

Strategies for Reading and Writing Learning Difficulties (Dyslexia)



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1 Introduction

Advancements in brain research have made it possible to understand the functionality common to human beings, as well as to analyze the diversity of functions in individuals. It is widely accepted that there are people who display normal brain function and are able to live independently, but have difficulty in some types of task and require greater effort than other people to accomplish such tasks, which in turn disadvantages them. Looking back to one's elementary school years, many may remember classmates who could speak fluently in ordinary conversation, but when asked to read a textbook out loud in class, became flustered or struggled to answer a question about the content of the textbook. This is also true of reading English texts out loud in class in junior high school, high school, and college. Although people are required to read out loud less and less frequently as they become older, many preschool, school and college students suspected of having developmental dyslexia (hereafter referred to as "dyslexia") will have lifelong difficulties such as slow reading and writing speeds, frequent misreading, leaving out words while reading, and misspelling. Since oral and silent reading and writing hold an important position in school education, in many workplace activities, and for improving vocational competence, people with dyslexia are often deprived of the opportunity to demonstrate and promote their talents because of their reading and writing difficulties, even though they have normal or above-normal ability in other areas. Furthermore, lack of chances to make best

use of their talents and being misunderstood by others as having little talent or ambition may lead to loss of self-confidence, anxiety, stress and alienation, and ultimately may cause psychosomatic disorders, which in turn leads to dropping out from school and withdrawal from society.

It is necessary to establish a support system that helps teachers to identify early children with reading and writing disabilities when they begin elementary school, and take necessary measures in a timely manner, to ensure that children with dyslexia are able to learn in normal classes, develop their potential, and live fulfilling lives. For this purpose, it is necessary (i) that research on the current situation of dyslexia in Japan be conducted, and (ii) that research on causes and cases of dyslexia, as well as methods for early diagnosis with high accuracy and sensitivity, be promoted, and (iii) that research and development of support systems and teaching materials for people with dyslexia be fostered.

2 What is Dyslexia?

2-1 Definition

Developmental dyslexia ('dyslexia' hereafter) is a specific difficulty in learning to read and write caused by perturbed development of neuronal bases for reading and writing, without accompanying intellectual sensory or motor disabilities, lack of concentration or motivation, or family or social hindrances^[Note]. In the domains of neuroscience, clinical medicine, and psychology, the English term "developmental dyslexia," along with its Japanese translation "hattatsu-sei nandoku-sho (developmental

reading difficulty)” or simply “dyslexia” have been traditionally used. These days, however, the terms “hattatsu-sei yomi-kaki shogai (developmental reading and writing difficulties)” and “dyslexia (written in Japanese characters)” are preferred by some people. The term “dyslexia” is used throughout this article because a plain term that does not implicate defect is desirable for the convenience of people with dyslexia and their families. It is recommended that in the future, specialists and knowledgeable people be invited to discuss and determine an appropriate term that can be commonly used in society.

2-2 Prevalence Rate of Dyslexia

The prevalence rate of dyslexia from a neurological viewpoint is the same among different societies and nations, and reportedly, 6 to 10% of the entire population have a predisposition to some degree of dyslexia^[3-5]. For people with dyslexia, it is especially difficult to read a language where the relationship between the orthography and the pronunciation of words is not consistent. The less consistent the sound-spelling relationship, the higher the risk that children with dyslexia have difficulties in the process of language acquisition. As far as the Japanese language is concerned, the relationship between kana letters and their sounds is consistent, and the meaning of fundamental

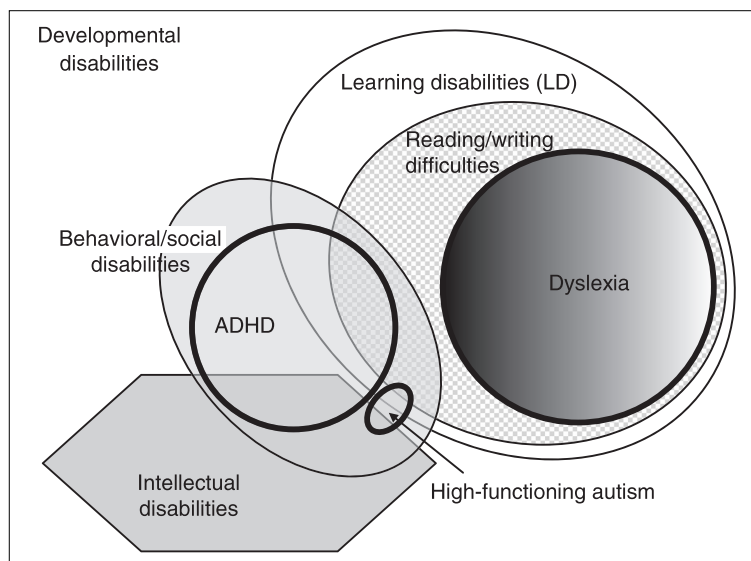
kanji letters can be assumed from their structure even if their pronunciation is not known. For this reason, it appears that dyslexia difficulties manifest themselves as explicit problems less often in Japan than in other countries. However, because a comprehensive survey has not yet been conducted in Japan, this cannot be firmly concluded. Detailed research conducted at 3 public elementary schools (Grades 1 through 6) in two cities (with a population of 400,000 and 50,000, respectively) has shown that 1%, 2 to 3%, and 5 to 6% of students appear to be dyslexic when reading out loud hiragana, katakana, and kanji, respectively, and 2%, 5%, and 7 to 9% of students are diagnosed as being dyslexic when writing hiragana, katakana, and kanji, respectively^[6].

2-3 Position of Dyslexia in Reading and Writing Disorders

Dyslexic people can read and write but only slowly and with higher propensity to make errors. Dyslexia is distinguished from alexia that is characterized by a complete inability to read.

Etymologically, dyslexia (dys + lexia) means “reading difficulties.” In acquired reading disorders caused by a stroke, external injury, or tumor after language ability has been acquired, only reading may be disturbed by focal damage. When the damage is spread over diverse areas,

Figure 1 : Position of dyslexia relative to developmental disabilities such as reading and writing difficulties (basic concept)



It is estimated that about 10 % of all children have a predisposition to dyslexia. The degree to which symptoms manifest themselves depends on the severity of the condition and the language. For theories on overlapping of the disorders, refer to related journal articles.

complex symptoms may occur. A symptom may be reduced to separate components, and each component is analyzed regarding functional localization in the brain^[10]. Neurologists and language therapists specialized in acquired reading disorders take part in treatment. For developmental dyslexia, the ability to read and write, short-term memory and the retrieval of letters are affected, although there are individual differences in the degree of severity for each component. During the development of the brain, specialization of the common brain areas for linguistic abilities (the language area) begins in the fetal period, before children are exposed to spoken language. In dyslexia, a portion of the language areas responsible for reading and writing is selectively affected by certain inherent factors. These days, dyslexia studies focus on the relationship between the affected locus and aspects of difficulty. In this case, pediatricians, pediatric neurologists and language therapists specialized in the developmental stage are involved in treatment.

For children with attention deficit disorders,

attention deficit hyperactive disorders (ADHD) and high-functioning autism, (i) there are many cases where the development of brain loci associated with reading and writing is affected, so that reading and writing difficulties appear as one of the complex symptoms, and (ii) there are cases where lack of concentration or interest in interaction or linguistic communication with others prevent the acquisition of reading and learning skills. Considering the current situation described below, it is necessary to immediately conduct a survey on the actual situation of dyslexia in Japan to clarify the distinction from other similar disorders, to provide proper diagnosis and support, and to disseminate accurate information to those in clinical practice and in education.

- (i) Attention tends to be more directed to autistic children and children with ADHD, those who have problems with behaviour and social skills, as well as to children with hearing and speech disabilities. In contrast, for children with dyslexia who have no

Figure 2 : Examples of misreading and miswriting

		Fault	Correct
a. Misreading	1	<i>kona-o-atsumeru</i> (collect powder)	<i>kona-o-neru</i> (knead powder)
	2	<i>oniku-ga-oishii-desu</i> (this meat is delicious)	<i>oniku-ga-yasui-desu</i> (thid meat is inexpensive)
b. Miswriting	1 Hiragana		sakana (fish)
			megane (glasses)
b. Miswriting	2 Kanji		(word, bird, health)
			(lake, garden, state)

a1: Example of confusion due to structural similarity
a2: Example of confusion due to meaning
b1: Example of a 7-year-old child
b2: Example of multiple children

Source: Author's compilation based on the database collected by Professor Toshihide Koike^[11]

social or conversational problems, the need for support tends to be overlooked.

- (ii) In Japan, dyslexia is not yet well known by the public, and it is confused with autism and ADHA, and people with dyslexia may receive inappropriate treatment.
- (iii) There is a relatively high prevalence rate of dyslexia; about 70 to 80% of children with learning difficulties are dyslexic.
- (iv) If appropriate support is provided to children with dyslexia at an early stage, they can be integrated into normal classes more easily than children with ADHD or autistic children.

2-4 Symptoms

The features observed in people with dyslexia are not uniform; there are individual differences in terms of aspect and degree of difficulty. Reading problems include a lack of fluency and omission of words. Writing problems include mirror-imaged writing, distortion of letter forms, creation of letters, difficulty in recollecting forms of letters just seen, and difficulty in copying letters on the blackboard, etc. Generally, for people with dyslexia, hiragana is the easiest to learn, then katakana, and kanji is the most difficult to learn. As with kana, they have problems with numbers, for example, reversed numbers, poor handwriting, incorrect numbers, and misreading. People with dyslexia may have normal or above normal ability in the reasoning and logical thinking skills that are required for mathematics.

2-5 Test Methods

(1) Psychological tests

Currently, general psychological tests and aphasia tests are adapted to diagnose dyslexia based on the criteria that, "Generally, there are no perturbations of visual, auditory, or motor function, but only unexpectedly low achievement in reading and writing with respect to other functions." These tests are not specifically developed to diagnose dyslexia, and it would be meaningful to develop a test with high sensitivity and accuracy to identify dyslexic individuals using the Japanese language.

(2) Achievement tests

Usually, skill in reading, writing and copying drawings is tested using letters and numbers that children have learned one or two years earlier at school. Children with dyslexia make significantly more errors with letters that they should have mastered two years before. Even if there is no difference in accuracy, children with dyslexia need much longer to respond^[12]. Currently, there are no standard sets of Japanese letters (hiragana, katakana, and kanji) for the tests. It is necessary to establish a standard composition of the letters and their presentation protocols in testing so that common criteria are used in research, health checkups, diagnosis, training, etc.

2-6 Growing Process

(1) Early childhood

Generally, children begin to show interest in letters and numbers around the age of 4. Children with dyslexia tend to show little interest in them although they may like pictures or stories read aloud. In Sweden, longitudinal studies of children from families with a high prevalence rate of dyslexia (described later) and control families are being conducted from birth to school entry and throughout the school years. It is expected that findings from the study will help identify early indicators of dyslexia^[3, 13]. It is also suggested that the first signs of dyslexia appear around the age of three and a half^[14].

(2) Lower grades of elementary school

In Japan, many children at age six, when they enter school, can read almost all hiragana letters, and can write 60% of them^[15-17]. Health checkups at school entry provide a good opportunity of identifying children with dyslexia, and of providing support, so that they can prepare for learning in normal classes. It is recommended that a test system be developed for this purpose. Reading and writing difficulties appear at the early stage of elementary school, but it is difficult to detect problems at the lower grades of elementary school, because the syllabus is still simple and children may be able to compensate for their difficulties by painstaking exercises if the dyslexia is mild. Sometimes, signs of dyslexia appear in such a way that children who have no

significant problems with reading and writing letters cannot do math or struggle to answer comprehension questions. It is useful to prepare guidelines and make them available to parents and teachers so that they can identify children who have such unbalanced skills.

(3) Higher grades of elementary school

When children have to learn a growing number of kanji letters, especially those with abstract meanings, from around the 3rd grade of elementary school, children with dyslexia can hardly cope with learning more letters, no matter how hard they work and how many times they repeat the exercises, and signs of dyslexia become more evident. Furthermore, 10-year-old children begin to compare their own achievements with those of their peers, and try to imagine their future by considering their own talents and preferences. When they become aware of, or someone else points out, that they are slow to learn reading and writing, they may lose confidence and become anxious about the future^[18]. If 10-year-old children believe that 'they cannot read and write, so they are not smart,' how can they imagine themselves living successfully as adults in present Japanese society? Osaka Medical College has a dedicated unit treating children with learning disorders. Most dyslexic children who visit the unit are in Grades 1 through 3. Why do higher-grade children not visit the facility for the treatment of learning disorders despite the fact that dyslexia manifests itself more strongly more at these higher grades? According to Doctor Shuhei Suzuki in the unit, "for dyslexic children, the problem of psychosomatic disorder has already become more serious than the problem of reading and writing, so they visit the psychosomatic disorders unit first instead of the learning disorders unit." It is essential to provide appropriate support for children with relatively serious dyslexia at the lower grades of elementary school.

(4) Junior high school

With English, dyslexia tends to manifest itself with higher probability because the language is phonologically complicated, contains a lot of inconsistent relationships between orthography

and pronunciation, and requires visual and auditory processing that are difficult for people with dyslexia^[19]. As a result, when Japanese children with dyslexia begin to study English at junior high school, those who have apparently had no problems in learning Japanese show difficulty in learning English. This is also the case in Italy, because there is high consistency between orthography and pronunciation in Italian. Up to now, few English teachers in Japan know about dyslexia. Furthermore, dyslexia is not yet known by teachers in English cram schools where students expect to make up for delay in learning at school. It is necessary that those involved in teaching English notice problems associated with dyslexia, learn from training strategies for dyslexic students used by native English speakers, and develop a support system appropriate for Japan.

Children with dyslexia have to spend more energy than other children on learning through reading and writing, at the cost of content comprehension and expansion of vocabulary and knowledge^[20]. This burden tends to increase the gap between dyslexic children and non-dyslexic children, resulting in even mildly dyslexic children being more at risk of being left behind in learning at junior high school and in higher education.

There are also children who have difficulty in reading and writing numbers. However, logical thinking and reasoning, fundamental factors in mathematics, are not affected by dyslexia; in fact, some people with dyslexia demonstrate outstanding talent in this area^[21]. Brain research suggests that two neural pathways are involved in mathematical thinking. It is important not only to provide support for children with dyslexia to compensate for their weakness, but to discover what they can do and encourage them to do it better, or to use their strong points to compensate for their weak points.

(5) High school and higher education

To succeed in examinations, students are expected to read questions accurately and write answers correctly within a limited time, so dyslexic students, who are slow to read and write and make many errors, cannot demonstrate their

competence or skill. As a result, many dyslexic students have unexpectedly little success in college entrance exams and employment exams. In the UK, preferential treatment is given to dyslexic students by giving them extra exam time. However, even though they may enter college, some dyslexic students drop out because they cannot cope with the heavy burden of course content, and they cannot complete the required assignment papers. In a modern society where the workplace is flooded with information, people are required to accurately and quickly handle many documents when they get a job, and thus people with dyslexia have lifelong difficulties.

2-7 Causes of Dyslexia

When the diagnosis of dyslexia depended only on its psychological and/or pedagogic aspects, there was a risk of labeling other difficulties as dyslexia^[22]. Through the development of neurological studies, more basic knowledge was obtained about the biological aspects of dyslexia. A convincing explanation of the causes of dyslexia has not yet been presented, so it is necessary to promote basic research to clarify the causes of dyslexia.

(1) Anatomical factors

In most people, the left hemisphere of the brain is dominant for language, and the language areas are bigger than their corresponding areas in the right hemisphere^[23]. This left-right asymmetry is detectable in the fetus as early as 31 weeks of gestation^[24], and this provides evidence for the theory that language ability is innate. Both anatomical^[25] and brain-imaging^[26] studies have confirmed that the asymmetry of language areas is reduced in the brains of people with dyslexia. Focal abnormalities of the cerebral structure (approximately 0.2 millimeters wide) have been observed in their brains, with a higher incidence in the language areas^[27].

(2) Physiological factors

When skilled readers recognize a series of letters as language, they convert visual information into auditory information without explicit awareness of it. Rapid eye saccade

and information processing in the order of milliseconds are required for fluent reading. When sensory information proceeds to the neocortex, rapid-phase information is carried by the magnocellular pathway, and slow-phase information is carried by the parvocellular pathway. Many studies suggest that both the anatomy and information processing of the magnocellular pathway of dyslexic people are different from those of non-dyslexic people^[28].

Generally, when reading or writing, the language areas in the left hemisphere are more active than in a resting state. Studies using functional magnetic resonance imaging (fMRI) have shown that, in people with dyslexia, the activation of language areas during reading and writing is relatively feeble (Figure 3b)^[29].

From a psychological point of view, the left cerebral hemisphere is dominant in processing rapid visual and acoustic information. Some studies have shown that the left hemisphere in people with dyslexia does not fully respond to rapidly changing stimuli and that the response could be enhanced through training^[30].

(3) Genetic factors

It has long been pointed out that dyslexia runs in families. Epidemiological studies suggest that dyslexia is caused by multiple genes. Studies in Finland, the UK, the US, and Canada have shown that there are high-risk families with a propensity to dyslexia. A study in Finland has shown that the concordance rate is 34% in high-risk families, whereas it is 9% in control families^[31]. The concordance rate of dyslexia is reported to be 66% and 43% in monozygotic and dizygotic twins, respectively. A longitudinal study is being conducted for children born to high-risk families or control families from birth to an age when accurate diagnosis is possible through learning at school. Retrospective analysis shows differences between the two groups and the age of divergence. Recent studies suggest that genes related to dyslexia are located on chromosomes 1, 2, 3, 6, 12, 15, 18, and X, and special attention is being paid to those on Chromosomes 6 and 15. Candidate genes for dyslexia vary among different families living in different countries. In Japan, a genetic analysis of dyslexia has not yet

been conducted, so it is necessary to conduct epidemiological studies on dyslexia.

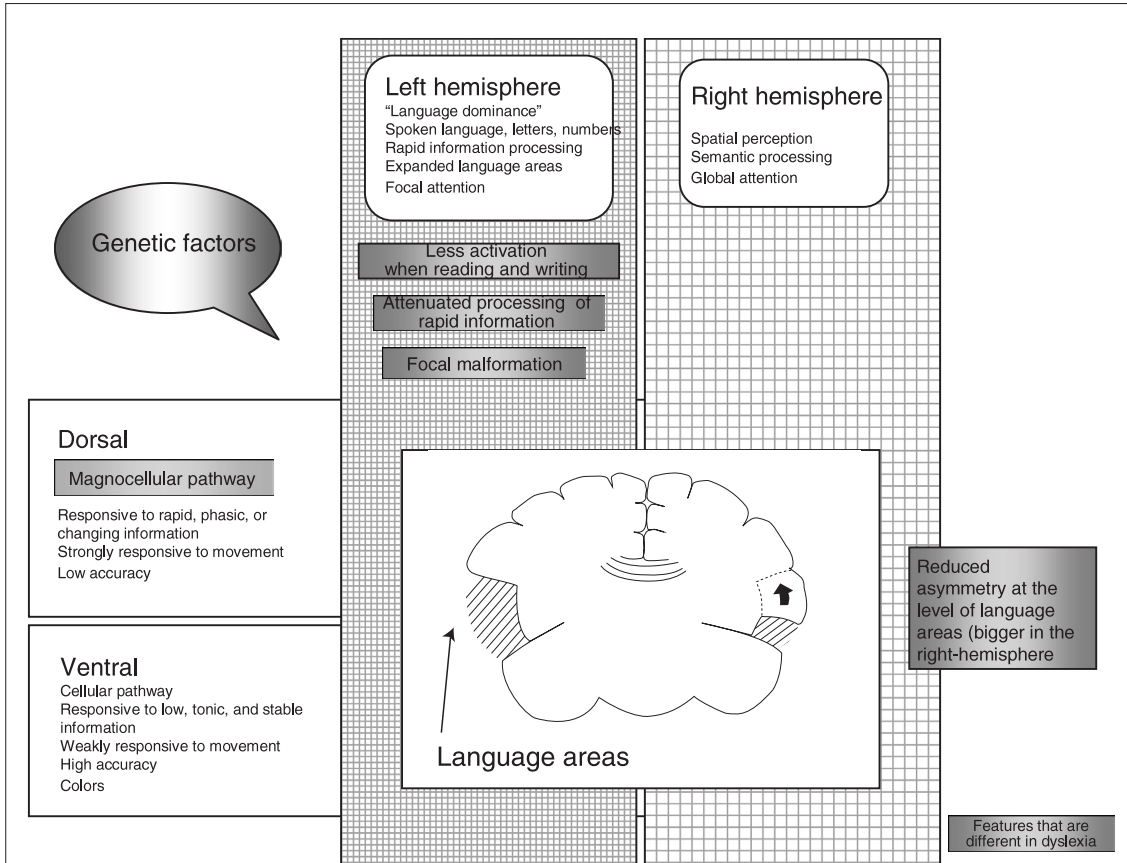
(4) Factors ‘Not’ related to dyslexia

It is necessary to make the best use of TV programs and printed media to deliver the message to the public that laziness, and lack of

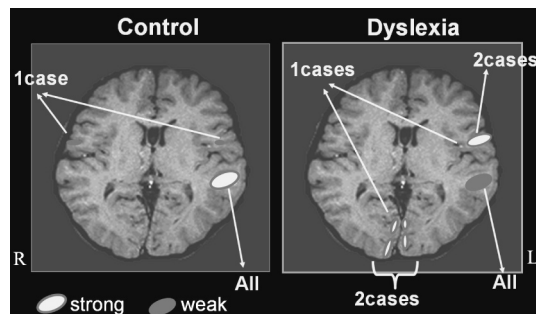
concentration and motivation are not related to dyslexia.

In the 1960s, a hypothesis that a child’s upbringing is related to dyslexia was widely discussed but rejected. However, in a society where knowledge about dyslexia is not sufficiently disseminated to the public, if children

Figure 3 : Indications of dyslexia



a. Illustration: Functional localization in the brain and indications of dyslexia



b. Summary of brain activity in dyslexic children and non-dyslexic children when they are reading

Strong activation was observed in the language areas of the left hemisphere in the group of non-dyslexic children when they were reading, while only weak activation was observed in these areas for all dyslexic children examined. Functional MRI was used to measure changes in the brain activity of five children aged 9 to 11 years old.

L: left brain, R: right brain

Source: Author’s compilation based on the report by Seki et al [29]

Table 1 : Support methods

Support domains	Example
Educational materials	<ul style="list-style-type: none"> • Recorded textbooks • Printed copies of blackboard writing • Easy-to-read textbooks (concrete, concise expression and representation)
Normal class	<ul style="list-style-type: none"> • Avoid repetition of ineffective exercises • Teacher/student collaboration (role change intended to develop students' error awareness^[17])
Supplemental class	<ul style="list-style-type: none"> • Demonstration of the elements of orthography and pronunciation • Demonstration of construction and relationship among these elements • Multi-sensory approach • Small-group learning for children with similar difficulties
Consideration	<ul style="list-style-type: none"> • Helping students to become aware of their errors by themselves when they are reading^[17] • Praising students and encouraging other subjects that they are good at as well as their particular skills
Preferential treatment	<ul style="list-style-type: none"> • Prolongation of exam time • Oral tests instead of written tests • Multiple-choice tests instead of descriptive tests • Use of computers

cannot read and write well, mothers in particular feel guilty, deny their children's difficulties, and cannot act objectively. They thus risk missing the opportunity to obtain the support they need. Therefore, it is also important to consider the emotional aspects of the parents. Teachers, too, sometimes have mixed feelings about the difficulties of their students.

There was a hypothesis that dyslexia is more prevalent in boys than in girls. Recently, however, some studies contradict this. Girls tend to talk earlier than boys in early childhood, so it is not advisable to diagnose dyslexia based only on the criterion that language development is 1 or 2 years behind the average. A study has shown that dyslexia affects males and females equally, or slightly more females than males at college entry age^[31]. However, it has not yet been determined whether the developmental profiles of dyslexia are the same in males and females, so it is necessary to conduct careful analysis while considering individual differences.

3 | Support Methods

Educational materials such as recorded textbooks are useful not only for dyslexic students but also for visually impaired students. However, they have not been widely available because of copyright problems, etc. It is necessary to rapidly promote the development of teaching materials for dyslexic students.

As for English education, it is necessary to

identify possibly dyslexic students and take proactive measures if there is a significant gap between Japanese and English learning ability. It is necessary to study and learn from special support methods in countries where English is the mother tongue, such as the teaching strategy of phonological processing in English that does not exist in Japanese. It is also important to develop an original support method appropriate for English education in Japan.

4 | Position of Dyslexia Relative to Policy of Support for Developmental Difficulties

In 2002, the Basic Program for Persons with Disabilities was decided by the cabinet, and a directive was issued stating that "Children with special needs in education and remedial training, for instance, those with Learning Disabilities, Attention-Deficit/Hyperactivity Disorder, and autism, should be provided with appropriate educational support." On December 3, 2004, a bill for assistance for children with developmental disabilities was passed by the cabinet (and the Act was enforced on April 1, 2005). The Act says that the central and local governments must take responsibility for providing support for the early detection of and fostering the development of non-mentally retarded children with developmental disabilities, including, but not limited to, "autism, Asperger syndrome, and other pervasive developmental disorders, learning

disabilities, attention-deficit hyperactive disorder, and other similar brain function disorders.”

Meanwhile, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) is currently reforming the education system “to prepare a system that provides special supportive education for children with learning disabilities in all elementary and middle schools by 2007.” It is required that this special supportive education be based on scientific evidence, so it is important to promote scientific research providing such evidence.

The “Draft of Criteria for Identifying Children with Learning Disabilities (LD)” prepared by MEXT covers children “who have significant difficulty in acquiring and using particular abilities in hearing, speaking, reading, writing, calculating, and/or reasoning.”^[32] Dyslexia affects reading, and writing abilities and sometimes influences calculating ability. Studies in the areas of neuroscience and cognitive science increasingly focus on the structure of individual ability such as in speaking and reading, as well as the difference between calculation and reasoning functions in the area of mathematics. It is necessary to systematically promote studies to ensure that they provide a scientific basis for new methods of education.

5 Strategies for Dyslexia

5-1 Current Situation Survey

In Japan, a comprehensive survey on the current state of dyslexia has not yet been conducted, so this is an urgent task. In Japan, there is not even an official definition of dyslexia. Therefore, the following tasks are required.

- To immediately establish a definition based on scientific findings on dyslexia
- To determine standard test methods based on scientific evidence
- To review and improve test methods as research progresses
- To conduct longitudinal studies on dyslexia

5-2 Public Communication

It is urgently necessary for the government to make the best use of mass media such as TV,

printed media, and the Internet to disseminate knowledge about dyslexia, and convince the public of the need for support and win understanding.

5-3 Establishing an Early Detection Method

The onset of acquisition of hiragana by preschool children has been getting earlier over the last several decades (Figure 4). Recently, most young children can read hiragana before they enter elementary school, and 60% can write it. Just after entering elementary school, even non-dyslexic children may confuse letters, but these mistakes are corrected in a year. Children with dyslexia make characteristic patterns of mistakes such as high frequency of mirror-imaged letters, and these mistakes cannot be corrected by conventional exercises. It will soon become technically possible to identify children at risk of dyslexia when health checkups are conducted at school entry. It may not be easy, however, to carry out tests to identify dyslexia at this early stage before knowledge about dyslexia is disseminated to the public and before parents are psychologically prepared to accept a diagnosis of their child’s dyslexia. Teachers may be able to identify children who show poor performance in reading and writing by the end of the first term in the first grade of elementary school. As a preparation step, it is recommended that parents’ attention be directed to ‘dyslexia’ by distributing printed materials that include the following information: (i) there are children who can learn reading and writing only with difficulty due to developmental problems, (ii) it is possible to undergo precise tests performed by a local specialist, and (iii) it is also possible to receive consultation and basic training in language schools operated by local governments, non-profit organizations, etc. For this purpose, schools are required to establish a referral system that allows local specialists, language therapists, language schools, relevant non-profit organizations, etc. to be contacted.

Young children are acquiring hiragana at an increasingly earlier age for two distinct reasons, i.e. forced learning and an improved environment for learning letters^[16]. If young children are forced to learn letters, those with dyslexia must

suffer mental distress during early infancy. As far as the mental problems of children are concerned, it is necessary to study the actual situation of teaching letters and numbers at school, at home, at kindergarten, and at daycare centers, as well as how teaching influences the development of the child's mind.

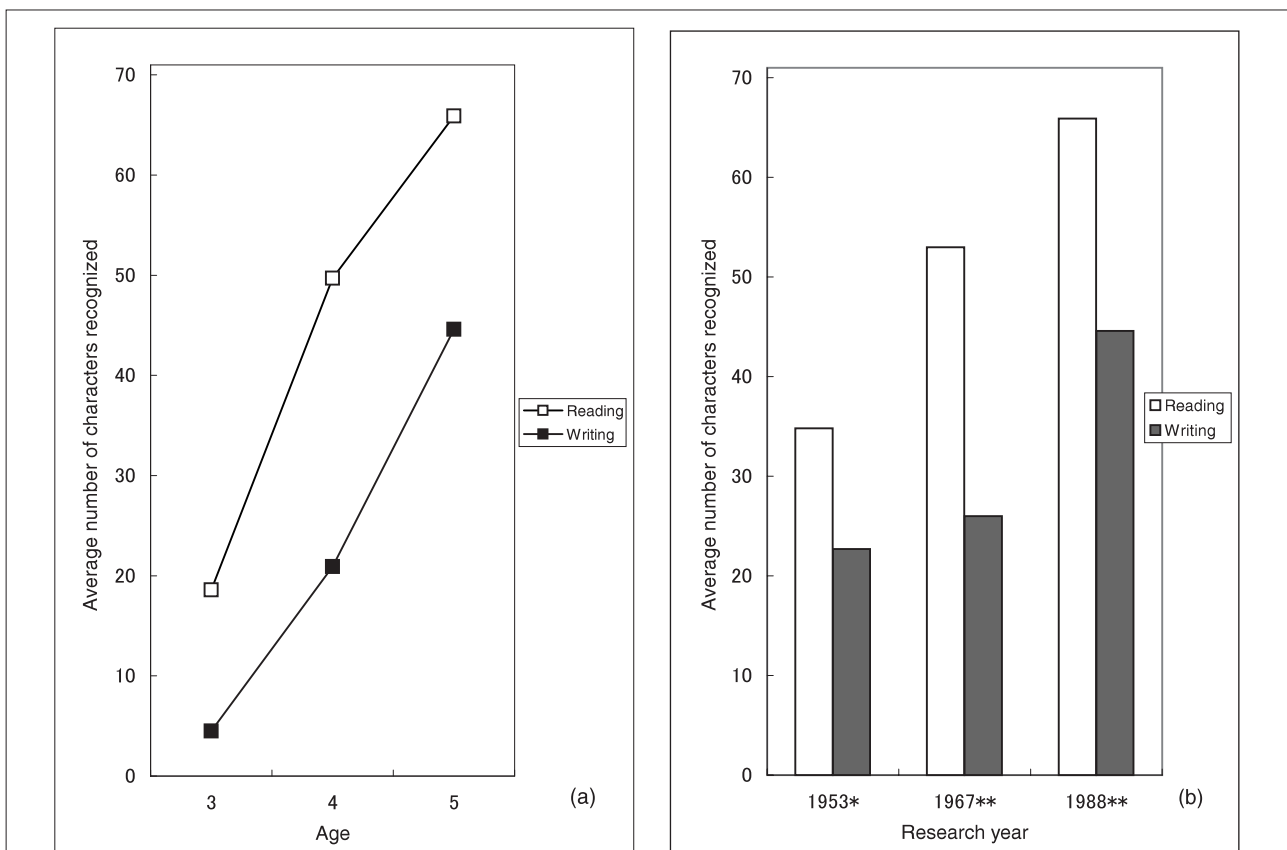
5-4 In the Medical Setting
(1) Clinical physicians

Up to now, most language problems encountered by clinical physicians are cases of adults suffering brain damage. It is necessary to train clinical physicians and medical researchers so that they can treat the complex language problems of children, which involve mental development and learning. For this

purpose, medical schools are required to set up undergraduate courses in which neuroscience, cognitive science, behavioral science, and psychology are systematically taught, and competence in these areas should be evaluated in a national exam. It is also necessary to establish a system in which pediatricians, pediatric neurologists, and pediatric ophthalmologists who have passed the national exam participate in training that allows them to treat children with developmental reading and writing disabilities and the resultant secondary problems.

It takes about 1 hour or 1.5 hours to provide medical treatment or support for one child with a developmental disorder. Medical treatment or support for people with dyslexia, which involves psychological tests, guidance, and counseling, but

Figure 4 : Average number of hiragana letters recognized by preschool children



a. Development of letter recognition by age (according to a research paper in 1988)

The number of characters recognized is based on the total 71 hiragana characters.

Source: Author's compilation based on a report by Shimamura et al^[16].

b. Historical changes in children's letter recognition

* Six-year-old children just after entering school, in April or May (regardless of whether they went to kindergarten or a daycare center)

** Five-year-old children at kindergarten or a daycare center, tested in November, 4 months before school entry

Source: Author's compilation based on a report from the National Institute for Japanese Language^[15] and a report by Shimamura et al^[16].

not medication, is rated low in terms of treatment fees. Even if good medical treatment and a guidance method are developed, they may not be widely practiced if there is no profit from the viewpoint of medical management. It is necessary to reconsider the medical system so that public medical institutions and private hospitals can commit themselves to the mental and learning problems of children within a framework of viable medical business operations.

(2) Language therapists

In Japan, there are only a small number of language-hearing therapists able to deal with developmental language problems. Currently, it would be effective for experts in acquired reading disorders and alexia take courses on specific developmental problems so that they can work with people with dyslexia. At the same time, it is necessary to train language therapists specialized in developmental disorders who have knowledge of brain science and psychology, and who can cope with the secondary problems resulting from reading and writing difficulties. As far as the training of personnel is concerned, there are currently only limited places for practical training. School boards and schools should recognize that it is necessary to involve language therapists to promote special supportive education, and that they should provide training places.

5-5 At School

(1) Training system for teachers

“A Vision of Special Support Education (Final Report)”^[33] published in 2003 includes an estimation of children with reading, writing, and calculating difficulties, compiled based on a questionnaire survey for teachers. As a result, several papers on reading and writing disabilities were presented at the annual meeting of the Japanese Academy of Learning Disabilities held in 2004. The academy provides training and issues certificates for special support education specialists for children with Learning Difficulties (LD), ADHD, and related difficulties. It is useful to increase the quality and number of such experts, making a good use of knowledge from the National Institute of Special Education and

centers of advanced research. It is also useful for educators, physicians, language therapists, and scientists to hold regular seminars to consolidate cooperation in the community.

(2) Translation Science

It is important to promote “translation science” and to train implementers who translate knowledge from science and technology studies, making it possible for teachers to understand and use it. It is effective to set up training courses in university faculties of education, or at graduate schools of life sciences and medical sciences. MEXT’s promotion is increasing the number of degree recipients from graduate schools. It is therefore effective to select and hire degree recipients who are more interested in scientific writing and enlightenment work than laboratory work.

5-6 Developing Social Infrastructure

The Act for Assistance for Children with Developmental Disabilities encourages care for children after school. Local municipalities set up “language classes” to support the development of children’s spoken language. Children with dyslexia have only reading and writing difficulties, and their speech is often fluent and rich, so in many cases, they are not accepted in languages classes. In some cities where dyslexia is well understood, children with dyslexia are integrated into language classes, and this should standard for every language class in the state. In addition, it is necessary that experts provide knowledge to parents’ associations and related NGOs, and make efforts to understand what people with dyslexia and their families think about their problem^[34] to understand the demand.

(1) Support system in the UK

In the UK where English is the mother tongue and the problem of dyslexia is more evident, an NPO was established at the beginning of the 1970s to provide support for people with dyslexia. The NPO disseminates knowledge about dyslexia, provides special support education for individuals or for small groups, trains special education professionals, and develops support

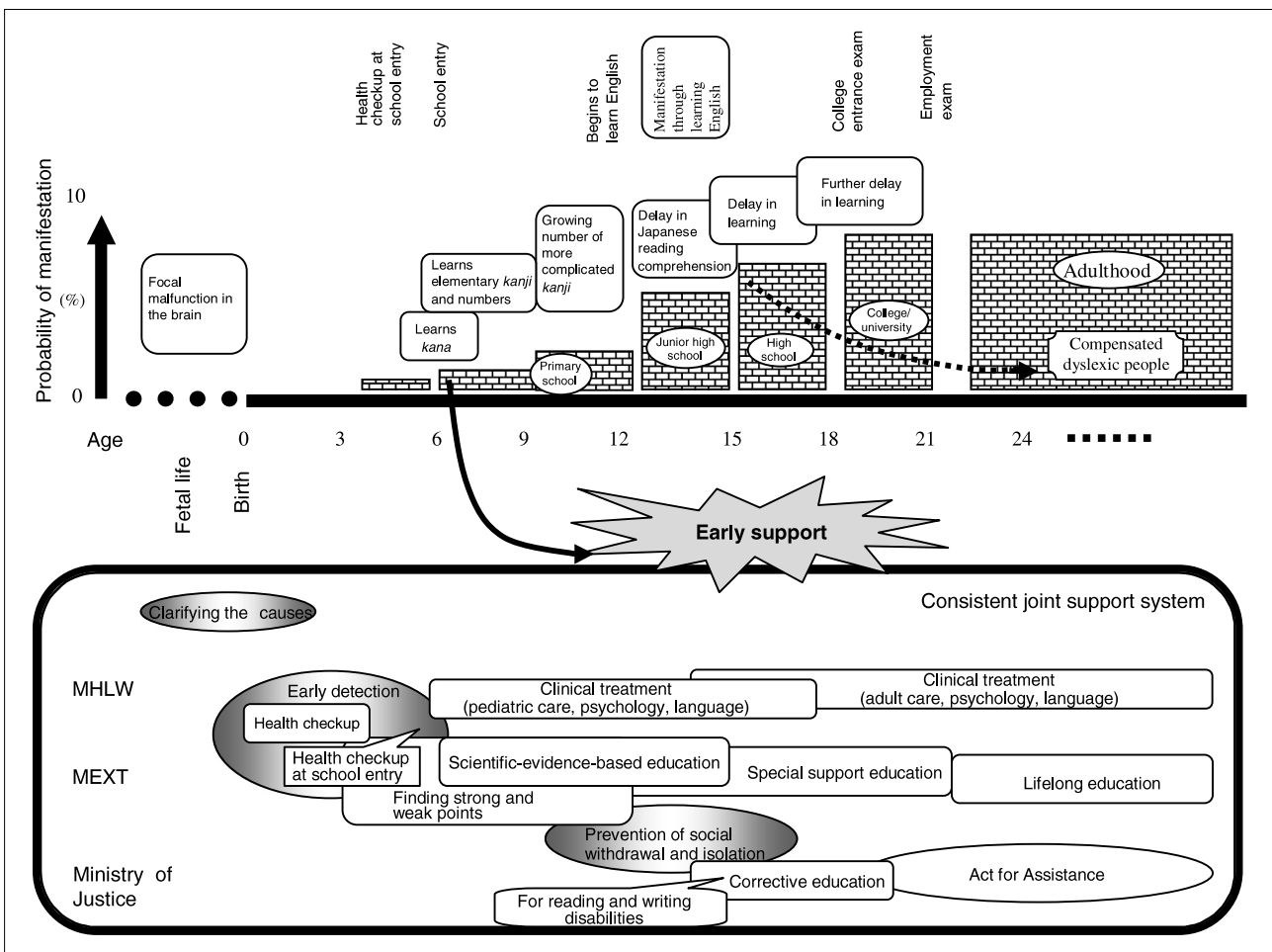
methods. The NPO also advises companies that need the knowledge for their product design, considering that about 10% of their customers may be dyslexic. There are private schools that are authorized as meeting the facility and system requirements for accepting children with dyslexia. State schools also provide special support education. In the UK, it is well recognized that children with dyslexia account for 10% of all children, and about 3% are certified as needing special support education, and schools receive subsidies from the government. However, parents must pay the certifiers a lot of money for certification. Therefore, there is a tendency that only children whose parents are wealthy enough to afford the certification or private school enjoy generous support. In October 2003, dyslexia was legally recognized as disability, and the right to receive generous lifelong support has been legally guaranteed.

Basically, schools prepare an Individual Education Plan (IEP) for each child and provide guidance according to the plan. There is a Special Educational Needs Coordinator (SENCO) at schools, who supervises the condition of the child, coordinates between multiple supporters such as the classroom teacher, special support teacher, and speech therapist, and evaluates implementation of the policy.

(2) Sweden

In Scandinavian countries where the welfare system is highly developed, countermeasures for dyslexia were implemented early on. In Sweden, a national research institute for education for children with disabilities was established at the beginning of the 1990s to develop, produce, and disseminate support materials, along with instructions on how to make good use of them. The institute also advised producers of

Figure 5 : Manifestation of dyslexia throughout the life cycle



The above chart represents the appropriate rates of people identified as having dyslexia in the same age group with the maximum rate reaching 10%. Compensated dyslexic people: people who overcame dyslexia by their own efforts, with support from their surroundings, and by innovating a job that does not need complicated reading and writing skills

educational materials. In 2001, when the basis of the activity was complete, the national institute made the transition to a special education society^[35, 36].

(3) Singapore

It is remarkable in Singapore that Senior Minister Lee Kuan Yew, a widely known and respected statesman who studied law and graduated from Cambridge University with a double First Class Honours and who served as Prime Minister from 1959 to 1990 was diagnosed at the age of 62 and revealed in 1996 that he is dyslexic, and donated private funds to a NPO helping people with dyslexia in Singapore. His revelation helped to disseminate knowledge about dyslexia to the public in Singapore, removed the sense of shame felt by people with dyslexia and the prejudice of the people, resulting in an improved support system. Admittedly, Singapore is different from Japan, being smaller, and politicians and policymakers such as Mr. Lee having immense power, for example. However, it is possible to swiftly establish a comprehensive support system in Japan if the government takes the initiative and promotes the dissemination of knowledge about dyslexia and the development of support systems.

(4) Philippines

In the Philippines where state finances are tight, the parents of children with dyslexia established an NPO, which persuaded the officers of a Catholic university to provide special support education and training for educators. A representative of the NPO said: "There are things one can do even on a small budget."

5-7 *Promotion of Scientific and Technological Research*

Because dyslexia is clearly a phenomenon "caused by neurobiological factors,"^[1] the promotion of neurobiological research is absolutely necessary to elucidate all of its aspects and to find a scientific basis for special support education. In addition, analysis of the mechanism of dyslexia that genetically produces a peculiar disability in language function serves as an effective clue in exploring the genetic

background, origin, and biological foundation of language.

The difference in the left-right asymmetry of the cerebral language areas and local structural anomalies attributed to dyslexia have been described from 20 years ago, but little progress has been made since in analyzing its mechanisms. In Japan, on the other hand, studies with mutant animals, and lissencephaly (hypoplasia of the brain characterized by absence of convolutions of the cerebrum), etc., are proceeding to advanced analysis of cerebral neurogenesis, neuronal migration, layer formation, and specific neural network formation, etc. It is not currently clear what actual mental functions these studies aim to elucidate. It is important to explain the mechanism of linguistic ability and other higher functions by clarifying the cause of dyslexia.

The morphology of the normal brain is formed by the overproduction of neurons at the first stage of neurogenesis and the consequent programmed natural cell death. Anatomical analysis infers that the right hemisphere of the dyslexic brain is larger than normal as a result of a decline in natural cell death^[37]. Detailed research is progressing concerning regional differentiation within the brain due to the expression of specific genes and the mechanism of natural cell death; it is anticipated that this will lead to research that clarifies left-right asymmetry and function localization of the brain.

Language is not something that suddenly appeared in human beings today, but is considered to have developed in combination with various functions shared by other animals. Currently, in Japan, studies are being conducted on the mechanism of the visual and auditory cognition of monkeys and on the neuronal mechanisms for learning syllables in birds. It is valuable to elucidate the biological origins and foundations of language by analyzing the genetic mechanisms of acquiring normal linguistic ability together with the aforementioned studies. It is desirable to develop optimal methods of producing, transmitting, and presenting linguistic information based on the cognitive and neural mechanisms of human beings.

Highly skilled speed-readers can read over 10,000 words per minute (the ordinary speed is

approx. 500 words/min.) Although speed-reading is apparently the reverse condition of dyslexia, there is low activation of the language areas of the left brain as is the case for people with dyslexia^[38, 39]. Elucidation of cognitive and neuronal mechanisms underlying this phenomenon is expected to lead the development of new circumventive training methods for people with difficulty in learning to read.

Academic organizations taking up dyslexia as their major research subject include the International Dyslexia Association (IDA, headquarters in USA)^[40], Hattatsusei Dyslexia Kenkyukai (Developmental Dyslexia Study Group), and Ninchi Shinkeishinrigaku Kenkyukai (Cognitive Neuropsychology Study Group) in Japan. These societies present research results and give lectures in various fields spanning basic research, medicine, welfare and medical services, psychology, pedagogy, the classroom and other actual educational strategies, the press, non-profit organizations, etc., and proficient scientific translation is becoming ever more important.

In Japan, a tremendous amount of basic research is being conducted in the fields of information science and engineering on visual or voice analysis, and linguistic recognition, and the private sector is conducting research and development of information analysis and transmission. Devices that recognize the human voice and converts content into written language are effective aids not only for people with dyslexia but also for those with visual disability and elderly people. Although voice recognition and sight tracing for children are more difficult compared with those for adults, it is hoped that support equipment for children will be developed and commercialized. Manufacturing companies are increasingly required to consider easier operation by people with disabilities. Dyslexic-user-friendly products will very probably benefit people with other reading and writing disabilities, elderly people and small children. Development of special support educational materials and equipment is spurring innovation toward the development of new industries and markets.

5-8 *Introducing a Comprehensive Perspective*

An individual is not defined by his or her disability, nor is a person's life sectionalized into the educational institution or social organization that such a person is affiliated with at a particular time. It is necessary for the Ministry of Health, Labour and Welfare, Ministry of Education, Culture, Sports, Science and Technology, Ministry of Justice, and other relevant ministries and agencies to cooperate with local public organizations to provide consistent support for people with dyslexia during their entire lives.

When the focus is on medical and educational issues, dyslexia is a "functional disorder," but when viewed in terms of brain function, it is "one of the facets in the diversity of human beings." Comprehensively considering an individual, it is insufficient to evaluate a person only by an aspect cumbersome to that person. If deviation from average brain function is relevant, then not only the disadvantages but also the average elements and the advantages should be evaluated. In terms of dyslexia, awareness of average or outstanding ability leads to recovery of confidence. It can also lead to the use of excellent abilities such as circumvention. Methods and measures to evaluate outstanding ability are also necessary. Some outstanding qualities may be observed in people with dyslexia such as "good understanding and fluency in spoken language, expressiveness, capacity for abstract thinking and logical thinking (early maturity in the use of conceptual frameworks, use of generalizations and visualization by manipulation of concepts, etc.), fast, flexible thinking, abundant information-processing ability, superb problem-solving ability, creativity (the ability to ignore the irrelevant among diverse elements and to integrate ideas and a creative, powerful imagination), visuo-motor coordination, artistic and musical talent" and others^[41, 42].

6 | Road Map to Establishing Support Systems for Dyslexia

The aforementioned tasks will be implemented, if the government exerts clear policies and

Table 3 : Road map for the organization of support systems for dyslexia

Promotion stage	Issues
1st stage	Public relations: Increasing awareness of the existence of dyslexia through the media (TV, printed media, the Internet) and nurture psychological readiness in parents and teachers toward the issue
	Committee of specialists: Establishment of a definition of dyslexia and a method of standardized test strategies based on scientific evidence (periodically verified and reformed)
2nd stage	Wide-scale survey Public relations: Promotion of understanding of dyslexia by all citizens
3rd stage	Early discovery (Preliminary stage): Identifying children with slow acquisition of reading and writing skills by the end of the 1st term of the 1st year of elementary school, calling it to the parents' attention and advising them to consult a medical specialist Medicine: In-service training concerning learning disabilities including dyslexia held at pediatric clinics, child neurology practices, and pediatric ophthalmology practices Education on cognitive science and behavioral sciences at medical schools Applying for training courses on developmental disability and support from language-hearing therapists specializing in acquired disability Organization of a system of fostering language-hearing therapists specializing in the developmental period (in cooperation with educational experts) Scientific and technological research: Language science to clarify dyslexia. Promotion of research in brain science, cognitive science, psychology and behavioral science Genetic analysis of familial dyslexia traits in Japan. Development of material and equipment for support education Education: Diffusion of evidence-based education on dyslexia (Education for undergraduates, graduate students, reeducation of teachers)
4th stage	Early discovery: Diagnosing the possibility of dyslexia at health check-ups on entering school Medicine: Enhancement of a medical system to enable the use of the latest strategies of diagnosis, treatment, and instruction. The addition of the subjects of cognitive science and behavioral science to the national examination for medical practitioners Fostering of developmental language-hearing therapists (support of classroom education) Scientific and technological research: Elucidation of the cognitive and neural mechanisms of reading and writing. Elucidation of the biological origins and foundations of language Developing an optimal method for the formation, transmission, and presentation of language based on human cognitive and neuronal configurations Education: Fulfilling evidence-based education for dyslexia

strong leadership from the initial stage. If the government frequently presents effective policies concerning highly visible issues for citizens such as mental health and education and discloses their process of implementation, citizens would trust the government more, and government promotion of science and technology would progress more smoothly. It would also be a good opportunity for researchers to gain public understanding on research in brain science and cognitive science and their benefits to social and personal life.

7 Conclusion

7-1 What Comes After Enhancement of Literacy

During the late half of the Edo Period, children of the general public received fundamental education in reading, writing, and abacus calculation according to personal proficiency at small private schools all over the nation. Literacy

in Japan had already reached one of the highest levels in the world. The Meiji Government furthermore established as its objective “No illiterate person in the home and no illiterate family in the community,” instituting mass entrance to school from a prescribed age, and endeavored to raise literacy further. This policy and its effects continued after World War II. The high literacy rate must have contributed to the rapid introduction of modern science and technology after the Meiji Restoration and the spectacular reconstruction of the nation after World War II. The method employed under this policy was repeated practice in reading and writing large amounts of material. Japan has now virtually reached saturation point in terms of the conventional conception of “wider and earlier introduction of literacy” (Figure 4).

In Japan up to now, the structure of the Japanese language that is easy to manipulate for dyslexia has operated favorably to elevate literacy, but problems may also arise if the situation

does not progress. English-speaking nations that have the disadvantage of dyslexia easily manifesting itself are turning it into the concept that “difficulty in reading and writing is not the same as inability to learn,” preparing conditions for enhancing the learning of children with dyslexia who account for 10% of all children, and progressing in explicating the cognitive causes of other learning disabilities and providing support. The actual situation in Japan where on the surface there appears to be a high literacy rate should be reexamined, and a system should be created where children with dyslexia can learn to read and write without immense effort as in the past, and to direct this effort to creative activities, development of the capacity to define and solve problems, and acquisition of a wide range of knowledge. To this end, rather than adhering to conventional methods of arriving at mutual understanding, transmission of information, learning, and education, these should be conceived of as skills, and their mechanisms should be scientifically explicated to elucidate conditions for the development of the skills. In terms of information media as well, readily recognizable formats and means of presentation should be developed.

7-2 *Diverse, Flexible Society*

To develop one’s own potential and make best use of it and to be able to esteem one’s own abilities as well as to receive just evaluation from others are basic conditions or even requisite for the well-being of the individual. This is particularly important for the mental development of children. The pursuit of education that enhances individuality is not to instruct children in “activities considered to be individualistic” that already exist but to elucidate the necessary conditions for each child to fully exhibit his or her own abilities, to prepare these conditions, and to leave the rest up to the child. Diversity of the brain, innovative problem-solving, and creative thinking are also among matters most needed for a Japanese society that tends to make itself uniform. Detailed preparation of support systems for dyslexia would contribute to reform in this direction.

<Complementary notes>

Definition by the International Dyslexia Association (IDA)

Dyslexia is a specific learning disability that is neurological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. Secondary consequences may include problems in reading comprehension and reduced reading experience that can impede the growth of vocabulary and background knowledge^[1, 2].

Definition by the World Health Organization (WHO)

Specific Reading Disorder: The main feature is a specific and significant impairment in the development of reading skills that is not solely accounted for by mental age, visual acuity problems, or inadequate schooling. Reading comprehension skill, reading word recognition, oral reading skill, and performance of tasks requiring reading may all be affected. Spelling difficulty is frequently associated with specific reading disorder and often remains into adolescence even after progress in reading has been made^[2].

In addition to the above, the diagnosis criteria from DSM-IVTR by the American Psychiatric Association are sometimes used in Japan.

Why only reading and writing?

Homo sapiens, to which all modern human beings belong, first appeared about 250,000 years ago. The biological requisites for the development of language appeared around the same time. The results of a phylogenetic analysis of the similarities among the Indo-European languages support the hypothesis that they split from an Anatolian language between 7,800 and 9,800 years ago^[7]. Their precursor language must be even older. It is thought that spoken language as we know it today emerged as late as about 50,000 years ago,

when human beings began to leave on cave walls the oldest known symbols used by human beings, and began to develop a variety of technologies^[8]. The appearance of written language, “a task to represent speech sounds by symbols (writing) and to convert written symbols to speech sounds (reading),” was not very long before oracle bone characters appeared about 3,000 years ago, and Mesopotamian characters appeared between 5,000 and 6,000 years ago. The history of reading and writing is very short compared with that of spoken language. Although one can find languages that have no written form, one would never find people who have no spoken language, even if you go deep into the jungle or visit a remote island. When children are born, they begin to speak spontaneously unless they have a heavy disability. Spoken language is an innate ability^[9], although people must master reading and writing skills through explicit training.

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