青年期における運動能力の因子構造の発達的変化

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Growth Changes in Factor Structure of Motor ability in Adolescence[1]

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要　約

　この研究は異なる年令の標本から得られる運動能力の因子構造の変動のなかに，発達的な原則を発見しようとするものである。中学1年から高校3年までの男子生徒580人のテスト・データを分析し，第1主軸の貢献度と因子構造の単純度を得，それを Garrett の分化仮説に従って発達的に検討した。その結果，この発達期間においては因子構造は年令と共に分化することが，貢献度の加令に伴う低下によって明らかにされた。

Since the introduction of multiple factor analysis to the study of physical education, researchers in this field have devoted themselves to the identification of the number and types of factors underlying human motor ability. Despite the increase in volume and scope of this kind of research in motor ability the derived knowledges have showed that numerical size and contents of factors given by different analyses did not always coincide. Some attempts have been made to form a theoretical framwork which would satisfactorily explain the differences in factor structures. One aspect of theory that has received considerable attention has been the developmental changes of factor abilities. The process by which human ability differentiates from one global and undifferentiated ability, so called g factor, in childhood to the complex pattern of abilities in college students has been proposed for many years. Garrett (1) has attempted to explain developmental changes of the factorial structures of intelligence by proposing an Age Differentiation Hypothesis (ADH), the basis of which is the differentiation of intellective ability from one general ability to a complex pattern of specific abilities.

　Ichimura (3) proposed the mathematical methods that gave three mathematical expressions for measuring the differentiation level to given factor structures. Those three were 'Convergence' which was defined by the percentages of contribution of principal component, 'Simplicity' defined by normalized Varimax criterion and 'Clearness' defined by the degree of goodness of fitness to hypothetical

structure which was composed according to physiological and factor analytical knowledges derived from previous studies of motor abilities. Mathematically restated the ADH, it would be proposed that the size of contribution of principal component progressively decrease, while simplicity and clearness of factor structure increase with age. This study is purporting to test the ADH in the domain of motor ability by comparing factor structure in a small battery of motor ability test at six chronological ages. Two of three indices proposed by the author, convergence and simplicity, were applied to measure the degree of differentiation.

Procedure

A total of 580 subjects was used in this study. They were male students in public junior high school and high school in Tsuchiura city. Their school age ranged from 7 to 12, in which school age 7 corresponds to chronological age 12. A more detailed presentation of the sample is as follows.

School Age	Sample Size	School Age	Sample Size
7	98	10	93
8	99	11	98
9	98	12	94

A battery of 9 tests from Sport Test developed by Japanese Ministry of Education was used in this study. Nine tests were divided into two groups which were applied to measure two ability domains, strength and flexibility, respectively. The first group of test consisted of 7 tests were supposed to measure strength domain, and the second consisted of 2 tests were supposed to measure flexibility domain. Test items were as follows:

The first group; 50 meter dash, long jump, handball throw, side step, vertical jump, back strength and grip strength.

The second group; Abdominal stretch and toe touch

Data were factor analysed by principal axis method to determine the size of contibution of the first principal component and to extract three factors following the assumption that a battery of 9 tests may insure measurement of three factorial abilities, explosive strength, static strength and flexibility. Three factor loading vectors were rotated for simple structure by normalized Varimax rotation, from which Varimax criterion was given.

Results

Each one of the age samplings has been treated separately. The first group consisted of 7 tests in strength domain was analysed, and then additional two tests were analysed together. The results of the analyses of 7 tests and 9 tests are found in Table 1.

Convergence that is the contribution of the first principal component which corresponds to Spearman's g factor is highest at school age 7 in both analyses. Convergence tends to show progressive decreases with age. Convergence of 7 tests is lowest at school age 11 (second grade of high school), and that of 9 tests is lowest at school age 12. Convergence of 9 tests consisted of the tests in strength and

flexibility domain is lower than that of 7 tests which represent strength domain at every school age levels.

Table 1   Convergence and Simplicity of Factor Structure of Motor Ability Tests at Different School Ages

(male)

(A)   Convergence

School Age	7 Tests Contribution of Comp.		9 Tests Contribution of Comp.	
	1	Sum of 3 Components	1	Sum of 3 Components
7	57.1	78.5	48.5	70.5
8	56.3	80.5	46.9	71.8
9	54.3	78.8	43.6	68.3
10	51.6	76.2	41.8	66.5
11	46.1	74.4	37.5	63.7
12	47.1	75.3	37.3	65.3
				(per cent)

(B)   Simplicity

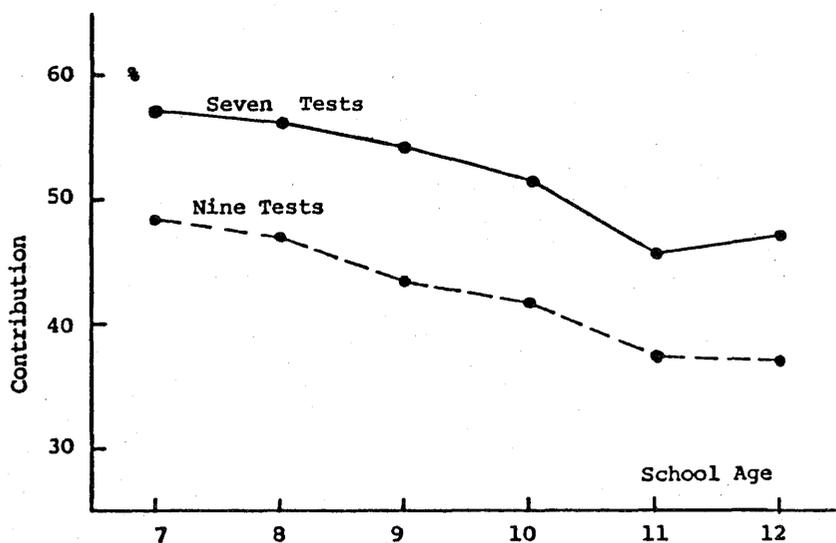| School Age	7 Tests	9 Tests
7	0.52	1.00
8	0.30	1.00
9	0.16	0.62
10	0.20	0.36
11	0.28	0.33
12	0.71	0.72

Fig. 1   Contribution of First Principal Component at Six Age Levels

Summation of the contribution of the largest three components also progressively decreases with age. Transitional figure of simplicity does not have linear correlation with aging. Simplicity of factor structure of nine tests is high at school age 7 and 8 (1.00) although it tends to be lower at succeeding ages. This trend seems to be against the ADH, however, at school age 12 simplicity increases significantly.

Discussion

When it comes to testing the ADH, it may be partly supported by the result of data analyses. Decreasing of convergence with age clearly supports the hypothesis. Contribution of sum of three components also supplementarily supports it. Following the ADH, it is assumed that a set of abilities becomes to be grouped into the larger number of simpler and clearer factor abilities with aging.

Attending only to the transiting of convergence, two major phenomenal facts are inferred. The first fact is that numerical values of correlation coefficients in the matrix becomes smaller with age, from which it is concluded that a set of test performance becomes to be determined by a single factor ability in the smaller extent with age. It may be assumed that with ageing in the age range of this study factor structure tends to be the greater dimensional factorial figure. The second fact is that the figure of individual difference becomes such multiphasic one that, for example, one who is excellent at a certain test is not always excellent at other tests.

From the standpoint of simplicity the ADH could not be supported sufficiently. There raise some questions about accepting the ADH, if the result of the analysis in simplicity is considered. The question of importance is if the differentiation process is simply transiting one. So far as the age range this study concerns, convergence decreases simply. Another study by this author (2), however, showed the level of convergence of 55 tests at third grade at primary school was a little bit greater than that of second grade of high school. Difference between convergence of two age groups was so small that it was difficult to assume the existence of decreasing process between them. It may be reasonable to assume that there exists waving or circular process in the differentiation rather that simple linear process when it is examined by multivariate statistical methods on the basis of correlational relationship among test performances. Further studies will be needed to examine this point.

Summery and Conclusions

To test the Age Differentiation Hypothesis in the domain of motor ability factor structures obtained from six different age groups ranging from junior high school to senior high school were compared. Transitional figure of convergence of factor structure supported the existence of differentiation process in these ages. Simplicity did not change according to the hypothesis. Further investigation in testing to hypothesis and theoretical reconsideration of it are needed.

References

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