

## Exploring Peripheral Areas with an Inquisitive Mind and Curiosity

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### Abstract

In Japan, the Act on Promotion of Children's Reading was enacted in 2001. With the rapid increase in the number of middle- and high-school students owning smartphones and the launch of the government's GIGA School program for creating an environment in which every student has one device connected to the Internet, the impact of reading habits during infancy on the academic performance of children is attracting attention. We interviewed Tessei Kobayashi, a senior distinguished researcher at NTT Communication Science Laboratories, about the progress of his research activities to elucidate the mechanisms of children's language development and using these mechanisms to support education.

*Keywords: language development, personalized picture book, social-emotional development*

### Create human-friendly interaction technology based on scientific evidence

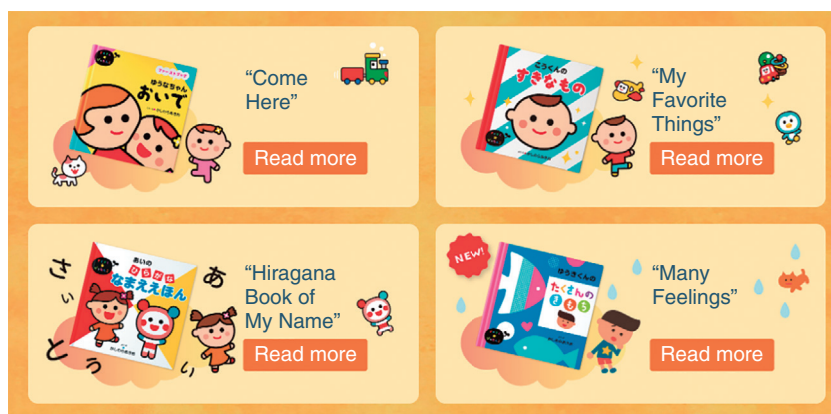
*—Could you tell us about your current research activities?*

In the field of human development, I'm researching the mechanisms of children's language development and using these mechanisms to support education. With the goal of creating human-friendly interaction technology based on scientific evidence, I'm implementing systems on the basis of a deeper understanding of human development and attempting to advance such technology by verifying them in the field. Put simply, I'm trying to understand the mechanisms by which children naturally learn a language, and I'm devising enhanced methods—on the basis of this understanding—for supporting individual children's

language development by, for example, using psychology, data science, and language-processing technology.

Children generally acquire the basics of their native language by approximately 3–4 years of age. Focusing on how infants learn the vocabulary, syntax, and letters that make up a language, I'm attempting to elucidate the mechanisms and factors that affect language development by conducting detailed laboratory verifications and field surveys at nursery schools and medical facilities.

I've also started research on children's social-emotional development. I'm investigating how we can measure this social-emotional skill and use the findings to support children's development. I'm also focusing on the environment surrounding children by investigating the characteristics of language development of children admitted to residential childcare



The above picture books are authored and illustrated by Akio Kashiwara.

Fig. 1. Personalized Educational Picture Books (on sale from NTT Printing).

facilities and regional differences in reporting abuse to child-guidance centers.

While striving to enhance the Japanese Word Familiarity Database that has been continuously researched and updated by our laboratory as basic language resources in fields such as psychology, linguistics, and natural language processing, I've also begun researching language development in hearing-impaired children and children with cochlear implants.

*—It seems that evidence-based support for comprehensively understanding the environment surrounding children will significantly contribute to society. Could you tell us about the specific findings of your research?*

I'll give some examples including projects spun off from basic research. The long-term effect of reading books to children has been attracting much attention. For example, one study [1] found that the frequency of book reading by parents to children aged 1 to 2 years is correlated with receptive vocabulary, reading comprehension, and intrinsic motivation to read at age of 8 to 9 years. This correlation remained after statistically taking into account parental education and family income (socioeconomic status: SES). Considering such previous studies, my research colleagues and I believed that supporting book reading to Japanese children from an early age would be effective in enhancing their education and social investment.

As I mentioned in the previous interview, my

graduate studies in infant psychology led me to supervise an educational television program for young children after I joined NTT. In that role, I found that although the program staff had sufficient knowledge, the program was not structured on the basis of scientific evidence. I felt the need for scientific evidence on language development when one program staff commented, "It would be reassuring if we had guidelines based on scientific data on language development."

Considering this background, we built two databases that are among the largest of their kind in the world. One, called the Child Vocabulary Development Database, is based on vocabulary-checklist data collected from 1500 children aged 0 to 4 years. According to the data in this database, the first word a child understands is the child's own name, which about 50% of children can understand by the time they reach about 7 months. In terms of the age at which children can speak, about 50% of children can say the word "bow-wow" at 15 months, while it takes them until 26 months to say "dog." They can also understand and use words for social communication, such as "peek-a-boo!" at 14 months and "bye-bye" at 17 months.

This database is used to create Personalized Educational Picture Books, which is a series of individually optimized picture books that reflects each child's interests and development, including their names, favorite things, and words that the child will learn (Fig. 1). For example, one of the books, "My Favorite Things," for 1- to 2-year-olds, was created by selecting words to be learned on the basis of estimations



Fig. 2. Pitarie-Touch (left) and its screenshots.

from the Child Vocabulary Development Database.

### Cooperating with local governments to verify the effect of personalized book-reading support

*—The development of the largest database of its kind in the world is a significant achievement both academically and socially. Please tell us about the other database and the associated field survey.*

The other database, the Picture Book and Children’s Book Database, was constructed by inputting the entire text of approximately 6000 picture books. We created this database when we developed a picture-book search system called *Pitarie*, and it was initially intended to be used to clarify what words appear in each picture book and how the frequency of words in picture books correlates with the vocabulary development of young children. *Pitarie* is the world’s first artificial intelligence system in the field of picture books and children’s books and combines the Child Vocabulary Development Database with functions such as graph-indexing similarity search and natural-language processing to enable users to retrieve picture books that match children’s interests and developmental stages.

Beginning in 2019, *Pitarie* was introduced sequentially at the Fukui Prefectural Library, nursery schools in Tokyo, and other locations. Many people have had the opportunity to use the system. As a more advanced version of *Pitarie*, *Pitarie-Touch* consists of a robot called *Sota*\* that recommends the picture book to a user after asking a series of questions (Fig. 2).

The Personalized Educational Picture Book “Hira-

gana Book of My Name” was created on the basis of the results of using the Picture Book and Children’s Book Database. Analysis of this database revealed two key points. First, when children learn letters, they learn to read from letters that appear frequently in picture books [2]; second, the degree to which they see and hear each letter is a key factor in their vocabulary acquisition. However, if we consider children on an individual basis, we see that individual children will probably also be looking at the letters of their names quite often as well. Accordingly, we decided to create a picture book in which letters of each child’s name frequently appear in the text and encourage the first step of letter acquisition in a way that is adapted to each child’s language environment.

This picture book contains special pages related to the child’s name. For example, if the child’s name is “Akari,” pages such as “‘A’ is for *aisu-kuriimu*” (ice cream, in Japanese) or “Let’s find ‘A’ on this page” appear (Fig. 3). If the child rubs or pokes the letters of their name to open the next page, the letters will become larger or smaller. I hope that by having fun reading the picture book while touching the letters of their names in this way, the child will acquire letters naturally.

*—We have heard that field surveys using Personalized Educational Picture Books and Pitarie are expanding.*

In the last interview, I talked about us cooperating with Onna Village in Okinawa Prefecture from January 2020 to encourage children to go to the library by

\* “Sota” is a registered trademark of Vstone Co., Ltd.



Fig. 3. Hiragana Book of My Name (authored and illustrated by Akio Kashiwara).

creating a Personalized Educational Picture Book for parents and children who came for infant-health checkups. In accordance with the Joint Research Agreement on Promotion of Reading for Lifelong Learning concluded among Nishinomiya City, Hyogo Prefecture, NTT Printing, and NTT, we are investigating the possibility of facilitating parent-child picture-book-reading activities by providing the Personalized Educational Picture Books and installing Pitarie at libraries.

Specifically, at the health checkup for one-and-a-half-year-olds, we distribute application tickets for the Personalized Educational Picture Books, and applicants for the book can create their picture book online. Between October 2021 and March 2022, half of the approximately 2000 people eligible for the health checkup applied for the picture book “My Favorite Things.”

About 400 application tickets for “Hiragana Book of My Name” for 2- to 5-year-olds were distributed at each library from January to March 2022, and more than 90% of the applicants signed up. A follow-up survey revealed that about 80% of the children liked the book, and about 60 to 70% of the families of those children read the book at least once a week.

In 2021, Pitarie and Pitarie-Touch, which children can use, were installed in three libraries in Nishinomiya City, and approximately 20,000 searches were conducted for the former, and approximately 30,000 people used the latter. More than half of the users of Pitarie-Touch were children aged up to 5, meaning we successfully reached the target demographic. In fact, during our observations at the libraries, we noticed many children taking the picture-book list output from the receipt printer and taking it to the counter. I wondered how the child perceive the information recommended by the robot. That is an inter-

esting question for child psychology.

—*You are also researching children’s emotions and environment. What have you discovered?*

We examined differences in the types of language conveying emotions (“emotion words” hereafter) and their tendency to appear in parental speech and picture books. We first created a list of 770 emotion words for Japanese-speaking children by referring to previous studies and emotional-expression dictionaries. We then analyzed the frequency degree to which these emotion words appear in a database of picture books and children’s books (about 6000 books) and in a corpus of parent-child conversations (448 conversations). The results of the analysis showed that picture books contain a greater variety of emotion words than parental utterances. Looking at the top-twenty words with the highest frequency, we also found a qualitative difference; namely, positive-emotion words appeared more frequently in picture books, whereas negative-emotion words appeared more frequently in parental utterances.

We also compared data on vocabulary development of children raised in family environments and those raised in residential childcare facilities to analyze how environment affects the vocabulary development of children. The results of the analysis showed that there was no significant difference between both environments in terms of the number of words they could speak and the order in which they acquired words [3]. Among the children raised in residential childcare facilities, however, those who had been abused showed some delay in vocabulary acquisition.

Considering these results and looking at the picture-book initiative, I feel the importance of creating a support system that reaches parents and children

who really need it. During the COVID-19 pandemic, I heard a speech therapist say in regard to remote training, “The digitization of existing language training tools has not been progressing, and since it violates copyright law, we can’t digitize such tools without permission, and we haven’t been able to provide enough training.” Therefore, our next challenge is to create a system, including original digital support tools, that supports the development of children by collaborating hand-in-hand with medical professionals and people in the social-welfare field.

### A researcher is someone who deciphers the laws of nature

*—What is important to you in your research activities?*

I believe that an attitude of inquiry is critical and place great importance on conducting research by switching between field and laboratory work. Inquiry-based learning has been included in the curriculum guidelines for high school students in Japan, and I believe that its importance has been felt throughout our country. Even the youngest children have curiosity or a budding spirit of inquiry, don’t they? I have been wondering lately about how to nurture and support children’s spirit of scientific inquiry, and I believe that if I conduct research without this spirit of investigation, I will not be able to make discoveries or create technologies through my research.

With that thought in mind, I’m applying an inquisitive mind and curiosity to not only my area of expertise but also to related areas. Of course, it is essential to delve deeply and profoundly into specific research topics; even so, in pursuing my area of expertise, I want to observe not only the children but also their environment and their social, historical, and geographical backgrounds to understand things from a broad perspective. In that sense, field surveys and cooperation with researchers and others in peripheral areas are necessary.

I’m fortunate that my superiors and others around me allow me to pursue research themes (such as infants and education) that are rare at NTT and that I can conduct research that contributes to society. To gain an understanding of those around me regarding my research activities, I try my best to set research themes that strike at the essence of the subject and explain to them my research purpose and significance.

For that reason, passion is more important than

anything else, and even at the proposal stage, a plan without passion will be noticeable. Recently, I’ve been having a lot of discussions with the younger group members about how to make other people understand our research plans. I think that repeating these discussions fosters skills to communicate with passion.

*—Finally, what do you think is the essence of being a researcher? What would you like to say to the younger generation?*

I believe that a researcher is a person who deciphers the laws of nature. In that sense, in my research on human development, I want to support the development of children by deciphering their naturally nurtured rules while considering environmental factors.

Research is a time-consuming activity; that is, research planning, data collection and analysis, writing papers, and preparing materials for presentation; it takes time to get it right. In other words, it is not so easy to plan, analyze, write papers, and prepare materials, so you have to spend much time and gradually develop your skills as a researcher.

During those activities, researchers listen to the words of many people, but in the end, they follow what they believe in. That belief is the “sense” of each researcher. What I mean by “sense” is the ability to notice things that are not visible. Even when people with the same level of knowledge, skills, and experience look at the same thing, some people will notice what is hidden in it, while others will not. I want to become a researcher who can decipher the laws of nature as much as possible with the ability to notice those invisible things.

I hope to work with young researchers who are full of vitality and take the challenge of conducting research that overturns established theories and proposing methods that strike at the essence of the subject, no matter how difficult it may be.

Selecting a research theme is therefore critical. I want to conduct research that strikes at the essence of the subject; however, I don’t know how to conduct such research and where to start to reach the goal. As I mentioned, I also conduct field surveys outside the laboratory, but that approach is not always the right one. In other words, I myself have not yet found the answer to the question of how to conduct research that strikes at the essence of the subject.

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### ■ Interviewee profile

Tessei Kobayashi received a Ph.D. in psychology from the University of Tokyo in 2004. His research interests include child language development, specifically vocabulary spurts and syntactic bootstrapping.