# Study on the Standardization of DE-Visual Sequential Memory Test (VSM)

——Standard Value of the DE-VSM in the Primary School Children——

Osamu SHOJI*, Akiko KAWAKAMI**, Mika SAKUMA**, Eri MURATA**
Ikuko SATO**, Keiko MARUYAMA**, Tadao MUKAI***, Yukio MUKAI**

**Synopsis:** The purpose of this study is to establish a standard value for the DE-VSM score in primary school children. This test was developed by the authors' research group as one of the screening tests for neurological disorders such as mental retardation, epilepsy and minimal brain dysfunction syndrome in school children.

The authors developed this new DE-VSM with reference to Ikuzawa's "New K-Developmental Test" in 1985. Through trial and error experiments, we selected one of the sub-tests named "Tapping blocks" and thought that it would be effective to evaluate the visual sequential memory for the children. The original test items of "Tapping blocks" in the K-Developmental Test consists of twelve items, but out of these twelve items we selected seven items and added three newly developed test items. The time needed to administer the DE-VSM is about two minutes forty seconds per child.

The subjects of this study were 757 apparently normal children ranging from six to twelve years of age in I Town, Tsukuba-Gun, Ibaraki Prefecture.

The developmental change of the average score and standard deviation by age and sex were obtained. Based on these data, "pass-nonpass criteria" by age and sex were established.

The validity and reliability of DE-VSM for primary school children will be examined in Part II in this study.

## Introduction

It is no doubt that health examinations (mass-health checkup) in schools have as a function to screen and to detect diseases or disorders of children. The result of the health examination show the health level of the school compares with that of other schools. In other words, it can be used as a school health index to evaluate the result of health activities in schools and communities.

However there are not so many simple health indices applicable for a massive group of children.

The authors' research group has been studying mainly mass-neuro-pediatrics for a quarter century and developed various kinds of simplified CNS function tests for children. Through studying mass-neuro-pediatrics, authors have reported that simple health indices have various

\*    Ryutsu Keizai University
\*\*   Institute of Developmental Epidemiology
\*\*\* Mito Clinic

**Table 1**                     **Functions of Simple Health Indices(Simplified Tests)**

1. As individual Indices.

  (1) As a screening test.

  (2) Occasionally usable as one of the items in diagnostic criteria of the clinical diagnosis.

  (3) If the result of a simple test is available in advance, simple health indices will improve efficiency of the

    clinical test administered later.

1. As Indices of the group.

  Example (1) Usable as a health index when searching the causatives factors of diseases in the

    epidemiological studies.

  Example (2) Usable as indices of the community child health diagnosis, school health diagnosis, and

    community diagnosis.

  Example (3) If mass-screening of a disease by means of simplified health indices is widely carried out, mild

    and atypical cases of the disease will be detected and consequently the analysis of clinical

    picture including symptomatology will be improved.

  Example (4) Promoting the studies of pediatrics efficiently.

    a) Usable as objective and simplified criteria for normal children.

    (The simplified test can be the screening test for selecting the normal control children.)

    b) Usable as an index to control the quality of the subjects.

    c) Promoting the developmental studies efficiently based upon a large scale population survey.

functions and these functions have served not only as screening tests, but also as health indices of the population of children. (Table 1)

The purpose of this study is to develop a new simplified visual sequential memory test (VSM) for school children. It is well-known that children who are diagnosed as having minimal brain dysfunction syndrome or mental retardation often have disorders of visual sequential memory.

In this paper, the authors developed the simplified VSM with reference to the "new K-Developmental Test" to apply it to a group of children.

Part one of this study aims to establish the standard value of VSM in the population of primary school children.

**Table 2**                          **Subjects by age and sex**

| Sex \ Age | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Total |
|---|---|---|---|---|---|---|---|---|
| Boy | 31 | 57 | 64 | 56 | 65 | 62 | 56 | 391 |
| Girl | 25 | 57 | 47 | 48 | 51 | 72 | 66 | 366 |
| Total | 56 | 114 | 111 | 104 | 116 | 134 | 103 | 757 |

## Subjects and Method

Subjects in this study are primary school children aged 6–12 as shown in Table 2. The total number of children is 757 (boys 391, and girls 366).

The location of the school is in I town, Tsukuba-Gun, Ibaraki Prefecture. The town used to be a farming village before, but recently, the town office developed and subdivided land into residential area advertising "Bed Town of Tokyo." Therefore many people moved into this town creating various social classes. The selection of school is arbitrary, but qualitative deviation is avoided.
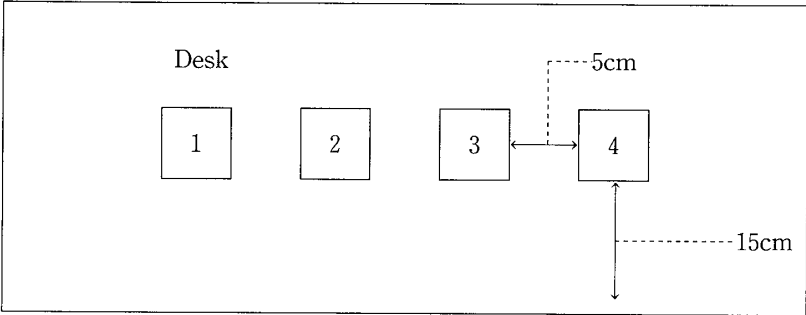
The newly developed DE-VSM is the simplified developmental test of visual sequential memory for children from six to twelve years old. The authors chose "Tapping Blocks" as one of the sub-tests of the New K-Developmental Test. The original "Tapping Blocks" consists of twelve test items which could be a good index of children's visual sequential memory.

However the majority of the test items in the new K-Developmental Test which we referred to

**Table 3-1**                        **How to administer the DE-VSM**

1. Four red blocks (2.3cm cube) are placed on the desk in front of the child. ( see the picture below)

2. The examiner must identify each block's number, one to four, from the left side of the child and remember them for his convenience. He should not write these numbers on the blocks.

Examiner



Desk

| 1 | 2 | 3 | 4 |

5cm

15cm

Child

3. The Examiner has another block in his hand and he should give the following explanation:

"Now, Let us play together. First I will show you how to play" at the same time, the examiner shows to the child and taps on each block. Then he says, "Please imitate me and tap on the blocks in the order that I did." The speed of the tapping is one second for each beat.

4. After the examiner taps each block of test item (a),table 1-2, he asks the child to repeat this action, and he says "Now, it is your turn. Please try, will you?"

The examiner hands his block to the child's right hand and urges him to try to do it.

5. Continue tapping the items from (b) to (j) in that order (see the table 1-2). If the child makes two test items consecutive mistakes, stop the test. The items are arranged in order from the easiest to the most difficult.

6. If the child begins to tap from the opposite side (from right to left), the examiner should say, "please tap the block from from this side," pointing to block (1) and urge him to begin.

**Table 3−2          The test items of the DE-VSM**

| (a) | 1. 2. 3. 4 | (f) | 1. 3. 4. 2. 3 |
| (b) | 1. 2. 3. 4. 3 | (g) | 1. 3. 2. 4. 1. 3 |
| (c) | 1. 4. 2. 3 | (h) | 1. 4. 2. 3. 4. 1 |
| (d) | 1. 3. 1. 2. 4 | (i) | 1. 3. 4. 1. 4. 2 |
| (e) | 1. 4. 3. 2. 4 | (j) | 1. 3. 1. 2. 4. 1. 3 |

1. Numbers (a) to (j) shows tapping order respectively.

2. Whenever child passes one item, he gains one point.

The highest number of point is ten.

**Table 4**  **The distribution of the subjects by DE-VSM score, age and sex**

| Age | 6 | | 7 | | 8 | | 9 | | 10 | | 11 | | 12 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Score \ Sex | boy | girl | boy | girl | boy | girl | boy | girl | boy | girl | boy | girl | boy | girl |
| 10 | | | | | | | | ⇒ 1 | ⇒ 1 | | ⇒ 1 | | | 5 |
| 9 | ⇒ 1 | | | | ⇒ 1 | | | | 3 | | 2 | 6 | 3 | 4 |
| 8 | | | ⇒ 2 | ⇒ 1 | | | | 1 | 1 | 2 | 3 | 9 | 4 | 7 |
| 7 | | | | | 6 | | 3 | 5 | 4 | 4 | 9 | 9 | 8 | 12 |
| 6 | 3 | | 4 | 5 | 4 | 8 | 8 | 10 | 9 | 12 | 14 | 12 | 11 | 10 |
| 5 | 5 | | 8 | 6 | 13 | 5 | 19 | 6 | 13 | 17 | 14 | 16 | 17 | 9 |
| 4 | 8 | 6 | 19 | 18 | 16 | 17 | 14 | 14 | 20 | 11 | 12 | 15 | 9 | 11 |
| 3 | 9 | 15 | 17 | 21 | 22 | 13 | 10 | 10 | 13 | 5 | 8 | 5 | 4 | 8 |
| 2 | 5 | 4 | 6 | 5 | 2 | 4 | 2 | 1 | 1 | | | | | |
| 1 | 1 | | 1 | 1 | | | | | | | | | | |
| 0 | | | | | | | | | | | | | | |
| Total | 32 | 25 | 57 | 57 | 64 | 47 | 56 | 48 | 65 | 51 | 63 | 72 | 56 | 66 |
| Average Score | 3.65 | 3.19 | 3.89 | 3.53 | 4.15 | 4.13 | 4.51 | 4.60 | 4.87 | 5.20 | 5.23 | 5.45 | 5.61 | 6.05 |

1)  ⇒ Cases rejected by Test of Rejection.
2)  Number of the subjects and average score by age and score was determined excluding rejected cases.

are so easy to pass for the high-grade school children that the authors struck off five items. Then, we added three newly developed items and made the test applicable for the children making ten test items all together.

Table 7 shows the percentage of "pass" for each item of the DE-VSM in primary school children. This result shows that DE-VSM consists of widely ranging items from easy to difficult ones.

How to administer the DE-VSM and scoring criteria are shown in Table 3-1 and Table 3-2.

## Results and discussions

Table 4 shows the distribution of the subjects by DE-VSM score, age, and sex. The mean score of six year old boys was significantly higher than that of girls $(p < 0.005)$. However, the mean score of ten and twelve year old boys was significantly lower than that of girls. It may be related to the physical growth and maturity, because girls usually grow and mature earlier than boys. There was no significant differences between boys and girls in the age of seven to nine.

Figure 1 shows the developmental change of the mean score of DE-VSM (and S. D.) by sex. This figure shows the mean score continues to rise from six through twelve years of age which implies that this test could be a good index of children's visual sequential memory according to age.
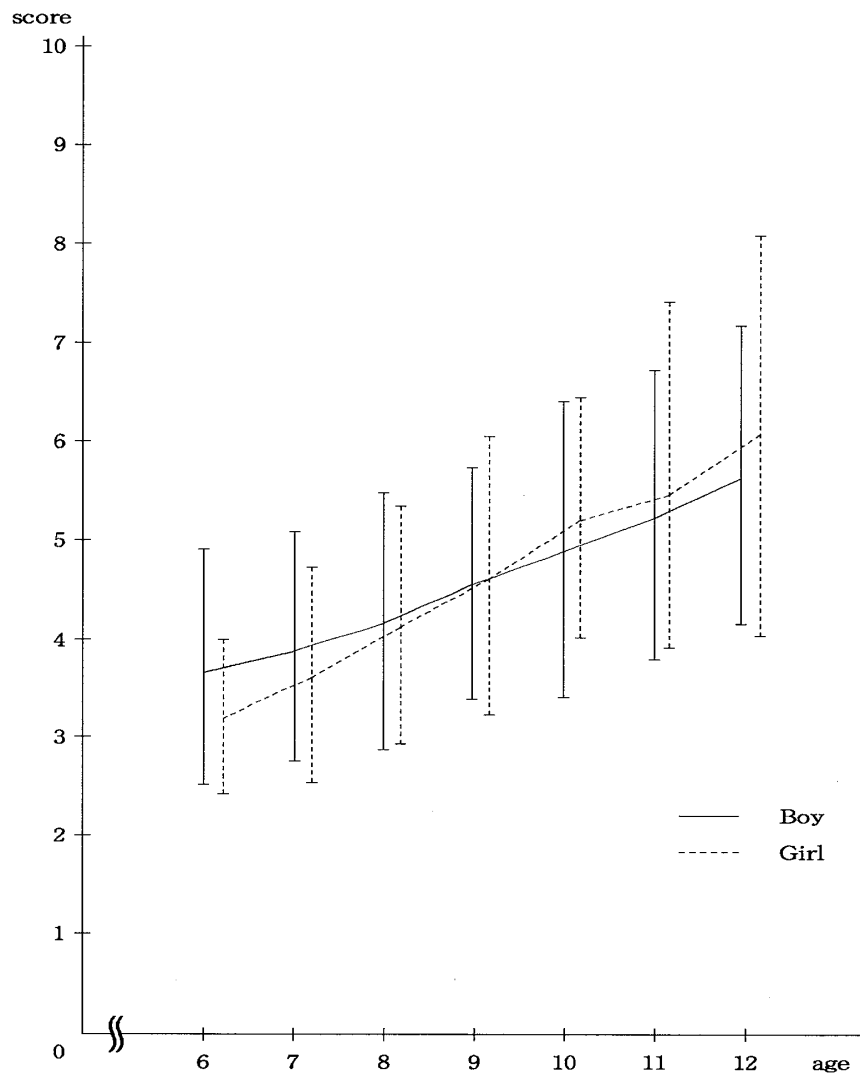
Fig.1. Developmental change of mean score of
DE-VSM (and S.D.) by sex.

Figure 2-1 and Figure 2-2 shows percentile by score in DE-VSM and by age. These figures (boys and girls) also show gradual increase of scores by age.

Table 5-1 and Table 5-2 shows the distribution of the boys and girls in percentile by DE-VSM score and age. Frequency and accumulative frequency are determined. Percentile of both boys and girls are corrected by mathematical smoothing. The mean score and S. D. by age are also shown. The cases which showed greatly deviated scores are rejected by the Rejection Test.

Table 6 shows standard value of DE-VSM for children by age. Changing percentages of "false positive" are shown when the screening level is shifted to various levels. "Pass-nonpass criteria" were established by age and sex. For example: when the screening level for boys is placed at the level 93.3 percentile (M-1.5 S. D.), false positive is 9.8%.

The validity and reliability of DE-VSM for primary school children will be examined in Part II in this study.
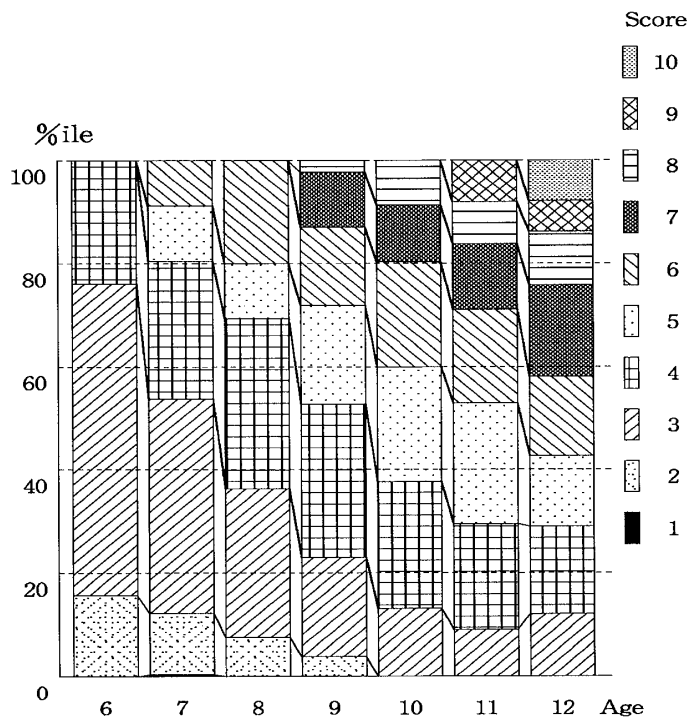
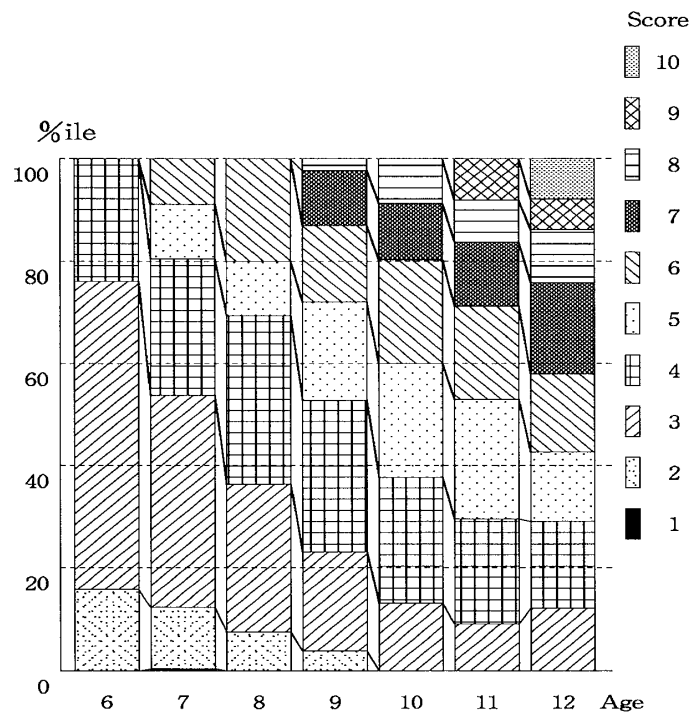Fig.2-1 Percentile by score in DE-VSM and by age (Boys).



Fig.2-2 Percentile by score in DE-VSM and by age (Girl).

**Table 5-1**  The distribution of the boys in percentile by DE-VSM score and age

| Age / Score | 6(n=31) F and% | 6(n=31) AF and% | 7(n=55) F and% | 7(n=55) AF and% | 8(n=63) F and% | 8(n=63) AF and% | 9(n=56) F and% | 9(n=56) AF and% | 10(n=64) F and% | 10(n=64) AF and% | 11(n=62) F and% | 11(n=62) AF and% | 12(n=56) F and% | 12(n=56) AF and% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | | | | | | | | | | | | | | |
| 9 | | | | | | | | | 3  4.7 | 3  4.7 | 2  3.2 | 3  4.4 | 3  5.4 | 3  5.4 |
| 8 | | | | | | | | | 1  1.6 | 4  6.3 | 3  4.8 | 5  8.9 | 4  7.1 | 7  12.5 |
| 7 | | | | | 6  9.5 | 6  9.5 | 3  5.4 | 3  9.2 | 4  6.3 | 8  13.5 | 9  14.5 | 14  20.6 | 8  14.3 | 15  26.8 |
| 6 | 3  9.7 | 3  9.7 | 4  7.3 | 4  10.9 | 4  6.3 | 10  14.3 | 8  14.3 | 11  20.7 | 9  14.1 | 17  30.5 | 14  22.6 | 28  39.4 | 11  19.6 | 26  46.4 |
| 5 | 5  16.1 | 8  25.8 | 8  14.5 | 12  28.0 | 13  20.6 | 23  37.3 | 19  33.9 | 30  45.7 | 13  20.3 | 30  56.1 | 14  22.6 | 42  63.8 | 17  30.4 | 43  76.8 |
| 4 | 8  25.8 | 16  51.6 | 19  34.5 | 31  56.6 | 16  25.4 | 39  65.6 | 14  25.0 | 44  72.9 | 20  31.3 | 50  81.3 | 12  19.4 | 54  86.1 | 9  16.1 | 52  92.9 |
| 3 | 9  29.0 | 25  80.6 | 17  30.9 | 48  88.2 | 22  34.9 | 61  93.5 | 10  17.9 | 54  97.3 | 13  20.3 | 63  98.4 | 8  12.9 | 62  99.5 | 4  7.1 | 56  100 |
| 2 | 5  16.1 | 30  96.8 | 6  10.9 | 54  98.3 | 2  3.2 | 63  99.4 | 2  3.6 | 56  100 | 1  1.6 | 64  100 | | | | |
| 1 | 1  3.2 | 31  100 | 1  1.8 | 55  100 | | | | | | | | | | |
| 0 | | | | | | | | | | | | | | |
| Mean Score | 3.65 | | 3.86 | | 4.15 | | 4.51 | | 4.87 | | 5.23 | | 5.61 | |
| S.D | 1.28 | | 1.12 | | 1.32 | | 1.19 | | 1.57 | | 1.53 | | 1.53 | |

F: Frequency    AF: Accumulative Frequency

**Table 5—2**  The distribution of the girls in percentile by DE-VSM score and age

| Age Score | 6(n=25) F and% | 6(n=25) AF and% | 7(n=56) F and% | 7(n=56) AF and% | 8(n=47) F and% | 8(n=47) AF and% | 9(n=47) F and% | 9(n=47) AF and% | 10(n=51) F and% | 10(n=51) AF and% | 11(n=72) F and% | 11(n=72) AF and% | 12(n=66) F and% | 12(n=66) AF and% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | | | | | | | | | | | | | 5  7.6 | 5  7.6 |
| 9 | | | | | | | | | | | 6  8.3 | 6  8.3 | 4  6.1 | 9  13.7 |
| 8 | | | | | | | 1  2.1 | 1  2.1 | 2  3.9 | 2  8.9 | 9  12.5 | 15  16.3 | 7  10.6 | 16  24.3 |
| 7 | | | | | | | 5  10.6 | 6  12.7 | 4  7.8 | 6  19.2 | 9  12.5 | 24  29.2 | 12  18.2 | 28  42.5 |
| 6 | | | 5  8.9 | 5  8.9 | 8  17.0 | 8  20.0 | 10  21.3 | 16  28.7 | 12  23.5 | 18  39.7 | 12  16.7 | 36  47.6 | 10  15.2 | 38  57.7 |
| 5 | | | 6  10.7 | 11  19.6 | 5  10.6 | 13  31.3 | 6  12.8 | 22  47.6 | 17  33.3 | 35  62.5 | 16  22.2 | 52  70.7 | 9  13.6 | 47  71.3 |
| 4 | 6  24.0 | 6  24.0 | 18  32.1 | 29  46.5 | 17  36.2 | 30  64.0 | 14  29.8 | 36  76.9 | 11  21.6 | 46  86.8 | 15  20.8 | 67  90.6 | 11  16.7 | 58  88.0 |
| 3 | 15  60.0 | 21  84.0 | 21  37.5 | 50  87.9 | 13  27.7 | 43  92.5 | 10  21.3 | 46  96.1 | 5  9.8 | 51  100 | 5  6.9 | 72  100 | 8  12.1 | 66  100 |
| 2 | 4  16.0 | 25  100 | 5  8.9 | 55  99.4 | 4  8.5 | 47  100 | 1  2.1 | 47  100 | | | | | | |
| 1 | | | 1  1.8 | 56  100 | | | | | | | | | | |
| 0 | | | | | | | | | | | | | | |
| Mean Score | 3.19 | | 3.62 | | 4.13 | | 4.60 | | 5.20 | | 5.65 | | 6.05 | |
| S.D. | 0.83 | | 1.12 | | 1.19 | | 1.44 | | 1.22 | | 1.73 | | 2.06 | |

F: Frequency    AF: Accumulative Frequency

**Table 6**          **Standard Value of DE-VSM for children by age**

——Changing percentage of false positive when the screening level is shifted to various levels——

**Boys**

| screening level | 6 P | 6 N | 7 P | 7 N | 8 P | 8 N | 9 P | 9 N | 10 P | 10 N | 11 P | 11 N | 12 P | 12 N | Number of nonpass among 391 | False positive (T. V.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 50%ile (M-0S. D.) | 4 | 3.5 | 4 | 3.5 | 4.5 | 4 | 5 | 4.5 | 5 | 4.5 | 5.5 | 5 | 6 | 5.5 | 203 | 52.5 (50.0) |
| 69.1%ile (M-0.5S. D.) | 3.5 | 3 | 3.5 | 3 | 4 | 3.5 | 4 | 3.5 | 4.5 | 4 | 5 | 4.5 | 5.5 | 5 | 159 | 41.4 (30.9) |
| 84.1%ile (M-1.0S. D.) | 3 | 2.5 | 3 | 2.5 | 3.5 | 3 | 3.5 | 3 | 4 | 3.5 | 4 | 3.5 | 4.5 | 4 | 84 | 21.7 (15.9) |
| 93.3%ile (M-1.5S. D.) | 2 | 1.5 | 2.5 | 2 | 3 | 2.5 | 3 | 2.5 | 3.5 | 3 | 3.5 | 3 | 4 | 3.5 | 38 | 9.8 (6.7) |
| 97.7%ile (M-2.0S. D.) | 2 | 1.5 | 2 | 1.5 | 2.5 | 2 | 3 | 2.5 | 3 | 2.5 | 3 | 2.5 | 3.5 | 3 | 11 | 2.8 (2.3) |

**Girls**

| screening level | 6 P | 6 N | 7 P | 7 N | 8 P | 8 N | 9 P | 9 N | 10 P | 10 N | 11 P | 11 N | 12 P | 12 N | Number of nonpass among 366 | False positive (T. V.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 50%ile (M-0S. D.) | 3.5 | 3 | 4 | 3.5 | 4.5 | 4 | 5 | 4.5 | 5.5 | 5 | 6 | 5.5 | 6.5 | 6 | 212 | 58.2 (50.0) |
| 69.1%ile (M-0.5S. D.) | 3 | 2.5 | 3.5 | 3 | 4 | 3.5 | 4.5 | 4 | 4.5 | 4 | 5 | 4.5 | 5 | 4.5 | 128 | 35.2 (30.9) |
| 84.1%ile (M-1.0S. D.) | 3 | 2.5 | 3 | 2.5 | 3.5 | 3 | 3.5 | 3 | 4 | 3.5 | 4.5 | 4 | 4.5 | 4 | 82 | 22.5 (15.9) |
| 93.3%ile (M-1.5S. D.) | 2.5 | 2 | 2.5 | 2 | 3 | 2.5 | 3.5 | 3 | 3.5 | 3 | 3.5 | 3 | 3.5 | 3 | 43 | 11.8 (6.7) |
| 97.7%ile (M-2.0S. D.) | 2 | 1.5 | 2 | 1.5 | 2.5 | 2 | 3 | 2.5 | 3 | 2.5 | 3 | 2.5 | 3 | 2.5 | 6 | 1.6 (2.3) |

M: Mean    S.D.: Standard Deviation     T.V.: Theoretical Value

**Table 7**  Percentage of "Pass" for each item of DE-VSM in Primary School Children

| | 1 (N=136) | | 2 (N=98) | | 3 (N=111) | | 4 (N=113) | | 5 (N=116) | | 6 (N=178) | | (N=752) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % | N | % | N | % | N | % |
| a | 136 | 100 | 98 | 100 | 111 | 100 | 113 | 100 | 116 | 100 | 178 | 100 | 752 | 100 |
| b | 129 | 94.9 | 95 | 96.9 | 109 | 98.2 | 113 | 100 | 116 | 100 | 178 | 100 | 740 | 98.4 |
| c | 110 | 80.9 | 86 | 87.8 | 99 | 89.2 | 112 | 99.1 | 116 | 100 | 173 | 97.2 | 696 | 92.6 |
| d | 49 | 36.0 | 50 | 51.0 | 66 | 59.5 | 78 | 69.0 | 84 | 72.4 | 147 | 82.6 | 474 | 63.0 |
| e | 32 | 23.5 | 37 | 37.8 | 34 | 30.6 | 57 | 50.4 | 60 | 51.7 | 106 | 59.6 | 326 | 43.4 |
| f | 13 | 9.6 | 19 | 19.4 | 23 | 20.7 | 29 | 25.7 | 37 | 31.9 | 84 | 47.2 | 205 | 27.3 |
| g | 5 | 3.7 | 6 | 6.1 | 20 | 18.0 | 24 | 21.2 | 28 | 24.1 | 82 | 46.1 | 165 | 21.9 |
| h | 2 | 1.5 | 9 | 9.2 | 7 | 6.3 | 20 | 17.7 | 27 | 23.3 | 52 | 29.2 | 117 | 15.6 |
| i | 0 | 0.0 | 4 | 4.1 | 5 | 4.5 | 4 | 3.5 | 11 | 9.5 | 37 | 20.8 | 69 | 8.1 |
| j | 0 | 0.0 | 2 | 2.0 | 0 | 0.0 | 3 | 2.7 | 4 | 3.4 | 10 | 5.6 | 19 | 2.5 |

\* $P<0.05$
\*\* $P<0.01$
\*\*\* $P<0.005$

# References

1. Mukai Y. : Proposal of Developmental Epidemiology, Jap. J. of School Health, Vol. 25 No.5 pp165-168, 1983.

2. Mukai Y. : Development of School Health for Minimal Symptoms, J. of School Health, Vol.30,4, pp162-168, 1988.

3. Ono E., Mukai Y. et al: Study on a Simplified Motor Function Test for High School Students, The Standard Value of DEMT for High School Students Jap. J. of School Health, Vol.23,6, pp286-294,1981.

4. Hashimoto Y., Mukai Y. et al: Study on a Simplified Motor Function Test, The Validity and Reliability of DEMT for High School Students, Jap. J. of School Health, Vol.23,6, pp444-450m, 1981.

5. Mukai Y. : Manual of MN-Developmental Screening Test, with Special Reference to Developmental Neuro-epidemiology, New Medical Sha, Mito, pp8-118,1982.

6. Kawakita E., Mukai Y, et al :DE-Bender Gestalt Test (BGT) for High School Students, Standard Value of DE-BGT, J. of Ibaraki Univ. Education Faculty, Vol. 28, 3, pp97-110, 1979.

7. Hashimoto Y., Mukai Y. et al : DE-BGT for High School Students, Validity and Reliability of DE-BGT, J. of Ibaraki Univ. Education Faculty, Vol. 28, pp111-122, 1979.

8. Shoji O., Onuma J., Mukai Y. et al : Study of the Simplified Motor Function Test for Children, Standard Value of DEMT for Children Aged 3-6, J. of Ryutsu Keizai Univ., Vol.25,2, pp27-39, 1990.

9. Shoji O., Kitami R., Mukai Y. et al : Study of the Simplified Motor Function Test for Children, Validity and Reliability of DE-BGT for Children Aged 3-6, J. of Ryutsu Keizai Univ., Vol.25,3, pp39-50, 1990.

10. Shoji O., Sumita C., Mukai Y. : Study of the Cause of Insufficient Predictive Validity of Developmental Tests, J. of Ryutsu Keizai Univ., Vol.25,3, pp39-50, 1990.

11. Shoji O., Suzuki N., Mukai Y. : Proposal of a New Method in the Prognostic Study of Neuro-pediatric Disorders, J. of Ryutsu Keizai Univ., Vol.26,1, pp11-18, 1991.

12. Shoji O., Kikuchi E., Mukai Y. : Developmental Neuro-Epidemiologic Study on Criteria of Normal High School Students, J. of Ryutsu Keizai Univ., Vol.26,2, pp30-40, 1991.

13. Shoji O., Ando C., Mukai Y., Standard Value of the DE-Bender Gestalt Test in Primary School Children, J. of Ryutsu Keizai Univ., Vol.27,1, pp17-29, 1992.

14. Ikuzawa M., Manual of New K-Developmental Test, Nakanishiya Shuppan,1985

15. Kirk S. A., McCarthy J. J., Kirk W. D., Examiner's Manual Illinois Test of Psycholinguistic Abilities Revised Edition (translated in Japanese) Nihon Bunka kagakusha, Tokyo Japan 1968.

16. Kirk S. A., Kirk W. D., Psycholinguistic Learning Disabilities: Diagnosis and remediation. University of Illinois Press Chicago,1971.