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# Development of Language-Cognitive Program for Prevention of Learning Disabilities in Preschool Children : One-Year Experimental Training Program for Five-Year-Old Children at High Risk for Learning Disabilities.

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# 1 Introduction

For more than 20 years, I have been studying the development of Hiragana literacy (Japanese syllabic letters) in first graders with learning disabilities (LD). I have developed an experimental training program which consists of the following: (1) an orthography program for Hiragana which is based on the formation of syllabic analysis, (2) a syntax program using models to represent the syntactico-semantic structures of sentences, and 3) a lexico-semantic-cognitive program which focuses on classification skills. The training experiments demonstrated that our teaching program was very effective in promoting both literacy development and overall improvement in general abilities. Occasionally, however, we encountered children with severe LD, who could not be remedied by one-two years' special training. Thus, in this experimental training, we identified LD children, or those suspected to have LD, at the end of the first term of the first grade and provided special individual training from the beginning of the second term, that is, in September( Amano, 1982,1998).

Our training program required one year and half or two years to allow children to master the fundamental reading and writing abilities in Hiragana. They were administered the training individually, twice a week, and their learning proceeded smoothly. When they had acquired the basic reading and writing abilities in Hiragana and the fundamental other language abilities emphasized by our training program, they were already in the third grade. Children with severe LD, those who could not be remediated by two years' training in our training program, usually showed difficulties in learning Kanji (Chinese characters) and written composition in the third grade. So we were required to develop new teaching programs for learning Kanji and oral and written composition. Such practical difficulties have stimulated us to develop various kinds of language teaching programs for the third and upper grade LD school children. On the other hand, we were concerned that our literacy program for LD school children has a was not able to remediate those with severe LD in the lower grades(Amano, 1998).

By the end of 1970's, when I began a project for the development of literacy among LD children in the National Institute for Educational Research (NIER)(Amano, 1982), it was generally believed that LD are manifest only in the school period when literacy and arithmetic skills are required, and that it is very difficult to make a

diagnosis of LD in the preschool period. Even now this belief predominates. “Early identification and early education” is one of the most important principles for education to handicapped children. But for a long time this principle could not be applied to the education of LD children mainly due to the impossibility of identification of LD in preschool period. If we consider that many of the characteristics of deficits in psychological functions (especially uneven development across various domains) of LD school children and the most fundamental developmental basis for learning in school are formed and developed through the activities in preschool period , it is very important to identify the children at high risk of LD in the preschool period and to give them interventional educational service before school entrance. To implement this belief, it is necessary to solve various theoretical and practical problems: the most serious and difficult problems are how to identify children at high risk of LD in the preschool period and how to organize their developmental education.

In the last decade the environment for teaching LD children changed, and many LD specialists and teachers in the United States and European countries began to discuss ways to identify children at high risk of LD in the preschool period (for example, see Brown, F.B. et.al.,1997) and the importance of education in the preschool period for the prevention and remediation of LD or reading difficulties. At the same time, many researchers began to study diagnostic methods for identification of children at high risk for LD during the preschool period, and many new projects began to be organized for the education of LD children. The study by O’Connor (1998, 2000) at the University of Pittsburgh, the projects at Oregon University (Baker & Smith, 1999; Coyne et. al., 2001), the projects by J.P. Das in Alberta University in Canada (J.P.Das,2001), the study on the diagnostic method for preschoolers by V.I.Lubovsky (2001), the study by Pylaeva and Akhutina (1997) in Russia serve as examples of these studies.

This emphasis on “Early identification and Early education” in LD education together with the above mentioned serious practical difficulties encountered when trying to remediate LD in school children, made us change the focus of our studies radically. Thus, instead of aiming our research on the remediation of LD in elementary school, we began to study ways to prevent LD from developing by starting with children in the preschool period.

Last year we began a new three-year-project entitled “Development of Language-

Cognitive Teaching Programs for the Prevention of LD in the Preschool Period". This project has the following three purposes: (1) to develop a diagnostic system which can identify children at high risk of LD at age five, (2) to develop a complex Hiragana literacy teaching program which includes a) a Hiragana reading and writing program, b) a syntax program, c) a lexico-semantic program, (3) to promote development of cognitive skills in the following domains: a) figural-spatial representation, b) basic concepts of number and quantity, c) perception and attention, d) kinesthetic-rhythmic functions.

After a one-year pilot study with preschool children at high risk of LD in 2000, we conducted from February until May 2001 the first diagnostic experimental research in seven kindergartens and nursery schools in Tokyo and Kawasaki using the diagnostic system we developed. Using this system, we identified 15 five-year-old children at high risk of LD out of about 190 children. From June 2001 until the beginning of March 2002, we organized individual special training for each of the 11 children using the above complex literacy program and cognitive-development programs on computers.

The purposes of this paper are, first, to describe our system of diagnostic screening and our teaching programs. Next we wish to share the results our one-year experimental training. Finally, we wish to discuss some important implications and potential problems for future studies.

## 2 The outline of our system of screening (diagnostic) tests for identification of children at high risk of LD at the age of five.

### 2-1. Rationale for creating diagnostic tests

To construct diagnostic tests for identifying children at high risk of LD at the age of five, we started with the following assumptions:

1) The most important characteristics of LD children, detected soon after school entrance, are underdevelopment of the fundamental pre-academic skills (especially skills in reading, writing, and arithmetic abilities) and basic language-cognitive functions such as speech, thinking, perception, memory, motor function ,attention and control of action; these factors constitute so-called school readiness(Lubovsky, 1988).

2) The so-called discrepancy definition of LD cannot be applied to preschool children

since they have not been received systematic instruction. We can, therefore, define the high risk of LD in preschool children only from a developmental point of view.

3) If a five-year-old child shows remarkable delays in both the actual development of pre-academic skills, and also in some of the domains of basic language-cognitive functions, we can consider this delay of development as a sign of risk for LD.

4) Even if a five-year-old child does not show any remarkable delay of actual development of pre-academic skills, if we can recognize a delay in some of the domains of basic language-cognitive functions, we can consider this to be a sign of risk for LD.

**2-2. A developmental diagnostic screening test.**

On the basis of the above assumptions, we constructed developmental diagnostic screening tests, which consist of tests in the following seven domains:

(A) Reading (naming) of Hiragana letters test (max. 71)

(B) Picture vocabulary test (max. 25 words).

(C) Counting numbers tests

1) Counting (saying) numbers as high as possible (max. 100).

2) Counting 20 marbles

(D) Verbal regulation tests (modification of Luria's method (1956)).

(E) Drawing (copying) figures while looking at a model:

(1) a perfect square.

(2) a circle

(3) a triangle

(F) Memory tests

1) Verbal memory test (12 words).

2) Visual memory test using picture cards)(12 words).

(G) Attention test.

In each test domain we selected the tasks which were confirmed to be performed well by almost all five-year-old children or had a definite age norm of performance at the age five.

**2-3. The test procedures**

(A) Reading (naming) of Hiragana letters test (max. 71)

The child was asked to name aloud each of the 71 Hiragana letters printed in random order in a booklet, with 3 letters on each page.

(B) Picture vocabulary test (max. 25 words).

This test consisted of 25 words, each of which was selected to be most representative of 25 categories such as animal, bird, tool, play and so on. The child was asked to name the pictures from the photos in a album. If the child had difficulty, he/she was given a hint about the object.

C) Counting number tests

**7** Counting (saying) numbers as high as the child can count (max. 100).

The child was asked to say aloud the numbers from 1 to as high as the child can count until the number 100.

3 Counting 20 marbles

The child was asked to count 20 marbles placed on the table by counting aloud while pointing to each marble and reporting the result.

(D) Verbal regulation tests

This test was a modification of the method first studied by Luria in normal and mentally retarded children (1956) and then by V.I. Lubobsky (Лубовский, В. И. 1978 ) in ZPR children. Our modified verbal regulation tests consisted of the following three kinds of tests; (1) Red-Yellow Marble Conflict Test, (2) Red-Yellow Marble Complex Conflict Test and (3) Red-Yellow-Blue Marble Conflict Test. As these tests played an important role in our diagnostic system for identification of high risk LD preschool children, we will explain the test procedures in detail.

(1) Red-Yellow Marble Conflict Test: Test materials consisted of 15 red and 15 yellow marbles and 20 sheets of small catalogue cards. Each card had either a small red disk or a small yellow disk on the card. Piles of 15 red marbles and of 15 yellow marbles were placed on the right and left sides of a table in front of the child and a pile of cards in random order was put face down on the table in the front of the child; a small glass bottle was also put on the table. In the first, non-conflict task, the following instructions were given by the experimenter: "I am going to turn over cards one after another. When

a red circle appears, take a red marble and put it into this glass bottle. When a yellow circle appears, take a yellow one and put it into this glass bottle" After confirmation of the child's understanding of the instructions, the experimenter turned over 20 cards successively, keeping pace with the child's action. In the second, conflict task, the experimenter gave each child the following instructions: "I am also going to turn over cards one after another, but this time you must take an opposite colored marble. When a red circle appears, take a yellow marble and put it into this glass bottle. When a yellow circle appears, take a red one and put it into this glass bottle" After hearing the instructions, the child was required to repeat orally the key instructions, "When the card is red, I take a yellow one, and when the card is yellow, a red one." The instruction was repeated again and again until the child could understand and repeat it completely at least two times. Then 20 cards were turned over one after another and the child's responses, including marble selection and verbal regulation were observed and recorded. When the child made an error, such as selecting a same-colored marble even one time out of 20, he/she was requested to repeat the task.

(2) Red-Yellow Marble Complex Conflict Test: This time 20 cards, with either a small red disk, a large red disk, a small yellow disk or a large yellow disk on cards were used. Other conditions were the same as in the above (1) test. The experimenter gave each child the following instructions: "I am also going to turn over cards one after another, but this time when a large red circle appears, you must take a yellow marble and put it into this glass bottle and when a large yellow circle appears, you must take a red one and put it into this glass bottle, but when a small red circle appears, you must take a red one and when a small yellow one appears, you must take a yellow one and put it into this glass bottle."

(3) Red-Yellow-Blue Marble Conflict Test: This time test materials consisted of 10 red, 10 yellow and 10 blue marbles and 20 cards, with a small red disk, a small yellow disk and a small blue disk on the cards. In the first non-conflict task the child was requested to take a colored marble matching the color of the disk on the card and put it into the glass bottle. Then in the conflict task, the experimenter gave the child the following instructions: "I am also going to turn over cards, one after another, but this time when a red circle appears, you must take a yellow marble and when a yellow circle appears, you must take a blue one and when a blue one appears, you must take a red one and put it

into this glass bottle.” Other test procedures are the same as above.

(E) Drawing figures task; copying figures from models:

(1) a perfect square

(2) a circle

(3) a triangle

When the child failed to draw independently, the experimenter demonstrated the drawing of the figures.

(F) Memory tests

(1)Verbal memory test (12 words).

We used 12 words which belonged to categories such as "fruit", "food", "instrument", "transportation,” "animals", "dinnerware", "clothing", and "body parts.” Words were presented orally at 2-second intervals, and the child was requested to recall as many words as possible in two minutes. The child was requested to perform the test twice with different words.

(2)Visual memory test using picture cards (12 words).

In this test 12 additional words, which belonged to the same categories used in the verbal memory tests, were used. A sheet of paper, on which a 3×4 matrix was drawn, was put in front of the child on the table. The experimenter placed a picture card on each square of the matrix, saying the name of the picture, and asking the child to repeat it. When all 12 picture cards were put on the matrix, they were covered by a sheet of opaque paper. Then the child was asked to recall the names of the pictures within two minutes. The child was asked to perform the test twice with different picture words.

(G) Attention test:

This test is a continuous performance test (CPT) for preschool children which was developed by Midorikawa(1997). It is conducted using a computer: on the computer monitor a forest is presented where various kinds of animals appears in different places and with different intervals. The child is asked to shoot at a lion as quickly as possible by clicking a certain key, every time it appears in any place on the monitor. We obtained a variety of information on the development of attention from this test, but in this paper we focus on the value subtracted from the percentage of correct responses on the finding lions task the percentage of incorrect responses to others; this value served

as an indicator of the degree of development of attention in the children. A more detailed analysis and explanation is given in another paper by Midorikawa and Amano in this session.

### 2-4. A checklist of problematic behaviors and the problems in the development of each child.

A checklist given to kindergarten and nursery school classroom teachers provided additional information about the behavior and development of the children in the study. The checklist consisted of about 80 items addressing the following areas: 1) talking and speech development, 2) hearing and understanding in speech, 3) reading letters, 4) writing letters, 5) physical movement, 6) understanding spatial relations such as right and left, 7) attention, 8) memory, 9) control of behavior, and 10) social relations. Each item was a description of behavioral characteristics, including behaviors often observed in LD children. The teachers were asked to check the appropriate items if the child showed such behavioral characteristics.

### 2-5 Standardized Developmental Scale (Intelligent Test)

We also used the WPPSI or WISC III as a Standardized Developmental Scale which gave us the current level of development of each child.

## 3 The first diagnostic experimental research

During the period from February until May 2001, we conducted the first diagnostic experimental research with about 190 five-year-old preschool children in five kindergartens and two nursery schools in order to identify children who were at high risk of LD and should be given special training for prevention of LD.

The procedures for conducting the screening tests varied, and depended on the condition of kindergartens and nursery schools (especially the numbers of 5 year-old children, and the degree of cooperation of the teachers). Ultimately, we established one system of diagnostic screening which can be applied in large kindergarten or nursery schools which have more than one hundred five-year-old children. A schema of this system is shown in Fig. 1.

1) The First Screening Test

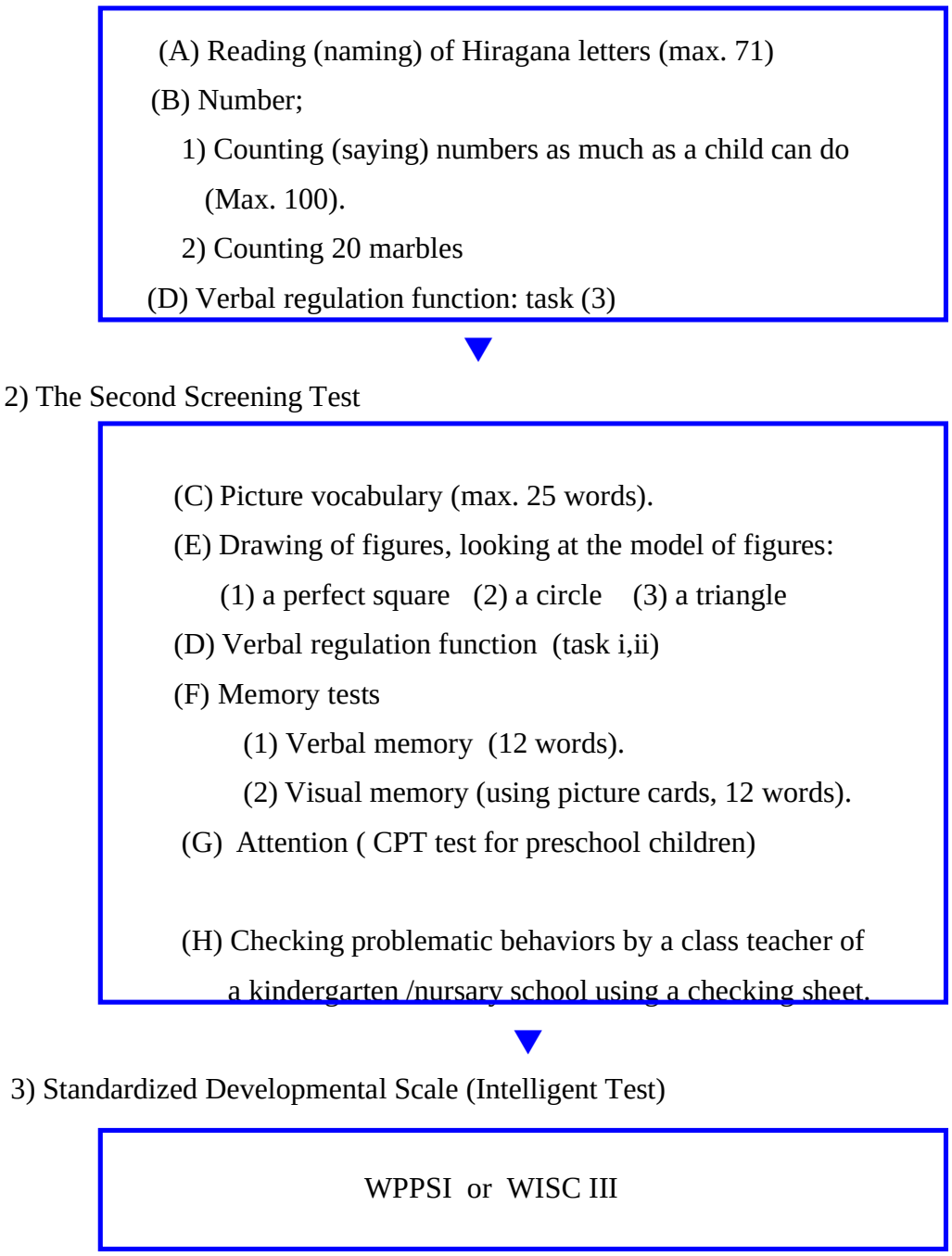


Fig. 1 The System of Diagnostic Screening Tests for Identification of Five -year-old Children at High Risk of LD

According to this diagnostic screening system, in the case of large kindergartens or nursery schools, we administered a first screening test to all five-year-old children

whose parents had given us consent. Then we administered the second screening test only to the children who were found to have remarkable deficiencies in one or more domains out of three; reading (naming) of Hiragana letters, counting numbers, and verbal regulation function. At the same time, we gave checklists to each of the classroom teachers and asked them to identify problems in the behaviors and the development of each child who participated in the second screening test. As a result of the analysis of the first and the second developmental screening tests, we identified the following three groups of children:

(a) Children who showed deficiencies in almost all seven domains.

(b) Children who showed remarkable deficiencies in two or more domains, for example in the domains of (A) reading, (B) vocabulary and (C) verbal regulation, or in the domains of (C) verbal regulation and (G) attention.

(c) Children who showed deficiencies only in one of the academic skills domains, that is in (A) reading or in (B) number, but not in other domains.

As it was possible that the above (a) and (b) groups of children had a high probability of being at high risk for either mental retardation or for learning disabilities, we administered the Standardized Developmental Scales, either the WPPSI or WISC-III to these groups of children. We also administered it to children who received very high scores on the checklist of problematic behavior based on teacher report. In the case of small kindergartens or nursery schools, we administered the seven tests from the beginning,.

We identified the children at high risk of LD by differentiating the children with high risk for mental retardation based on their performance on the Standardized Developmental Scale, either the WPPSI or WISC-III. Full scale IQ's of two children in the above (a) group were found to be below 60; they were identified as children with suspected mental retardation (MR.). Out of the 17 (b) group children, two were found to have Full-scale IQ's over 120 or over 100; thus, they were considered to be at low risk for LD. The 15 other children all scored below 100 in VIQ , PIQ, and Full scale IQ. These children were considered to be the children at high risk of LD. Thus, we found 15 children at risk of LD out of 189 children who participated in our diagnostic experimental

Table 1 The Various Ability Levels of the Subjects before Training.

| | Subjects | Age: Months | Sex | N.L (71) | Vocabulary (25) | Counting (100) | Counting 20 Marbles (20) | Verbal Regulation | Drawing (3) | Verbal Memory (12) | Visual Memory (12) | Attention % | WPPSI or WISC III* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | VIQ | PIQ | IQ |
| 1 | U.T. | 5:2 | m | 62 | 10 | 39 | 20 | IV | 2 | 1 | 6 | 92 | 68 | 83 | 70 |
| 2 | W.U. | 5:2 | f | 2 | 10 | 17 | 10 | II | 2 | 2 | 8 | 6 | 71 | 81 | 71 |
| 3 | S.Y. | 5:6 | m | 7 | 8 | 20 | 16 | I | 2 | 6 | 4 | 41 | 87 | 79 | 82 |
| 4 | I.K. | 5:1 | m | 3 | 10 | 10 | 11 | II | ? | 4 | 6 | 70 | 68 | 84 | 71 |
| 5 | O.K. | 5:6 | m | 2 | 14 | 10 | 10 | II | 1 | 7 | 2 | 2 | 94 | 74 | 81 |
| 6 | M.K. | 5:2 | m | 6 | 11 | 30 | 20 | II | 3 | 4 | 7 | 92 | 79 | 83 | 77 |
| 7 | K.M. | 5:4 | f | 0 | 16 | 39 | 17 | III | 1 | 6 | 5 | 69 | 87 | 80 | 80 |
| 8 | K.T. | 5:9 | m | 68 | 16 | 20 | 20 | IV | 1 | 3 | 8 | 83 | 81 | 68 | 72 |
| 9 | M.S. | 5:3 | m | 71 | 15 | 20 | 20 | IV | 3 | 3 | 8 | 67 | 99 | 68 | 82 |
| 10 | Y.A. | 5:2 | m | 0 | 8 | 20 | 14 | IV | 2 | 5 | 7 | 58 | 72 | 97 | 82 |
| 11 | T.Y. | 5:1 | m | 2 | 8 | 10 | 18 | II | 1 | 6 | 4 | 70 | 79 | 65 | 67 |
| MR | Y.D. | 5:9 | m | 0 | 10 | 10 | 11 | I | 0 | 5 | 1 | -6 | 60 | 54 | 48 |
| Age-Standard | | | | 50 | 16 | 52 | 18 | IV | 3 | 5.7 | 6.5 | 57 | 100 | 100 | 100 |

N.L.: The number of Hiragana letters which the child can read (name) out of 71.

Levels of Verbal Regulation:

Level I: The level in which the child cannot pass the (1) Red-Yellow Marble Conflict Test. Level II: The level in which the child can only pass the (1) Red-Yellow Marble Conflict Test. Level III : The level in which the child can pass the above (1), and also pass either the (2) Red-Yellow Marble Complex Conflict Test or the (3) Red-Yellow-Blue Marble Conflict Test. Level IV: The level in which the child can pass all of the above tests.

The value of attention means the value subtracted from the percentage of correct responses on the finding lions task the percentage of incorrect responses to others.

research. Additionally, there were some cases where the teachers of the kindergarteners participated in identifying those at risk. The actual ratio of identification of children at high risk for LD using our diagnostic system was 12/147, that is, about 8.1 percent.

Out of these 15 children, 11 whose parents consented to their participation became the subjects of our special training program. Their performance on tests and other characteristics before the training are shown in Table 1. We identified at least the following 4 subtypes among them. 1) Type 1: Children with significant deficiencies in reading (naming) Hiragana letters, numbers, vocabulary, verbal regulation having the tendencies of a so-called verbal LD, for example Y.A. and I.K. 2) Type 2: Children who have severe deficiencies in memory and attention in addition to weaknesses in verbal abilities, for example W.U. 3) Type 3: Children with deficiencies in spatial representation and kinesthetic functions, attention and visual memory, thus having the characteristics of a so-called non-verbal LD, for example O.K. 4) Type 4 : Children with hyperactivity, lack of control of actions, and deficiencies of spatial-motor skills in addition to weak verbal abilities, for example T.Y.

## 4 Language-cognitive teaching program for prevention of LD

### 4-1 Rationale for construction of teaching program

The purpose of this program is to develop in five-year-old children the fundamental psycho-pedagogical preparations necessary for learning in school (school readiness). There are various views as to what kinds of psychological functions should be promoted to develop readiness skills in five-year-old children at the risk of LD. In the present study I constructed our language-cognitive teaching program based on the following assumptions:

1. Language abilities, including reading and writing ability as well as grammatical-syntactic ability, lexical-semantic ability, are the most important components of school readiness.

2. It is essential that preschool children acquire fundamental reading abilities in Hiragana that will allow them to read texts constructed of the fundamental syllabic letters ([1]); this takes into consideration the fact that facilitating literacy ability in

[1] Japanese syllabic letters, Hiragana, consist of 71 fundamental syllabic letters and five special syllables.

preschool children has been the focus of four to five decades of research and that ninety-five percent of children acquire such reading ability in the preschool period(Muraishi,S.& Amano,K. 1972,Shimamura & Mikami , 1991, Amano,K.1994b)..

3. Concerning writing skills, children should be able to write Hiragana letters including writing each Hiragana in the correct form and using the correct order of strokes, thus acquiring knowledge of the basic orthographic rules of Hiragana.

4. It is also necessary to include in the program components which may promote the development of basic psychological functions such as perception of letters and figures, thinking, memory, attention, control of actions and behaviors, and fine motor function.

From the above assumptions, we determined that we could effectively promote school readiness in preschool children at risk for LD by using teaching programs modified from those which had been developed for LD school-age children (Amano,1994b 1997, 1998, 1999). Also, we believed that it was possible to construct a teaching program that could develop not only the above mentioned basic psychological functions (such as perception of letters and figures, thinking, memory, attention, control of actions and behaviors, and fine motor function), but also an interest and motivation in learning.

We constructed the following two programs.

(1) Introductory Hiragana reading and writing program for preschool children.

(2) Lexico-semantic-cognitive program based on classification activities.

The above programs exist as a software series developed by using “HyperCard” (Apple Com.) and “Flash”(Microsoft Com.).

### 4-2 Introductory Hiragana reading and writing program for preschool children

#### 4-2-1 The Structure of reading and writing program

Most of our subjects were five-year-old children who had no literacy skills or, at best, could only read and write some of the letters contained in their name. Thus, we were required to construct our reading and writing program to teach them from the beginning stages of early literacy, that is, from learning syllabic analysis, for reading, and from drawing pictures, for writing. In constructing the reading and writing program, we set our goal of forming and developing in children the basic abilities which would make it possible for them to read and write a first-grade textbook. More specifically, we were focused on improving their ability to read and write sentences constructed

using the fundamental syllables.

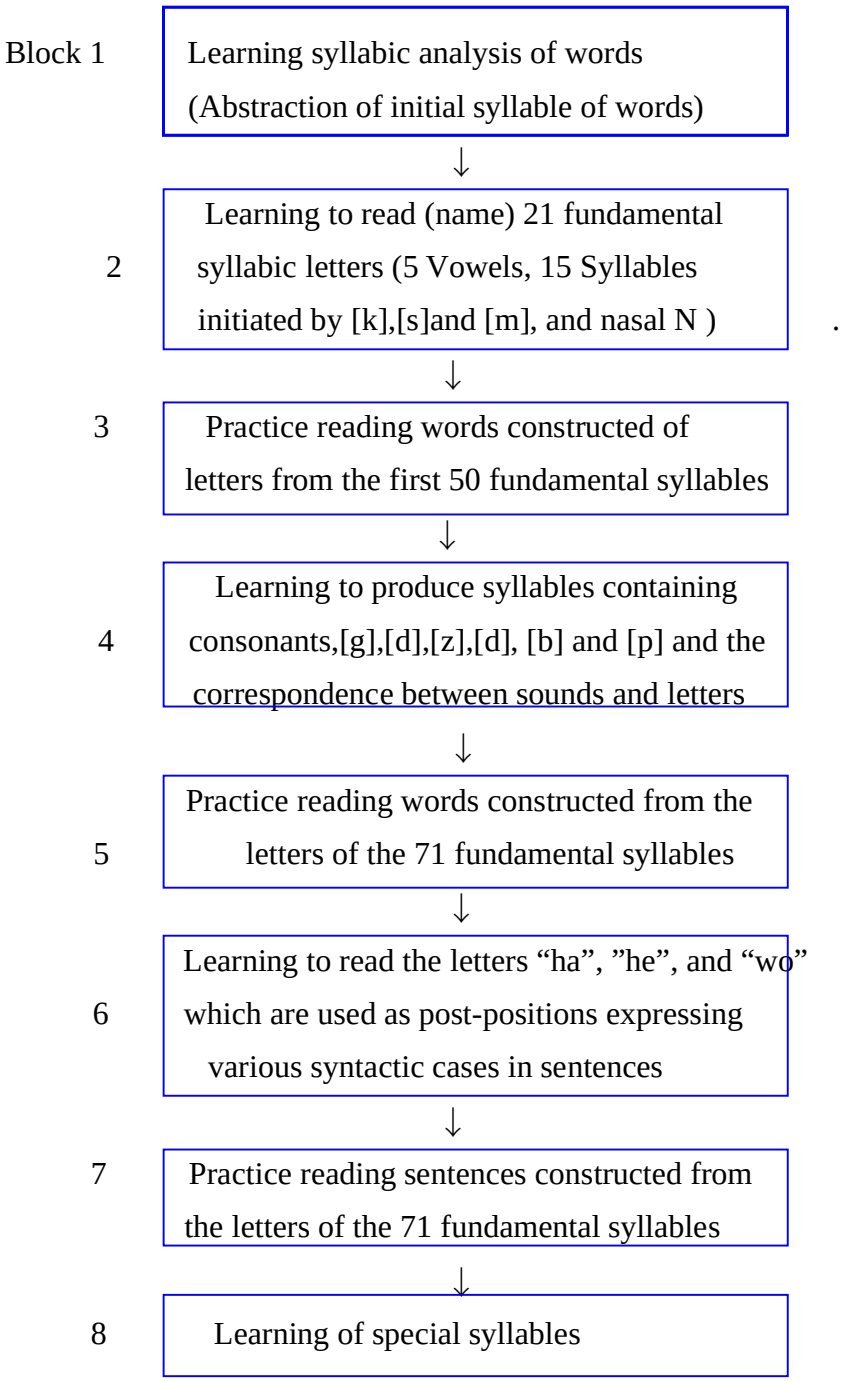


Fig.2 A diagram of the Hiragana reading program for five-year-old preschool children.

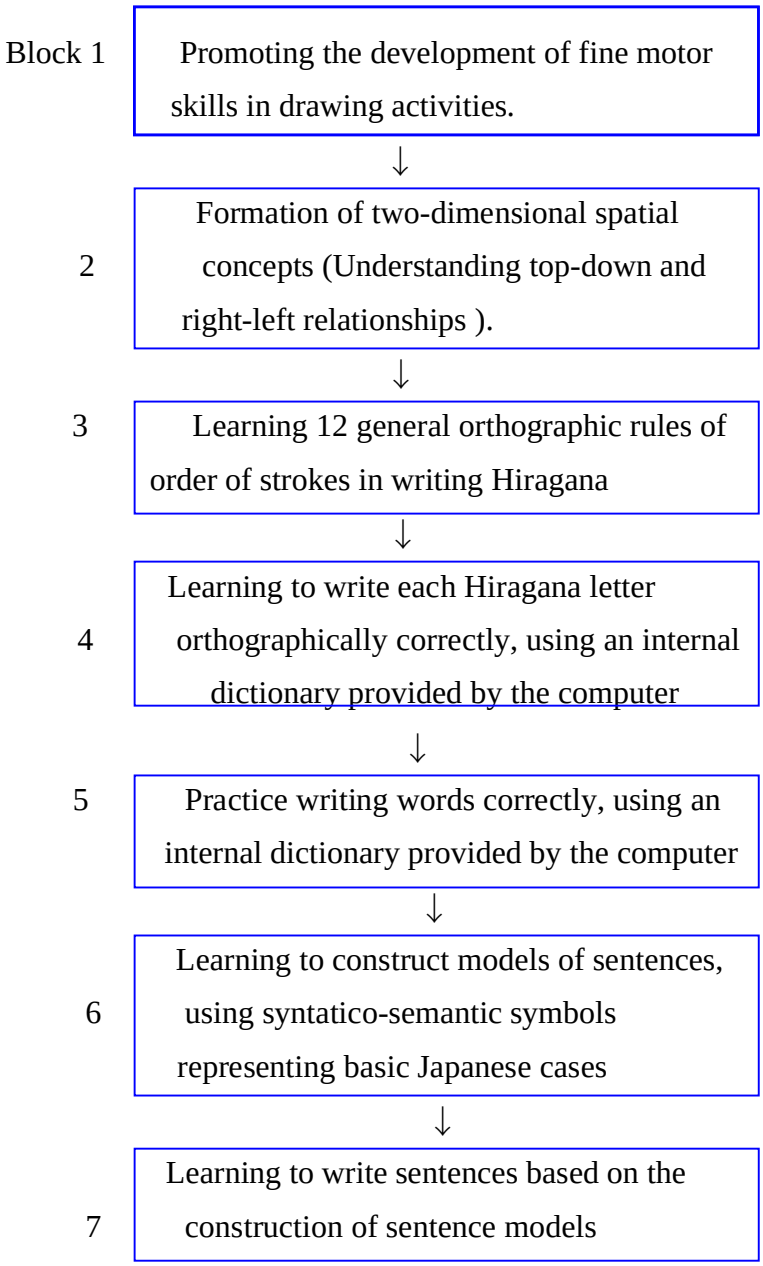


Fig.3 A diagram of the Hiragana writing program for five-year-old preschool children.

One of the most important characteristics of our reading and writing teaching program was that we taught basic literacy to each child using a computer as the main medium, while maintaining the dialogue between the trainer and child, and providing necessary help to the child. In a pilot teaching experiment with two five-year-old children conducted in 2000, we confirmed that even five-year-olds could accept instruction on the computer. The most important positive benefit of using a computer for teaching children at high risk for LD is the high probability of promoting the development of self-control. In addition, there is intensive attention during learning due to feedback mechanisms embedded in the software (e.g., a dictionary, which will be explained later) and rapid feedback provided in response to the actions of the children.

At the first stage of learning, children learn how to use the computer by manipulating the mouse. We developed 4 kinds of games which helped each child learn to manipulate the mouse. After the children were comfortable with the use of the mouse, they moved into the learning of reading Hiragana tasks. A diagram illustrating the teaching program for Hiragana reading developed and used in this training is shown in Fig.2. Also, the Hiragana writing program is shown in Fig.3. Below is an analysis of some important elements of these programs.

### 4-2-2 Learning to read (name) Hiragana

One of the distinguishing characteristics of our teaching program is that we did not instruct children directly on the sounds (name) of letters, rather we adopted a method in which each child discovered for him/herself the sounds (name) of letters. When the child reached the level of syllabic analysis in which he/she could abstract and identify the initial syllable of words presented orally, the child was thought to satisfy the prerequisite conditions necessary for learning to read Hiragana (Amano, 1986, 1989). Then we introduced the child to the following procedure on the computer:

5 First, we presented a letter, for example /A/ shown below, on the computer monitor.

2) If the child could not read it, we presented in the monitor a picture next to the letter of “ahiru”(a duck), which has the sound [a] in the initial position and three horizontal squares corresponding to the number of syllables in the word /ahiru/.

3) If the child could still not discover the sound (name) of this letter, the child was

asked to move a block from the side of the screen, onto the first square. When the child put a block into the first square from left, the letter [A] appeared under the button and the sound /A/ was spoken aloud by the computer.
(See Fig.4). The child was then asked to repeat the sound of the letter.

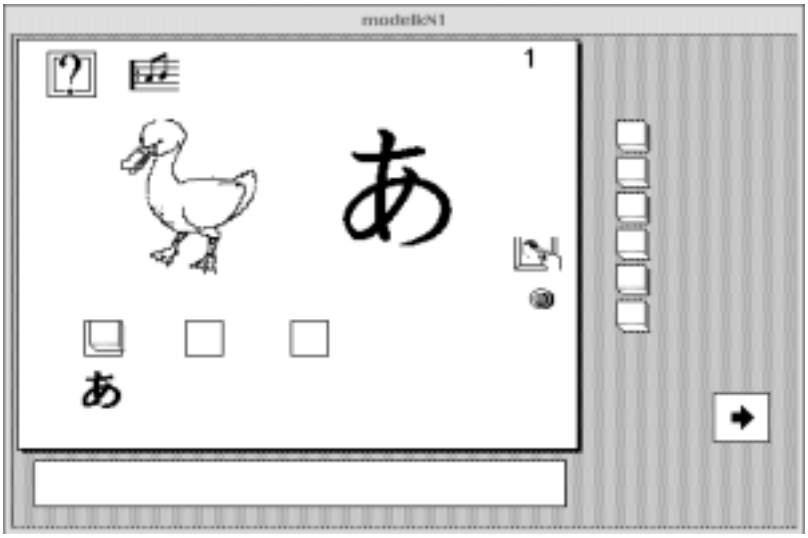


Fig.4 A picture of the monitor after the child has put a block on the first square from the left.

4) If the child still could not name the sound (name) of the letter in (3), the trainer taught him/her the sound.

Using this procedure, we introduced 10 letters to children in the first lesson and then gave them practice reading and constructing words composed of these 10 letters. During the training, children could look at cards arranged on the table; these cards are the ones which had been used during the introduction of the letters.

**4-2-3 The use of an internal dictionary on the computer during reading and writing training.**

The most important aspect of our computer-based reading and writing program may be the dictionary of Hiragana letters. This dictionary was not an ordinary one. It consisted of 71 cards inside the computer, and when a child was confronted with any letter which was difficult to read or write, he/she could refer to it and retrieve the necessary

information. Examples of cards from the dictionary and of the reading words task are shown in Fig. 5 and Fig.6.


Fig.5 One of the cards from the dictionary, which provides the child with information on how to read and write the letter [ ko]. /koma/ has /ko/ in the initial position of the word.

If the child confronted a letter difficult to read , for example [ ko] when he/she was attempting to read the word, [NOKOGIRI]（a saw), he/she could access the card for [ko] by clicking on the letter in the monitor (see Fig.6) thus, receiving additional information to help learn the sound of the letter. Similarly, if the child encountered a letter difficult to write in the writing task, he/she could access the card for the letter simply by clicking the letter in the word. Then the computer would show him/her how to write the letter correctly by presenting the order of strokes and the form of the letter through animation. In such a way, children could learn to read and write words in Hiragana very naturally, following a step-by-step process guided by a computer.


Fig, 6 An example of the reading task (software R3, made in Hyper Card)

**4-2-4 Preparatory training for learning to write Hiragana.**

As Hiragana letters originated from Kanji, Chinese characters, it is very difficult for children to learn to write them orthographically correctly. Hiragana has orthographic rules about not only the beginning and ending of each stroke, but also the order of strokes within each letter. Learning these rules requires children to learn spatial concepts, especially two dimensional coordinates, that is, the relationship of top-bottom and right-left. Of course, learning to write Hiragana, as with other letters, requires children to have well-developed fine motor skills.

We included three steps to prepare subjects for learning to write before training in writing Hiragana letters. As shown in Fig.3, the first block of training is designed to promote the development of fine motor finger movements in drawing activities, the second is to facilitate the formation of two-dimensional spatial concepts, such as understanding the relationship between top-bottom and right-left. The third training block is for learning 12 general orthographic rules about the order of strokes in writing Hiragana Letters. Here we will explain in detail how the computer teaches the second and third training blocks, by giving some examples of the tasks.

#### 4-2-4-1 Learning top-bottom and right-left relationships

The most important method for improving understanding of top-bottom and right-left relationships is to make children aware of their own right and left hands; once this is accomplished, children are then made aware of the right and left sides of objects in the outside world. In the beginning of the second training block, the trainer put a red ribbon on the child's right wrist and a yellow one on the left. Then he/she was given the task of following the model on the monitor. For example, in Task 2 shown in Fig.7, the child was asked first to observe and understand the model shown in left half of the monitor picture. Then the child was asked to create a similar pattern in the right half of the monitor by moving the blue, green, red and yellow buttons to the top, down, right and left sides of the person in the illustration. This was done by manipulating the mouse and naming each of the corresponding positions.

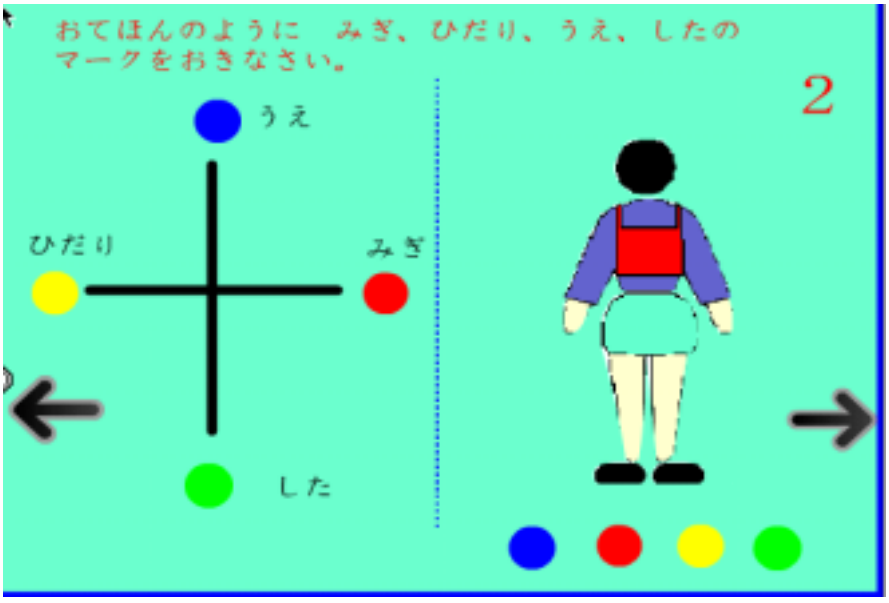


Fig. 7 Illustration of an item from Task 2 of Training Block 2

#### 4-2-4-2 Learning general orthographic rules for writing Hiragana

There are many orthographic rules for writing Hiragana which come from Kanji. We selected 12 rules which seemed to be the most general and basic for writing Hiragana. Below are some examples of these rules.

(1) A horizontal straight line should be written from left to right.

(2) An upright straight line should be written from top to bottom.

(3) When a horizontal straight line crosses a vertical straight line,

the horizontal line should be written first.

(4) Two horizontal lines should be written by starting with the upper line.

(5) Two vertical lines should written by starting with the left line.

(6) When two horizontal lines cross a vertical line the horizontal lines should be written first.

(7) A circle should be written clockwise.

(8) A line that goes around in a circle should be written clockwise.

The software program for teaching these rules consisted of 24 steps. The first 12 steps taught the child each rule by having him/her write directly on the monitor according to the rules. The other 12 steps served as practice in applying these rules to writing actual Hiragana letters. An example of the task of writing the Hiragana, ま /ma/, according to the rules is shown in Fig.8. In this figure, a red mark shows the starting point of writing and a blue mark shows the endpoint.

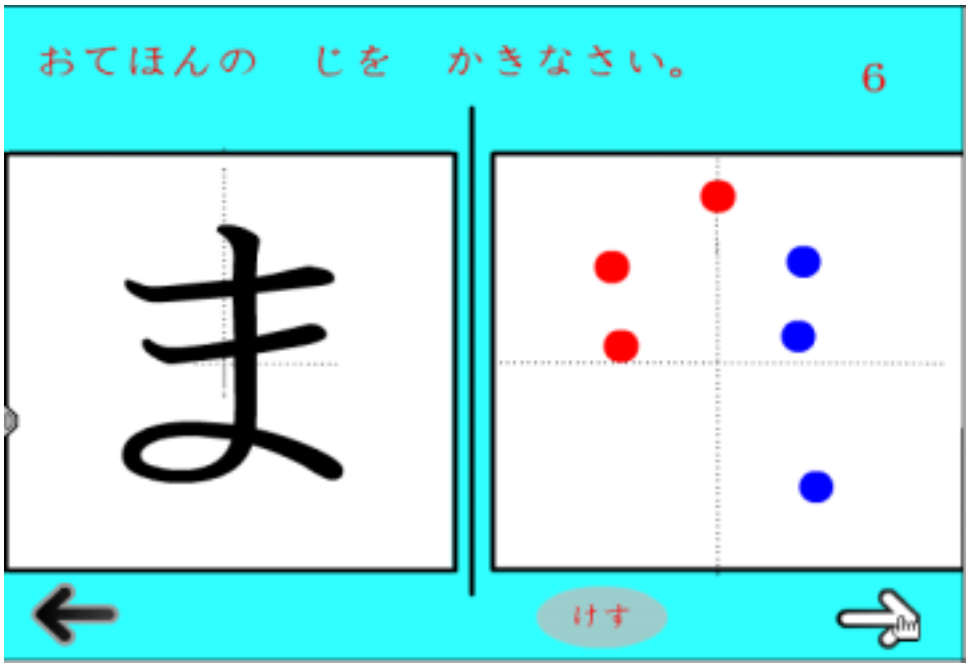


Fig.8 An example of a Hiragana writing task following the general orthographic rules of writing (/ma/).

**4-3 A lexico-semantic-cognitive program based on classification activities.**

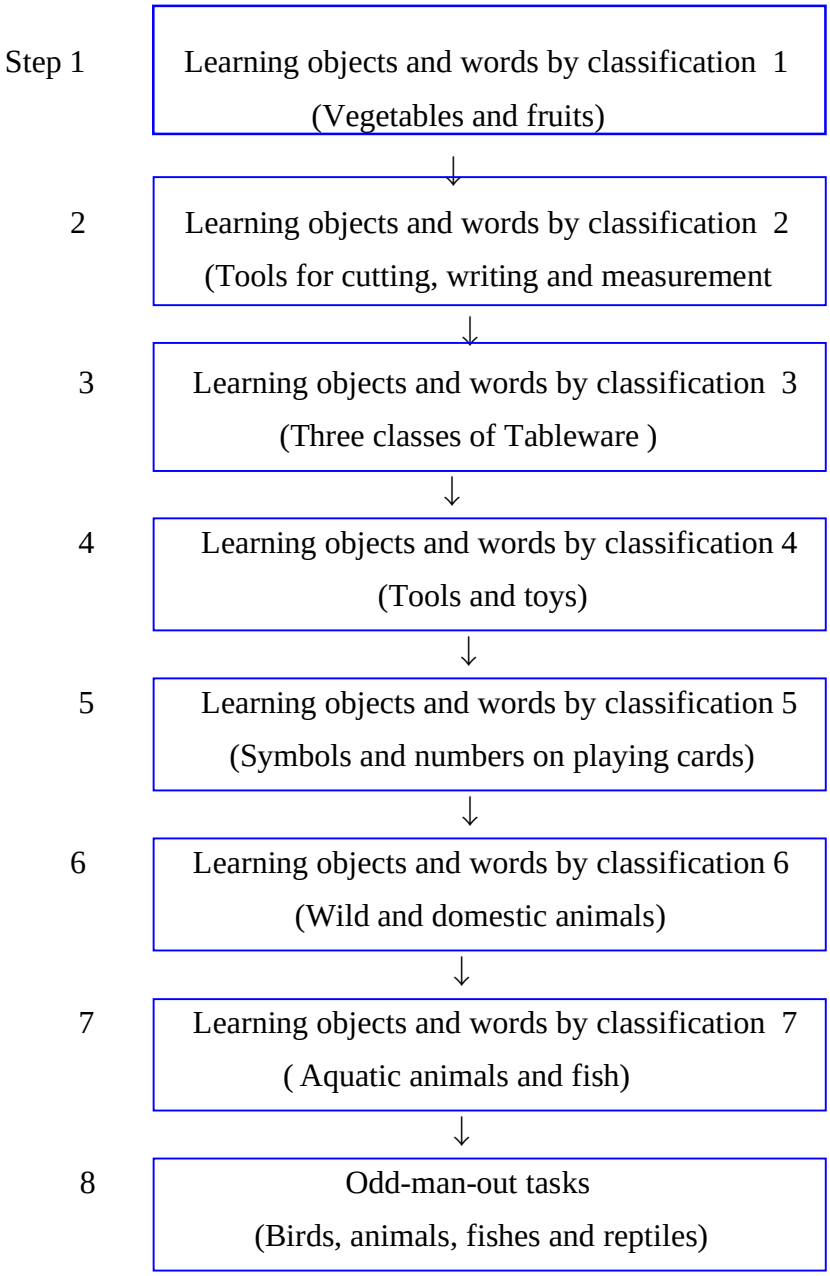


Fig.9 Flow chart of the lexico-semantic-cognitive program based on developing classification skills in five-year-old preschool children.

In order to promote children's lexico-semantic-cognitive abilities, we constructed a program consisting of 6 steps. The flow chart of the program is shown in Fig.9. This

program has three purposes: first, to familiarize children with various concrete objects from ordinary life and common animals to be used in training; second, to train them to classify these objects on the basis of a single dimension; third, to train them to generalize object classifications to higher order concepts such as class of object. In teaching this program, we did not use the computer, but used various concrete objects and plastic models.

In Step 2, ten objects, including a pencil, a pair of scissors, a scale, a crayon, a measuring cup, a small saw, a thermometer, a ball pen and a compass were presented on the table. First, the child was asked to name each object, (if he/she did not know the name, the examiner taught it). Then the child was asked to classify the objects into three groups by separating them into three dishes. If the child failed on the second trial, he/she was taught the use of the scale, measuring cup, thermometer, and compass. Then he/she was asked to attempt the classification a third time. After that he/she was asked to name the three categories which he/she had made.

## 5 Program teaching/learning procedures

Experimental training for our program was provided individually twice a week to five of the children (I.K., O.K., M.K., K.M., and T.Y.) in the observation room at Chuo University and to the other six children (U.T., W.Y., S.Y., Y.A., M.S., and K.T.) in the speech clinic center attached to the public schools in Kawasaki-City for approximately nine months, excluding one month's summer vacation, from the beginning of June 2001 until the beginning of March 2002.

The eight children who could read only some Hiragana or none and who remained at reading Level I or II, received training according to the schedule which is shown in Table 2. Because the learning abilities of these children were different, the tempo of learning varied. Two children (W.Y., S.Y.) could not perform the reading tasks in training block 8 and only three children (I.K., M.K. and M.S.) could perform the writing tasks of block 7. However, all children could learn to read sentences constructed by the fundamental syllable letters, despite the fact that all of the children except one (M.S.) read the sentences letter-by-letter. Three children who could read Hiragana letters and were already at the level IV before the training, began with the reading training block 3 in May. Their difficulty was mainly in

writing Hiragana letters.

Table 2 The general schema of the schedule of training in our program

| Phases | I | II | III | IV |
|---|---|---|---|---|
| Period | May-June | September-October | November-December | January-March |
| 1 Reading | B.1-2 | B.3-5 | B.6-7 | B.7-8 |
| 2 Writing | B.1 | B.2-4 | B.4 | B.5-7 |
| 3 Lexicon | - | - | St.1-5 | St.6-8 |

.

The most difficult tasks in their learning was learning to write each Hiragana correctly. Although they could master comparatively easily the tasks for learning the two dimensional spatial relationships and the general rules for writing Hiragana with the materials in the preparatory training, they required many repetitions of training in order to learn to write each Hiragana correctly. Of course, all children frequently used the internal dictionary of Hiragana in learning to write the letters.

The classification of objects tasks were found to be very difficult for our children. No children could classify correctly on the first trial the models of fruits and vegetables into two groups, which seemed to be the easiest for them. All children needed to repeat the tasks two or three times in order to classify objects into two or three groups at once. However, even though it was difficult for them to classify objects, all of them could learn the tasks in step 8, and their learning of classification of these objects seemed to promote the development of their vocabulary and knowledge of higher order concepts.

## 6 Evaluation of the effect of training by our program on children and of the diagnostic system for identifying high risk LD preschool children.

The most effective way to evaluate our teaching program might have been to create a control group of children by a pair-matching method and to compare the differences in their improvement on various tasks. However, we could not create such a control group for comparison mainly due to practical and ethical reasons. Instead, we decided to evaluate the teaching effect on the children in our study by conducting a series of school

readiness tests during March 2002 (the end of academic year ). We administered these tests not only to our training children, but also to children who had participated in our diagnostic experimental test and had been evaluated as children who were not at risk for LD. Conducting such school readiness tests in March to a group of normal control children who had participated in our diagnostic tests one year before should also serve as an effective evaluation of our diagnostic system for identifying high risk LD preschool children.

**6-1 Construction of school readiness tests.**

By adding some additional psychological tests to our diagnostic system, we composed a school readiness tests containing ten kinds of tests covering eight domains. A brief explanation of each area follows.

(A) Literacy:

(1) Reading 71 fundamental Hiragana and five kinds of special syllables.

(2) Reading and understanding sentences: 10 sentences constructed using fundamental syllable letters.

(3) Writing words constructed of 22 fundamental letters and 4 kinds of special letters

(B) Mathematics: (1) Counting numbers as high as possible up to 100

(2) Counting 30 marbles

(3) One-to-one correspondence counting 14 objects

(4) Conservation of number and length

(5) Elementary arithmetic operation: Similar tasks such as (2+3=, 4+6=, 5+7=) in the three levels( a concrete objective level, a semi-verbal and a verbal level),3 tasks in each level, 9 onens in all.

(C) Figure drawing; copying figures:

(1) a perfect square

(2) a circle

(3) a triangle

(4) a cross

(5) a Kanji [TA], which is composed by combining a perfect square and a cross

(6) a rhombus

(D) Visual Thinking

3. Ravens's colored progressive matrices test ( J.C. Reven, 1976)

4. Vengel's visual-figurative thinking test (L.A.Vengel and V.V. Kholmovskaya, 1978)

(E) Verbal Thinking: Ten odd-man-out tasks. Four words, for example, "apple," "peach," "pumpkin," and "banana," were presented orally and the child was asked to find the one that didn't belong and to tell the reason why. The answer was evaluated as correct, when the reason was categorical or rational. Ten tasks were given to children in all.

(F) Memory tests

1) Verbal memory test (12 words).

2) Visual memory test using picture cards (12 words).

(G) Verbal regulation tests : We added one more complex task to the previous test.

(1) Red-Yellow Marble Conflict Test: one additional.

(2) Red-Yellow Marble Complex Conflict Test:

(3) Red-Yellow-Blue Marble Conflict Test:

(4) Red-Yellow-Blue Marble Complex Conflict Test:

In test (4) we prepared 20 sheets of small cards, with a small red disk, a large red disk, a small yellow disk, a large yellow disk, a small blue disk and a large blue disk on the back of the cards. The experimenter gave the child the following instructions: "I am also going to turn over cards one after another, but this time when a large red circle appears, you must take a yellow marble and when a large yellow circle appears, you must take a blue one and when a large blue one appears, you must take a red one and put it into this glass bottle, but when a small red circle appears, you must take a red marble and when a small yellow circle appears, you must take a yellow one and when a small blue appears, you must take a blue one and put it into this glass bottle." Other procedures of the test were the same as earlier tasks. This task has been confirmed to be performed well by children by age six.

(H) Attention test: this was the same as the previous test.

This school readiness test was administered to all subjects and to about 60 preschool children in March 2002 in the four kindergartens and nursery schools in Tokyo and Kawasaki City from which our subjects came. Out of 60 children, 50 were children who

had participated in our diagnostic study in March 2001 and had been evaluated as normally developing children. We analyzed these children's data in order to obtain standard scores on the various tests at the age 6 just before school entrance in April.

### 6-2 Effect of special training to five-year-old children at high risk of LD.

The comparison between the performance of before-training tests and after-training tests of our subjects and the comparison of scores of after-training tests of our subjects with standard scores of six-year-old normal children just before school entrance are shown in the Table 3, Table 4 and Table 5. From this data we can identify very interesting and suggestive findings. We will analyze data on each problem in which we have an interest.

#### 6-2-1 Improvement of reading and writing abilities of the children

We conducted our language-cognitive training, focusing our attention mainly on the improvement of reading and writing abilities in Hiragana. In what ways have reading and writing abilities improved ? As shown in Table 3 and Table 4, the reading levels have changed dramatically. Before training one child (W.T.) was at Level I and six c hildren (S.Y., I.K., O.K., M.K., K.M., Y.A.,and T.Y.) were at Level III. As a result of our training, their reading abilities have shown remarkable progress, and on the post-tests, their reading levels were found to be at Level V, that is, the level of learning special syllables of Hiragana after having mastered reading the fundamental syllables. During the post-test, we gave each of them reading comprehension tasks in which ten sentences were presented on paper in the form of written questions for example, "Is it cold in the night of winter?", "Which do you like bread or rice ?", "Can you see the crescent and stars in the sky, when it is cloudy ?". The children were requested first to read the sentences aloud, and then to answer each question. Although nine children out of 11 in our training group still read the sentences letter-by-letter, four of the children could completely read them and answered correctly all ten questions; four other children could read and answer correctly more than eight questions. Only one child (S.Y.) could only answer six questions, but the other 10 children showed their performance to be similar to the normal group's standard scores (9.5). Three children (U.T., K.T., and M.S.) who were at the Level V before the training, improved to Level VII, where they could read sentences using a whole-word reading approach or by

reading sentences as a whole. They could read and answer the ten written questions almost completely in the post-test.

Table 3 The Levels of Various Abilities of the Subjects before Training in 2001.

| | Subject | Age: Months | Sex | Levels Of Reading * | V.Q.** | V. R. | Verbal Memory (12) | Visual Memory (12) | Attention % | WPPSI or WISC III | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | VIQ | PIQ | IQ |
| 1 | U.T. | 5:07 | m | V | 58.0 | IV | 1 | 6 | 92 | 68 | 83 | 70 |
| 2 | W.Y. | 5:02 | f | I | 62.3 | II | 2 | 8 | 6 | 71 | 81 | 71 |
| 3 | S.Y. | 5:06 | m | III | 53.6 | I | 6 | 4 | 41 | 87 | 79 | 82* |
| 4 | I.K. | 5:00 | m | III | 62.3 | II | 4 | 6 | 70 | 68 | 84 | 71 |
| 5 | O.K. | 5:06 | m | III | 83.6 | II | 7 | 2 | 2 | 94 | 74 | 81 |
| 6 | M.K. | 5:03 | m | III | 83.6 | II | 4 | 7 | 92 | 79 | 83 | 77 |
| 7 | K.M. | 5:04 | f | III | 82.6 | III | 6 | 5 | 69 | 87 | 80 | 80 |
| 8 | K.T. | 5:10 | m | V | 63.7 | IV | 3 | 8 | 83 | 81 | 68 | 72* |
| 9 | M.S. | 5:03 | m | V | 107.4 | IV | 3 | 8 | 67 | 99 | 68 | 82* |
| 10 | Y.A. | 5:02 | m | III | 42.1 | IV | 5 | 7 | 58 | 72 | 97 | 82* |
| 11 | T.Y. | 5:01 | m | III | 68.4 | II | 6 | 4 | 70 | 79 | 65 | 67 |

* Levels of Reading:

1) Level I is the level of ideography, where a child can not abstract and identify syllabic sounds of words.

2) Level II is the level where a child begins to abstract and identify initial syllable sounds of words.

3) Level III means the level of beginning reading, where a child begins to become aware of the sequence of syllables of words and can read (name) some letters in his/her name.

4) Level IV represents the level in which a child begins to read many letters very rapidly after he/she has learned to read about 20-25 letters.

5) Level V is the level in which a child begins to learn to read special syllables.

6) Level VI means the level where a child begins to transition from letter-by-letter reading to whole word reading when reading sentences.

7) Level VII means the level where a child can read sentences using whole-word reading or by reading sentences as a whole.

** V.Q.: Vocabulary Developmental Quotient: This quotient is the number of active words in a child's vocabulary as measured on a certain vocabulary test divided by the standard score for his/her age. If a child scores 100 on the VQ, it means that he/she had active Vocabulary which corresponded to the mean for his/her age. This V.Q. was calculated based on the research data studied by K. Amano and A. Ninomiya (1985).

Table 4 Levels of various subjects after training in 2001-2 and comparison of their performance with 6 year-old normal children.(1)

| | Subject | Age: Months | Sex | Levels Of Reading | V.Q. | V. R. | Verbal Memory | Visual Memory | Attention % | WPPSI or WISC III* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | VIQ | PIQ | IQ |
| 1 | U.T. | 6:07 | m | VII | 80.8 | V | 6 | 7 | 80 | 96 | 98 | 96 |
| 2 | W.Y. | 6:01 | f | V | 75.8 | III | 3 | 5 | 95 | 92 | 78 | 82 |
| 3 | S.Y. | 6:05 | m | V | 69.5 | V | 1 | 5 | 68 | 80 | 90 | 83* |
| 4 | I.K. | 6:01 | m | V | 96.8 | III | 4 | 4 | 80 | 90 | 84 | 92 |
| 5 | O.K. | 6:05 | m | V | 99.6 | V | 5 | 7 | 40 | 86 | 83 | 81 |
| 6 | M.K. | 6:02 | m | V | 98.5 | V | 7 | 7 | 60 | 81 | 78 | 76 |
| 7 | K.M. | 6:05 | f | V | 99.6 | IV | 6 | 7 | 87 | 107 | 97 | 103 |
| 8 | K.T. | 6:09 | m | V | 70.4 | V | 5 | 7 | 92 | 76 | 69 | 70* |
| 9 | M.S. | 6:02 | m | VII | 108.3 | V | 9 | 6 | 95 | 91 | 68 | 82* |
| 10 | Y.A. | 6:00 | m | V | 62.8 | V | 7 | 2 | 100 | 76 | 101 | 87* |
| 11 | T.Y. | 6:00 | m | V | 91,.0 | V | 6 | 6 | 82 | 100 | 80 | 88 |
| Age Standard | | | | VI | 100.0 | V | 5.9 | 7.3 | 56.7 | 100 | 100 | 100 |

* With these children IQ test was conducted using WISC III

Table 5 Levels of various abilities of subjects after training in 2001-2 and comparison of their performance with 6-year-old normal children.(1)

| No | Subjects | Read-ing senten ces (10) | Percent Correct in Writing Hiragana % | Draw-ing of figures (6) | Addi-tion (9) | Ravens's coloured progressive matrices test A (12) | B (12 ) | AB (12) | Venger's visual-figurative thinking test (44) | Verbal Thinking (10)* |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | U.T. | 10 | 77.2 | 3 | 8 | 8 | 6 | 6 | 32 | 4 |
| 2 | W.Y. | 9 | 86.4 | 4 | 4 | 6 | 4 | 6 | 23 | 0 |
| 3 | S.Y. | 6 | 40.9 | 5 | 6 | 9 | 4 | 5 | 32 | 4 |
| 4 | I.K. | 9 | 81.8 | 5 | 4 | 6 | 4 | 6 | 24 | 4 |
| 5 | O.K. | 10 | 86.4 | 4 | 4 | 7 | 3 | 2 | 14 | 5 |
| 6 | M.K. | 10 | 90.9 | 6 | 5 | 7 | 6 | 4 | 21 | 6 |
| 7 | K.M. | 10 | 63.6 | 5 | 3 | 8 | 5 | 4 | 21 | 9 |
| 8 | K.T. | 8 | 77.3 | 3 | 2 | 7 | 1 | 2 | 6 | 5 |
| 9 | M.S. | 9 | 100 | 6 | 5 | 9 | 10 | 7 | 36 | 7 |
| 10 | Y.A. | 8 | 95.4 | 5 | 5 | 10 | 10 | 6 | 29 | 4 |
| 11 | T.Y. | 10 | 95.5 | 5 | 3 | 7 | 3 | 2 | 23 | 4 |
| Age Standard | | 9.5 | 13.9 | 4.8 | 7.8 | 9.2 | 8.3 | 6.8 | 29.7 | 7.3 |

* The value presented in parenthesis under each item represents the maximum score of

This does not means that they have reached an average level of reading when compared to other children. We analyzed the distribution of children among the levels of reading development of the fifty children who participated in our school readiness diagnostic research. The result is shown in the Table 6. This data explains to us that our 11 children have barely entered into the lowest quarter of children with the same level of reading development.

Table 6 Distribution of Children among the Four Levels of Reading Development

| | IV | V | VI | VII | Total |
|---|---|---|---|---|---|
| Number of children | 3 | 12 | 9 | 27 | 50 |
| % | 3.0 | 24.0 | 18.0 | 54.0 | |

But quite different picture can be gained with improvement writing in children. Each child spent much time learning to write Hiragana correctly based on the orthographic rules in our training. As shown in Table 5, they showed very high performance on the Hiragana writing test. Even in the worst case (K.M.), the child's performance in writing words (letters) is 63.6 % correct, and many children in the training group showed more than 80 % correct in the writing test. As preschool children always write Hiragana neglecting orthographical rules about the order of strokes, the standard scores of normal developing preschool children in writing letters was found to be extremely low, that is 13.9 %.

### 6-2-2 Improvement of the Lexicon in Children in the Training.

In our training we have tried to promote children's lexico-cognitive development through teaching them to classify objects and animals along a single dimension. How did such training have an effect on their development in this domain? When we compare the values of V.Q. of each child between the pre-test (Table 5) and the post-test (Table 6), we can see that the values of V.Q. of all children improved significantly, during the training period, especially in children whose V.Q. were very low before the training. For example, the V.Q. of the child, I.K. changed from 62.3 to 96.8 (the difference is 34.5) and with other three children, U.T.,Y.A. and T.Y. the values of the V.Q were found to have improved by over 20 and with other three children, S.Y., O.K., and K.M., over 15, during the training period. These facts clearly show that our lexico-cognitive training program had a notable effect on their vocabulary development.

### 6-2-3 Improvement of attention, verbal regulatory function (Verbal control of behavior) and verbal memory

As I described earlier, we had hypothesized that teaching reading and writing using the computer had a high probability of promoting the development of attention and

verbal self-control of behavior. Was there data to support this hypothesis from our training study? A comparison of the performance on the CPT during the pre-test and the post-test tells us an important fact that all five children who showed comparatively weaker performance before the training, that is, W.T., S.Y., O.K., M.S., and Y.,A., showed high performance on the post –test of CPT.

This is also true of performance in the domain of verbal regulatory function (verbal control of behavior) and verbal memory. In the pre-test, seven children out of 11, (all except four children, U.T., K.T., M.S. and Y.A.), showed very low levels in the verbal regulatory function tasks. But their verbal regulatory functions improved gradually and on the post-test, four children reached Level V, one reached Level IV and the other two Level III. The three children who could recall only one to three words in verbal memory on the pre-test, that is, U.T., K.T. and M.S. could recall more than 6 words on the post-test. These facts suggest that our training program contributed positively to children's development, not only in the domains of reading and writing, but also in the domain of the basic psychological functions which serve as the basis for acquisition of reading and writing skills.

### 6-2-4 Improvement of General Abilities of Children during the Training Period.

When we compare the data between Table 3 and Table 4 in the respect to IQ, we can easily recognize that at least five children showed remarkable improvement in their VIQ, PIQ and IQ during the training period. In particular, four children U.T., I.K., K.M., and Y.A. showed an improvement in their Full Scale IQ of over 20 points and W.Y. showed an improvement of over 10 points. An interesting common characteristic in the improvement of Full Scale IQ observed in these five children is that improvement of VIQ of over 20 points is always accompanied by improvement of attention (with one exception, U.T.). Of course, there are some cases in which improvement of Full Scale IQ is related to improvement of PIQ , as is the case with U.T., K.M. and T.Y. It is very difficult for us to explain all of the factors that have affected the improvement of children's IQ in the processes of our training to them. At the present it is even more difficult for us to explain the phenomena that some children do not show any improvement in VIQ or PIQ, despite their acquisition of reading skills and their remarkable improvement in various domains of language-cognitive functions (for

example, S.Y., O.K., and M.K.).

# 7 Discussion

I have described a research project conducted over the past academic year focusing on the development of a language-cognitive program for prevention of LD in the preschool period. This project included the development of a screening system, a teaching program and a one-year experimental training program. Now, I would to like to discuss some important issues related to the screening and the training.

## 7-1 Is our diagnostic system appropriate for the identification of preschool children at high risk of LD ?

We constructed a screening system designed to identify preschool children at high risk of LD and administered it to approximately 190 five-year-old preschool children. The most important criteria in the development of a diagnostic system is to create a system which would minimize the likelihood of missing a child who is actually at high risk of LD. In conducting our screenings, we made evaluations based on three criteria, as shown in Fig.3

First, when a child performed well on two of the tests of pre-academic skills (reading Hiragana, counting numbers, and counting 20 marbles) and the task of verbal regulation, he/she was determined to be a child who has no risk of LD.

Second, when a child did not show any retardation in the seven cognitive psychological domains, even if he/she showed clear retardation only in one of the pre-academic domains, he/she was determined to be a child who has no risk of LD.

Third, when a child had a Full-Scale-IQ below 60, we identified him/her as a child at high risk of MR.; that is, we used a score of 60 on the Full-Scale-IQ as a criteria for differentiation between MR suspect and LD suspect children.

Concerning the above two points, we tried to analyze whether these criteria missed children at high risk of LD based on data from school readiness research conducted just before school entrance. As a result of this analysis we confirmed that the first selection was valid, and that we had not missed any children at high risk of LD. The success of the first level of differentiation between children at risk of LD and those with no risk of

LD owes much to the strong diagnostic power of the verbal regulation task modified from A.R. Luria's method. A child who has any deficiencies in language acquisition or in memory or in attention or in control of action could not perform the verbal regulatory tasks as well as their five-year–old peers. Thus, this task was suitable for differentiating LD and MR children from normal developing children.

Concerning the second criterion, we found problems that warrant further examination. We will consider some data from the school readiness research conducted to fifty preschool children just before school entrance. From the data on the fifty preschool children who participated the both tests in spring 2001 and 2002, we identified the following three groups:

A group : Children who were evaluated as having no risk of LD from the first screening test; that is, those who passed the criteria from the first screening.

B group: Children who had deficiencies in reading Hiragana, but did not have any deficiencies in the seven other psychological domains. They were evaluated as having no risk of LD in the second level screening.

T group: Children who were identified as having a high risk of LD and had participated in the special training of our program for about 8 months before school entrance.

We compared these three groups on the following:

(1) Level of reading development
(2) Performance on the reading sentences test
(3) Performance on the writing letters test
(4) Performance on the verbal thinking test
(5) Level of development of verbal regulation

The results are shown in Table 7- Table 11. As shown in Table 7, 8, and 9, the level of reading development and performance on the reading sentences and writing letters tasks was higher for the training group than for B group children This is natural in the sense that the training group received special training in reading and writing in Hiragana. There was one boy who could not read or understand sentences at all in the B group.

Table 7 Comparison of the Levels of Reading Development among Three Groups Just Before School Entrance

| | IV | V | VI | VII | Total |
|---|---|---|---|---|---|
| A group | 0 | 3 | 1 | 8 | 13 |
| B group | 3 | 4 | 1 | 0 | 8 |
| T group | 0 | 3 | 1 | 7 | 11 |

Table 8 Comparison of the Performance of Reading Sentences Test among Three Groups just before School Entrance (Max. 10 points)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 13 |
| B | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 4 | 8 |
| T | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 2 | 2 | 5 | 11 |

Table 9 Comparison of the Performance of Writing Letters Test Among Three Groups just before School Entrance (Max. 22 points)

| | 0-5 | 6-10 | 11-15 | 16-22 | Total |
|---|---|---|---|---|---|
| A group | 1 | 2 | 6 | 4 | 13 |
| B group | 2 | 3 | 3 | 0 | 8 |
| T group | 0 | 1 | 1 | 9 | 11 |

Table 10 Comparison of the Performance of Verbal Thinking Test Among Three Groups Just before School Entrance(Max. 10 points)

| | 0-4 | 5-6 | 7-8 | 9-10 | Total |
|---|---|---|---|---|---|
| A group | 1 | 2 | 6 | 4 | 13 |
| B group | 0 | 2 | 6 | 0 | 8 |
| T group | 6 | 3 | 1 | 1 | 11 |

Table 11 Comparison of the Levels of Development of Verbal Regulation t Among Three Groups just before School Entrance

| | III | IV | V | Total |
|---|---|---|---|---|
| A group | 0 | 0 | 13 | 13 |
| B group | 0 | 0 | 8 | 8 |
| T group | 2 | 1 | 8 | 11 |

We began to inquire why he could not read and understand sentences at all by asking his mother and by conducting the WPPSI test and reading test again. Of course, I suspected the possibility of having our misdiagnosed him in our screening. But his delay was found to have come from quite a different environmental and educational source. His mother had removed all written materials, including lists of Hiragana from his home so that he would not become angered by his sister had acquired Hiragana before him and wrote many letters proudly before him. The result of WPPSI test showed that he was a normally developing child. Although we did not believe that this case was a misdiagnosis, but it suggested the importance of careful examination. That is, when a child shows clear retardation in only one of the pre-academic domains, and no deficiencies in the main cognitive–psychological domains, we can evaluate him/her as a child with no risk of LD, only if we inquire into the reason for the retardation in that pre-academic area.

Concerning the third criterion of MR. vs. LD, we examined this problem in the experimental training. In Japan when the Full-Scale-IQ of a child is below 70, he/she is generally considered to be MR or MR suspect. But in our study we did not accept such a cut-off. Instead, we tentatively accepted 60 as a cut-off for differentiation between MR and LD and tried to examine this criterion itself in the training experiment. There is a child, whose Full-Scale-IQ was below 70 and above 60, (T.Y.: VIQ:70, PIQ:65, IQ:67). We considered him to be a child at high risk of LD and included him in our training program. As a result of his participation in our special training for 8 months, his IQ changed remarkably, that is, into the values, VIQ:100,: PIQ :80. IQ: 88. This fact actually shows that he is not a MR child, but a child at high risk of LD who has large potential learning abilities.

Another MR suspect preschool child, Y.D.(VIQ: 64, PIQ:54, Full-Scale IQ: 48 before the training) participated in our training experiment under the same conditions as the others. His learning abilities were far lower than others, but he could learn to read words using the 71 fundamental Hiragana after 8 months training, even though he could not learn to read sentences yet. Now, he is learning how to write Hiragana. As a result of 8 months' learning in our program, his verbal IQ has shown remarkable progress, (VIQ:84, PIQ:49, FULL-Scale-IQ: 60). This result suggests that he is not LD, but MR children.

Generally speaking, we can say that our diagnostic system for identification of children at high risk LD was comparatively successful. However, we need elaborate on our system further based on a detailed analysis of data from the first diagnostic research and school readiness research study conducted in this academic year.

### 7-2 What are the benefits of a systematically organized teaching program for learning basic reading and writing?

In the previous section we have shown that our teaching program led to an improvement not only in preschool children's ability in reading and writing, but also in their basic psychological functions such as attention, verbal regulation and verbal memory, and sometimes in general abilities.

Of course we can not attribute such large scale improvement in children over various domains only to our teaching (training) program. Every day, each child played and learned in his/her home and kindergarten or nursery school with other children under the supervision of teachers and parents, and he/she enjoyed many experiences through his /her own activities. In this sense, the improvement shown in our data is a product of all of the activities and situations in which the children have lived. But what role did our strictly organized teaching (training) play in their development or improvement? Where is the difference between children's own spontaneous learning in home or in kindergarten (or nursery school) and teaching/learning by our structured program? In order to answer this problem, we would have needed to conduct special experimental observations in both groups, or to have a training group and a control group. As I said earlier, we were not able to include a control group mainly due to practical and ethical reasons. In order to analyze the effect of training of the program itself, we could prepare a comparison group which consisted of children similar to those in the training group who were at risk of LD. However, there was no one-to-one correspondence between subjects between the groups as in a matched-pair control group..

Our comparison group consisted of five five-year-old preschool children at high risk of LD. Three of these were children who had been identified among the 15 children at high risk of LD during the first diagnostic research study, but did not participate in the training due to either geographical reasons or lack of parental consent. The other two children were identified in the other research project. Some of these children had

deficiencies in reading in Hiragana, but others did not. They all shared some retardation either in attention or in verbal self regulation. The result of the both diagnostic tests administered in spring 2001 and 2002 are shown in Table 12 and Table 13 respectively.

Table 12 The Results of Tests of the Comparison Group in Spring 2001

| | Subject | Age: Months | Sex | Level Of Reading | V. R. | Verbal Memory (12) | Visual Memory (12) | Attention % | WPPSI or WISC III | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | VIQ | PIQ | IQ |
| 1 | U.K. | 5:03 | m | V | III | 3 | 8 | 21 | 64 | 68 | 59 |
| 2 | O.R. | 5:01 | m | V | I | 7 | 5 | 14 | 80 | 72 | 79 |
| 3 | N.M. | 4:11 | m | III | IV | 5 | - | 13 | 90 | 92 | 89 |
| 4 | S.Y. | 5:08 | m | III | II | 3 | 7 | 93 | 85 | 71 | 76 |
| 5 | N.K. | 5:11 | m | III | IV | 5 | 6 | -48 | 96 | 83 | 89 |
| Age Standard | | | | IV | IV | 5.7 | 6.5 | 57 | 100 | 100 | 100 |

Table 13 The Results of Tests of the Comparison Group in Spring 2002.

| | Subject | Age: Months | Sex | Level Of Reading | V.R. | Verbal Memory (12) | Visual Memory (12) | Attention % | WPPSI or WISC III | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | VIQ | PIQ | IQ |
| 1 | U.K. | 6:03 | m | VI | V | 2 | 3 | 92 | 67 | 82 | 72 |
| 2 | O.R. | 6:02 | m | VII | V | 1 | 6 | 32 | 89 | 78 | 80 |
| 3 | N.M. | 4:11 | m | V | V | 5 | 6 | -67 | 89 | 89 | 86 |
| 4 | S.Y. | 6:05 | m | V | IV | 7 | 7 | 48 | 81 | 78 | 77 |
| 5 | N.K. | 6:10 | m | IV | IV | 5 | 7 | 44 | 103 | 107 | 105 |
| Age Standard | | | | VI | V | 5.9 | 7.3 | 56.7 | 100 | 100 | 100 |

When we compare these two tables, we can easily recognize that the levels of reading development have improved during one year, with three children improving

from level III to level V or IV and two children from V to VI or VII. This degree of improvement is very similar to that of the children in the training group. This is also true of improvement of verbal regulatory function. Three children, whose level in verbal regulation was at the level I or II or III in 2001 improved to level V or IV after one year. One child whose level was IV one year before improved to level V in spring 2002. These facts suggest that improvements in the level of reading development and verbal regulation are very similar between the group of children who underwent special training and the group of children who did not.

However, when we examine the data on performance on the attention tasks, we see quite a different picture. As is shown in Table 4, performance on the attention test (CPT) of almost all children in the training group is remarkably high and always higher than the age standard in spring 2002. In contrast, performance of four out of five children in the comparison group are considerably lower and below the age standard. This suggests although they have learned to read words and sentences, their learning of Hiragana alone did not necessarily promote the development of voluntary attention. In contrast, the organized learning contained in the teaching program appears to have promoted the development of voluntary attention in the training children. Of course, this is only a suggestive finding obtained from a very small sample. Thus, it will be necessary to confirm this finding in a larger samples of children in order to characterize the effects of this organized teaching/learning structured program.

## 8 On the possibility to prevention of LD

The main purpose of our project was to develop a way of preventing LD through organizing screening and special education intervention in the preschool period. In the last academic year, we completed the first cycle of the project, including a diagnostic screening project, an experimental training for 8 months and a diagnostic school readiness program. The results of these projects allow us to discuss the possibility of prevention of LD in children.

There seems to be different phases or stages not only in the manifestations of LD, but also in the prevention of LD in children. Our experimental training focused on the initial

manifestations of LD observed during first grade. In other words, we wanted to prepare children at high risk of LD for the issues they might encounter soon after they entered school such as difficulties with learning to read, attend to their teacher, maintain continuous performance, make a friend, etc. The results of our study suggest that our special training has successfully prepared our children for these issues. In this sense, we were able to prevent at least the first uprising of LD difficulties. However, this does not mean that we can or could prevent the next phase of emergence of LD issues.

As our school readiness research has shown (Table 5), our children have many deficits or difficulties across various domain. If we compare their performance on the different tests with age standard norms, they are superior to average only in the tasks of writing Hiragana, drawing, and in voluntary attention, tasks in which they have acquired specific training. This research also found out that they were very weak in verbal thinking, visual thinking, arithmetic (addition), and spatial orientation. Some students were very poor in verbal memory or visual memory. Thus, even if they were able to deal with the first difficulty well, there is a high probability that they will experience difficulty in the next phase of school life.

As such, we plan to continue their training in our next program to take place this academic year. The goals of this second stage program are prepare them for the next set of difficulties which they may confront in the near future. This project aiming to prevent LD is quite a new type of research project, thus, we expect to confront many kinds of problems which will warrant further study. I believe that such research focused on the prevention of LD is very promising and will open a new perspective for LD education in the future.

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