5	1.89	7.4	2.0
AFM	0.359	0.552	11.3	2.75	11.7	3.10
SFM	0.159	0.691	8.8	2.43	9.0	2.22
PB	1.555	0.217	20.7	2.36	21.7	3.72
SB	2.264	0.138	24.9	7.93	21.4	9.85

Legend:
RFM – repetitive finger movements
RHM – repetitive hand movements
RFM – repetitive foot movements
AHM – alternative pronation-supination hand movements
AFM – alternative foot movements
SFM – sequential finger movements
PB – pegboard
SB – static balance
F – variance homogeneity
Sig – statistical significance
Mean (G) – mean value of girls
Mean (B) – mean value of boys
SD – standard deviation

Since the t-test showed no statistically significant differences regarding sex, the results are listed in one group only.

Basic statistical parameters are presented in Table 2. Results of the Kolmogornov-Smirnov test show normal distribution of the variables. The minimal, maximal and mean result is determined for each task.

Table 2: Basic statistical parameters of time performances

	Min	*Max*	*Mean*	*Std. E*	*Std. D*	*K-S*	*P (K-S)*
RFM	5.900	10.700	7.607	0.125	0.970	0.574	0.897
RHM	4.800	9.600	6.637	0.113	0.878	0.939	0.341
RFM	5.500	15.600	9.235	0.261	2.018	0.735	0.652
AHM	4.700	13.800	7.473	0.249	1.928	0.953	0.324
AFM	7.000	19.000	11.477	0.376	2.916	1.064	0.207
SFM	5.500	16.800	8.880	0.299	2.313	0.688	0.730
PB	15.300	29.600	21.195	0.404	3.131	0.634	0.816
SB	–40.000	–6.000	–23.117	1.166	9.035	1.499	0.023

Legend:
RFM – repetitive finger movements
RHM – repetitive hand movements
RFM – repetitive foot movements
AHM – alternating pronation-supination hand movements
AFM – alternating foot movements
SFM – sequential finger movements
PB – pegboard
SB – static balance
Std. E – standard error
Std. D – standard deviation
Min – minimal value
Max – maximal value
Mean – mean value
K-S - Kolmogorov–Smirnov test
P (K-S) – statistical significance of the Kolmogorov–Smirnov test

In spite of the fact that this great difference between the minimal and the maximal results is by itself an indicator of great individual differences, we sampled also the border results which are presented in Table 3.

Table 3: Border results of timed performances

TASK	***TIME (s)***
repetitive finger movements	8.9
repetitive hand movements	7.6
repetitive foot movements	12.1
alternating pronation-supination hand movements	10.4
alternating foot movements	16.6
sequential finger movements	12
pegboard	25.8
static balance	10.6

The border result is the bottom critical limit separating the worst 10% of performances from normal performances of individual tasks. Results that are lower than these border results are critical. The frequency of critical results (values under P10) is shown in Figure 1.

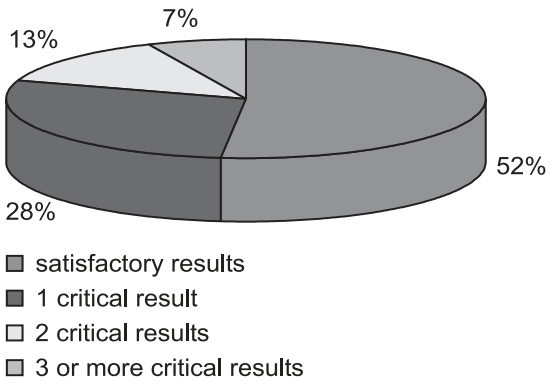

Figure 1: Graphic presentation of frequency of critical results (values under P10)

The risk group containing children with three or more critical results comprises 7% (N=4) of the entire sample (N=60). These children are clumsy and should therefore be given special attention.

DISCUSSION

Several authors studied pre-school children's motor skills in the past (e.g. Planinšec, 1995; Rajtmajer, 1993, 1997; Pišot, 1997, 2000; Videmšek & Cemič, 1991; Videmšek & Karpljuk, 1999). Their main subjects of interest were the reliability of metrical procedures and the structure of motoric space. They tried to establish connections between motor skills and child's other abilities. In the authors' opinion studying of younger children is, on account of this time of life's specifics, extremely demanding and problematic, which is the reason for this field being rather uninvestigated.

Moreover, fine motor testing of pre-school children is more complicated than testing of adults. Younger people are subject to several factors contributing to their better or worse performance of tasks. It is more difficult to persuade a little child to carry out the tasks to the best of its ability, but on the other hand, it is possible, if the motivation is right, to make it attain very good results (Smyth, 1992). Hence it follows that worse results are not necessarily a reflex of mild brain dysfunction based on which a child could be rated as clumsy. Therefore it is reasonable to submit all clumsy children suspected of suffering from mild brain dysfunctions to at least two tests.

On the basis of our research it can be summed up that 7% of clumsy children (4 out of 60) were present in our sample. These children performed the test way below the level of satisfactory results in at least three tasks. Their performance was neither fluent nor fast enough. It would be reasonable to retest these children and thus verify the established cause of their clumsiness, namely, mild brain dysfunction with no direct negative impact, perceivable only indirectly through lower efficiency in everyday tasks and bad social interaction.

So, the presence of one or two critical results does not yet confirm a child's clumsiness. Our analysis showed one critical result in 28% (17 out of 60 children) and two in 13% (8 out of 60 children). Hence, it follows that normal results were reached only by 52% (31 out of 60 children). It can be concluded that for some of the children certain tests were more suitable and that the children with better results were more focused on the performance of the tasks than those with one or two critical results. The children with three critical results would better be submitted to another test. Those children are most probably slower also in their everyday life, in movements in general as well as in performing everyday tasks.

With regard to the findings of foreign researches the results of fine motor tests do not differ significantly as to sex (Kremžar, 1987). Our research yielded similar results with no statistically significant differences between male and female children. All children had the greatest difficulties in the performance of alternating foot movements and sequential finger movements. The tasks were very demanding in terms of coordination, and the children helped themselves with numerous movements of other parts of the body. These two tasks are the quickest in detecting clumsy children, since they show significantly more coordination problems both in the quality of their movements and in their timed performance.

To improve the reliability of the confirmation of mild brain dysfunctions the children with three critical results should be submitted to some other fine motor tests besides this one, although it already proved suitable in the USA, since the tasks were verified by a sensibility test and a reliability test-retest (Largo, 2001).

In the past 25 years a number of standardized fine motor tests for extensive use in researches and in clinical practice were performed for verifying slight neurological dysfunctions. The common goal of these tests is to detect children with abnormal neuromotor ability; but there are no precise norms for definite age groups which would offer the possibility of a rapid and simple test with children suspected of having slight brain dysfunctions. For the purpose of our research we therefore defined our own border results; they are based on a relatively small population and are not entirely reliable, but they still give us the possibility of comparing the obtained results with those regarded as critical and pointing out abnormal neuromotor ability.

Deviations in fine and gross motor ability are noticeable not only in sport lessons but also in other school activities, in children's games and in their everyday need for expression with movements.

Most children with diagnosed motional troubles never grow out of their clumsiness (Kremžar & Petelin, 2001). If the established cause of their clumsiness is mild brain dysfunction, cooperation between parents and teachers must be established and the morning working programme at kindergarten or school complemented. A clumsy child should be treated by a special programme and with a lot of encouragement and understanding. In its early years suitable help can make it develop its fine and gross motor ability quite rapidly. Maybe such child's movements will never be as perfect as those of a normal one, but they will certainly satisfy its most important needs, so that it will never feel a failure. Thus a clumsy child can be spared a lot of difficulties in years to come, be it in the field of motor activities or in everyday life.

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