Analyzing an Infant's Reactions in Reviews on Picture Books Based on Developmental Psychology

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Abstract—The book reviews on picture books have different characteristics with other book reviews in terms of reviewers' reading styles. Generally, picture books are for the infants who are not capable of reading printing letters. Parents or childcare persons are readers who read them aloud. Meanwhile, infants perceive the meaning by listening to the voice and watching the pictures. This reading style frees infants from interpreting the printing letters, and enables them to activate their behavioral expression based on the stimuli from picture books. We extract the book reviews on picture books written on the Web site specialized in picture books, and found that those reviews reflect infants' behavioral expressions as well as their parents' reading activities in detail. Analysis of the reviews reveals that infants' reactions written on the reviews are coincident with the findings of developmental psychology concerning infants' behaviors. Additionally, patterns of the infants' reactions are found to be affected by the characteristics of the picture books such as rhythms of the phrases and visual effects of the pictures etc. Based on these findings, we constructed a recommendation system which recommends picture books which might induce expected infants' reactions specified by the users.

Index Terms—picture books, review analysis, recommendation system

I. INTRODUCTION

Generally, educational books focus on a specific subject to be learned such as science, sociology, etc. Picture books are exceptions, in terms of their efficiency for infants' cognitive developments [1] without any intention on specific educational subject with their style of expressions, i.e., funny stories and pictures. Additionally, picture books are outstanding in that those who read them are separated from those who perceive them. Readers are parents or child care persons who make book talks for infants who do not have sufficient literacy yet. Infants perceive and interpret incoming stimuli of the book talks and the pictures.

According to the research in the developmental psychology, infants are found to express variety of cognitive reactions to the external stimuli in accordance with their developmental stage. If picture books work as those kinds of stimuli, infants might express the cognitive reactions when the stimuli of picture books are perceived. Furthermore, this tendency might be amplified, because infants are free from understanding the printing letters of picture books.

This paper examines how the stimuli of picture books induces varieties of infants' reactions by applying text mining to a large amount of the reviews on picture books written by their parents or the childcare persons. Then, based on the findings, we construct a recommendation system that provides users with suggestion of the picture books close to their expectations for infants' reactions.

TABLE I. OVERVIEW OF EHONNAVI

(a) Principal Information				
Start date of the service	Number of titles	Number of unique users per month	Number of members	Number of reviews
Apr. 2002	55,600	1,055,000	343,000	289,000

(b) Distribution of the Number of Reviews according to Infants' Age					
Age of infants	0	1	2	3	4	5
Number of reviews	7,272	13,450	22,448	25,795	21,573	18,143

II. THE WEB SITE SPECIALIZED IN PICTURE BOOKS

To analyze the infants' reactions, text data of reviews on picture books are collected from EhonNavi[1], the web site specialized in picture books. EhonNavi provides with the information concerning picture books such as publishers, authors, outlines as well as a large amount of reviews written by the parents or child care persons, where the numbers of the titles of the picture books included in EhonNavi amount to about 55,600. The number of the reviews amount to approximately 290,000 as of January 2015 (shown in Table I). Other than EhonNavi, popular Web sites with a large amount of book reviews include Amazon[2] and Booklog[3]. Out of them, EhonNavi has unique characteristics in that its reviews

[1] http://www.ehonnavi
[2] http://www.amazon.co.jp
[3] http://booklog.jp

tend to be elaborated, reflecting the reactions of those who make book talks as well as those who perceive them. Additionally, it is also the EhonNavi's characteristics that the age of the infant is attached to each review. All these characteristics are preferable for our work aiming at detecting the infants' reactions in accordance with their developmental stages. Therefore, we employ the reviews of EhonNavi for the analysis of this paper.

III. CATEGORIZATION OF DESCRIPTIONS IN REVIEWS

Fig. 1 shows an example of the review of EhonNavi. As shown in the figure, the header of each review includes the age of the infant to whom the reviewer reads the picture book. As described above, reviews of EhonNavi include descriptions of book talkers' reactions, mixed with infants' reactions. Since reviewers are book talkers in all the cases, infants' reactions described in reviews are those observed by reviewers.
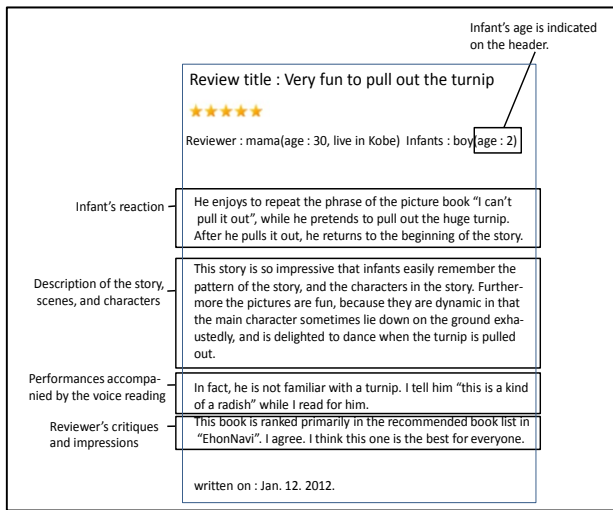
Figure 1. An example of a review of "The Giant Turnip".

TABLE II. TYPICAL EXPRESSIONS REPRESENTING INFANTS' REACTIONS IN REVIEWS

ID	expression
1.	gaze out
2.	Point fingers
3.	pretend
4.	imitate
5.	suppose
6.	onomatopoeic words
7.	game of make believe
8.	"?"
9.	enter into
10.	empathy
11.	stare into
12.	listen attentively to
13.	grasp
14.	Reach for
15.	murmur
16.	come to
17.	question
18.	get into one's part
19.	overlap
20.	excite

In order to categorize descriptions in reviews, we randomly picked up 345 reviews from 16 titles of picture

books and manually classified descriptions in those reviews. Table II shows the result of categorizing descriptions in reviews. Those descriptions are roughly categorized into reviewers' reactions, infants' reactions, and descriptions of the story. Reviewers' reactions are further sub-categorized as shown in the table. In order to further sub-categorize infants' reactions, we refer to studies of developmental psychology. In those developmental psychology literatures, they present categories of infants' cognitive developments in accordance with their ages. Next section introduces those categories of infants' cognitive developments and analyzes the reviews based on them.

IV. ANALYZING INFANTS' REACTIONS DESCRIBED IN REVIEWS BASED ON DEVELOPMENTAL PSYCHOLOGY

A. Collecting Typical Expressions Representing Infants' Reactions in Reviews

Descriptions in Reviews of each type in Table II are found to include typical expressions which frequently appear in descriptions in reviews. For example, an expression *"easy to read"* tends to represent the reviewers' impressions or evaluations on the books, where it appears in descriptions like below:

> This book is *easy to read*, because it consists of repetition of a simple short story.

Meanwhile, an expression *"my son becomes to"* tends to be used in the context of describing infants' reactions, where it appears in descriptions like below:

> *My son becomes to* perform voiced reading in spite of his primitive literal capability.

As such, typical expressions which frequently appear in certain types of descriptions in reviews can be considered as representing that type of descriptions. In this section, we especially focus on expressions that represent infants' reactions and manually collect them from those randomly picked up 345 reviews from 16 titles of picture books examined in the previous section. Table III lists typical expressions representing infants' reactions that are collected in this section.

B. Categorizing Infants' Reactions Based on Developmental Psychology

According to the theory of developmental psychology, infants express age specific reactions to incoming stimuli. We collect such infants' reactions that are specific to ages ranging from 0 to 3 from publications or papers concerning developmental psychology [2]-[5] and list them in Table IV. In this table, we list those 10 types of reactions in the order of from those observed in the early age 0 to those observed in the later age 3. This result indicates that infants at their very early stage of ages tend to react automatically with their physical expression, such as pointing the fingers, or grasping gestures, meanwhile, those at their later stage of ages tend to react consecutively expressing their intention, such as game of make-believe, or asking why, though some reactions are common over multiple ages.

TABLE III. CATEGORIZATION OF DESCRIPTIONS IN REVIEWS

Categories		Explanation	Frequency in 345 reviews of 16 titles
Reviewers' reactions	impressions/ cri-tiques	Reviewers' impressions and / or critiques on the picture books	177
	retrospection in their ages of infants	Reviewers' retrospective descriptions reflecting their own reactions when they were in their infants' ages	11
	performance of reading	Performance such as gestures and change of voice tones for attracting the infants' attentions when reading	33
	expectation of infants' reactions	Reviewers' expectations and concerns about how the picture book affect to their infants	177
Infants' reactions		Infants' reactions to reviewers' reading of the picture books	276
Description of the story		Description of the scenes, stories, and the characters of the picture books	147

TABLE IV. INFANTS' REACTIONS BASED ON THE THEORY OF DEVELOPMENTAL PSYCHOLOGY AND TYPICAL EXPRESSIONS IN TABLE III

Characteristics of developmental reactions	Explanations and examples	Typical expressions in Table 3	
		ID	expression
Reactions to visual stimuli	Showing an interest in the pictures especially the ones of foods. / Enjoy to find something in the pictures that are familiar to the infants.	1.	gaze at
Physical expressions mixed with verbal expressions	Pointing fingers and making gestures in case the infants are not able to express verbally. / Reaching for the things on the picture book as if they were the real things.	2.	point fingers
Pretend play	An example: If the infant is asked to hand something to his or her parents, he or she pretends to hand it to them even though it does not exist.	3.	pretend
Imitate	Imitating various things such as the persons, things, and the events surrounding the infant.	4.	imitate
Supposition	Finding common characteristics between real things and what are supposed to be.	5.	suppose
Reactions to repeating the same rhythm	Reacting to onomatopoeic words. / The infant repeats the onomatopoeic words because of their rhythmical sounds, though he or she does not understand what they mean.	6.	onomatopoeic words
Game of makebelieve	Reproducing the story of the picture book based on such activities that the infant imagines himself/herself to be in the place in the picture book.	7.	game of makebelieve
Interests in the relationship or the causality	Indicating intellectual curiosity by asking "why" frequently. / An example: "Does Papa read the newspaper because he works? Does Mama cook the dinner because she is a housewife?"	8.	"?"
Empathy for the story	Emotionally being involved in the world depicted by the picture book./ An example: "If I could enter into the picture book, I would save the cat."	9.	enter into
		10.	empathy

C. Allocating Typical Expressions Collected from Reviews to Categories of Infants' Reactions Based on Developmental Psychology

Assuming that some of the typical expressions listed in Table III represent the age specific reactions shown in Table IV, we allocate expressions in Table III to each category of Table IV. Allocated expressions are on the right hand side column of Table IV.

Hereafter, we examine whether those allocated expressions appearing in reviews of EhonNavi represent infants' reactions in the way coincident with respective age specific reactions asserted by developmental psychology. More specifically, in the next section, we examine the distribution of the numbers of the occurrences of those allocated expressions according to infants' age in reviews.

D. Analyzing the Distribution of Infants' Reactions According to Infants' Age

In order to examine whether expressions appearing in reviews of EhonNavi represent infants' reactions in the way coincident with respective age specific reactions asserted by developmental psychology, this section analyzes the distribution of those expressions according to the infants' age in reviews.

TABLE V. CATEGORIZATION OF DESCRIPTIONS IN REVIEWS

age of infants	0	1	2	3	4	5	total
number of reviews	1,491	3,150	4,306	4,062	3,203	2,033	18,245

In order to select sample reviews for the analysis, we first collect titles of picture books which have sufficient number of reviews. Here, we rank picture books in descending order of the number of reviews and select the topmost 99 titles, where the total number of the reviews of those 99 titles amount to 27,661. For those 27,661 reviews, we analyze the distribution of the frequencies of the 10 expressions in Table IV according to the infants' age in reviews. Here, as introduced in Section III, each review has the information of the infant's age indicated in its header. So, for each of the infants' ages ranging from 0 to 5, we use the age shown in the header of each review as an infant's age. Then, as shown in the blue plots of Fig. 2 to Fig. 5 (excerpts for the 10 expressions in Table IV),

we measure the frequency of each expression and normalize it by the total number of analyzed reviews for the certain age and plot it[4].

The blue plots of Fig. 2 to Fig. 5 are affected by the following two types of noises:

1) Matched reviews include both of the descriptions denoting the infants' reactions and those that do not.

2) The descriptions of the reviews imply the infants' ages that differ from the ones indicated on the header of the reviews.
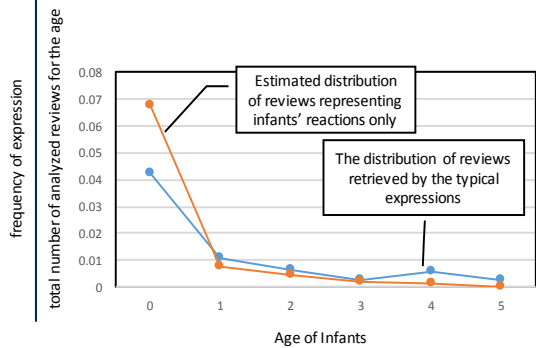

Figure 2. Distribution of the rate per age: frequency of the expression / total number of the analyzed reviews for the age (expression: *"gaze at"* (ID=1)).
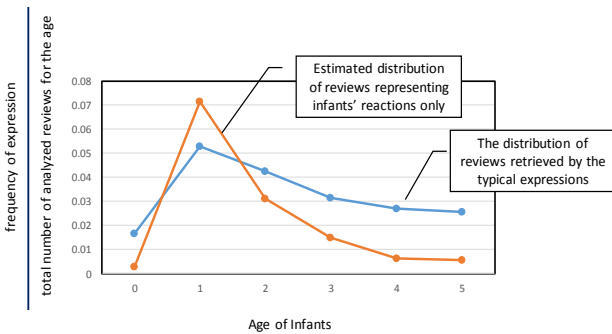
Figure 3. Distribution of the rate per age: frequency of the expression / total number of analyzed reviews for the age (expression: "imitate" (ID=4)).
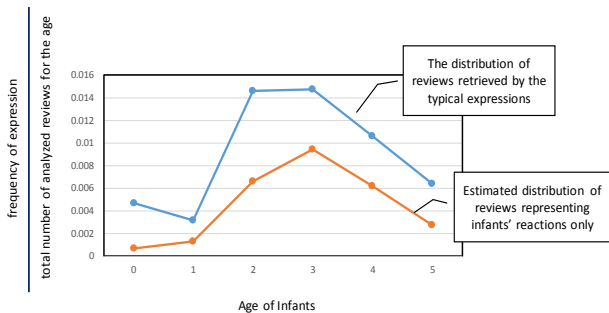
Figure 4. Distribution of the rate per age: frequency of the expression / total number of the analyzed reviews for the age (expression: *"game of make-believe"* (ID=7)).

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[4] As shown in Table V, out of the 27,661 reviews analyzed in this paper, within the range of ages from 0 to 5, the numbers of reviews are found to be distributed not uniformly according to the infants' age in reviews. Thus, we normalize the actually observed frequency of each expression by the total number of analyzed reviews for the certain age shown in Table V, and plot the rate in Fig. 2 to Fig. 5.
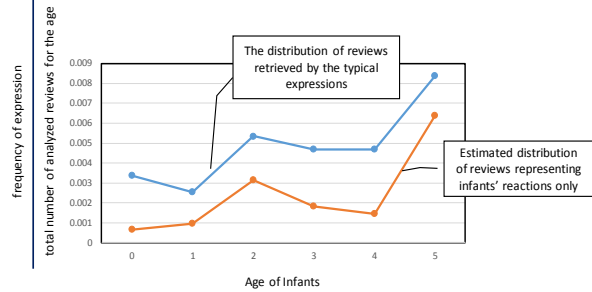

Figure 5. Distribution of the rate per age: frequency of the expression / total number of the analyzed reviews for the age (expression: "empathy" (ID=10)).

For the first type of the noises, for each expression and each age, we randomly pick up about 20 samples, manually discard those that do not reflect infants' actual reactions, and finally estimate the number of reviews which include infants' actual reactions. For the second type of the noises again, out of the randomly picked up samples for manual analysis mentioned above, we manually reallocate infants' ages, and finally estimate the number of reviews with the results of reallocated age information.

Finally, after incorporating corrections with the two types of noises, we add the red plots in Fig. 2 to Fig. 5.

Fig. 2 shows its peak around the age of 0, Fig. 3 around the age of 1, Fig. 4 around the age of 3, and Fig. 5 around the age of 5. Thus, the patterns of the distributions roughly imply that typical expressions can be considered as representing age specific infants' reactions in the context of developmental psychology. Although both of blue colored distributions and red ones show this correspondence, the shape of the red ones indicate the correspondence in more suitable way

V. ANALYZING THE DISTRIBUTION OF AGE SPECIFIC REACTIONS OF EACH PICTURE BOOK

For the analysis of this section, we pick up six picture books: "Peekaboo", "Hide and Seek", "Bodhidharma", "The Giant Turnip", "The Sound of Vehicle", and "The Giving Chair". The former three out of the six picture books are intended for infants in their very early stage, consisting of very simple phrases without any consistent story and clear-cut outlined pictures such as animals and foods. The latter three, on the other hand, are intended for infants in their later stage, consisting of scenes tightly tied by the development of the story. For each of those six picture books, this section presents the results of analyzing the distribution of age specific reactions as shown in Fig. 6 to Fig. 8. In each plot of those figures, the x-axis represents the typical expressions ordered as in Table IV. Those typical expressions are roughly ordered from those observed in the early age 0 to those observed in the later age 3. The y-axis represents the frequency.

In the three picture books, namely, "Peekaboo", "Hide and Seek", and "Bodhidharma", that we pick up in Fig. 6, visual effects and rhythm of phrases are emphasized rather than the stories. "Peekaboo" consists of repetitive scenes of peekaboo. Apparently, peekaboo is very simple games for the infants in their very early stage. "Hide and

Seek" has more active scenes compared with "Peekaboo". Scene by scene, the main character hides behind various things such as rocks and flowers. Infants enjoy seeking the character, evoking the action of pointing the fingers to hidden place. "Bodhidharma" is full of funny gestures of main character, Bodhidharma, urging the infants to imitate the gestures. As shown in Fig. 6, for these three titles, we mostly observe age specific reactions of infants of the ages 0 and 1. For "Peekaboo", we observe infants' reactions such as *"gaze at"* as well as *"imitate"*. For "Hide and Seek", we mostly observe those of *"point fingers"*. Finally, for "Bodhidharma", we mostly observe those of *"imitate"*.
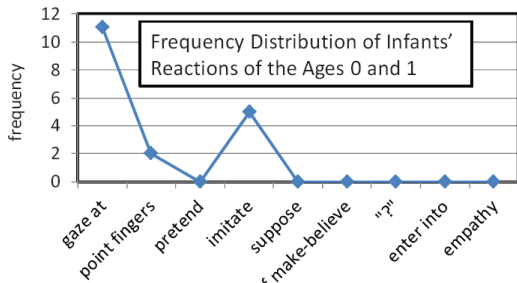
(a) Picture book: "Peekaboo"
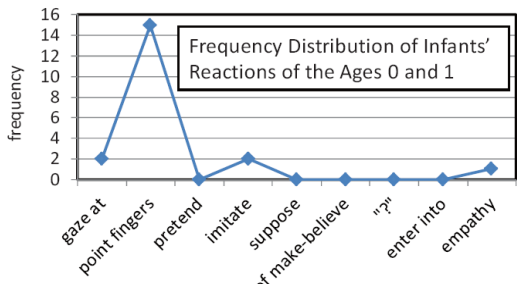
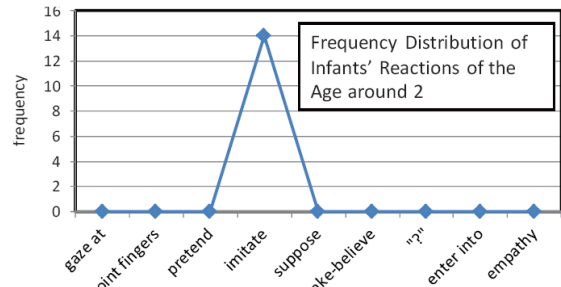(b) Picture book: "Hide and Seek"
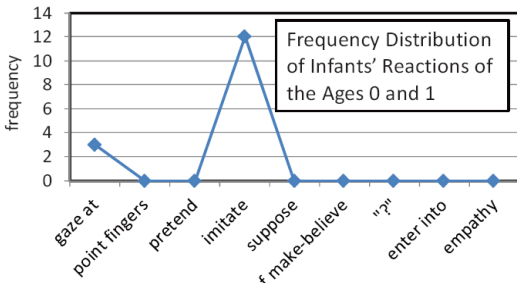
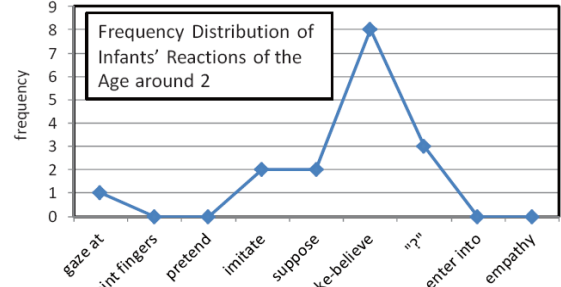
(c) Picture book: "Bodhidharma"

Figure 6. Frequency distribution of infants' reactions of the ages 0 and 1 (per picture book).

Next, in the two picture books "Bodhidharma" and "The Giant Turnip" that we pick up in Fig. 7, we observe age specific reactions of infants of the age 2. For "Bodhidharma", as in the case of the distribution for the ages 0 and 1 in Fig. 6(c), we mostly observe those of *"imitate"*. "The Giant Turnip", on the other hand, has the story with ascending tension to the climax. The main character, the old farmer found it hard to pull the giant

turnip out by himself, then his wife, his daughter, and a cat etc. appear one after another to join forces to pull it out but unsuccessful. This trial and error style might attract infants' interests to pulling out actions, resulting in notable peak of *"game of make-believe"*.
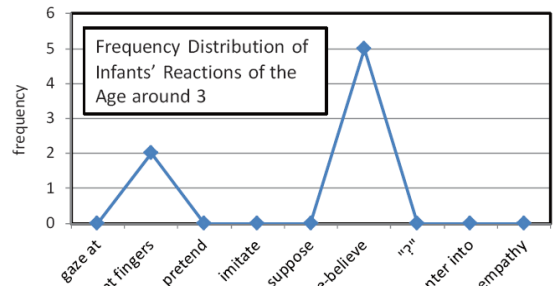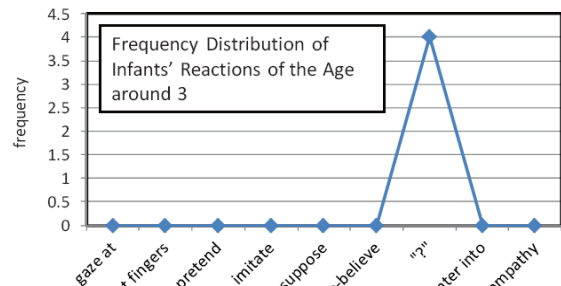

(a) Picture book: "Bodhidharma"

(b) Picture book: "The Giant Turnip"

Figure 7. Frequency distribution of infants' reactions of the age 2 (per picture book).

(a) Picture book: "The Sound of Vehicle"

(b) Picture book: "The Giving Chair"

Figure 8. Frequency distribution of infants' reactions of the age 3 (per picture book).

Finally, in the two picture books "The Sound of Vehicle" and "The Giving Chair" that we pick up in Fig. 8, we observe age specific reactions of infants of the age 3. The story pattern of the story of "The Sound of Vehicle" is similar to the one of "The Giant Turnip". Repetitive scenes of boarding vehicles attract infants' interests to boarding, invoking *"game of make-believe"* of boarding. "The Giving Chair" has an education oriented story which might make infants aware of the importance of helping someone else. Therefore, infants who do not understand this morality cannot understand its story, and tend to ask questions like "Why does its story develop like this? etc.", resulting in the peak of "?".

The analysis above implies that the differences of the style of the picture books evoke different stimuli to infants, leading to the diverse reactions.
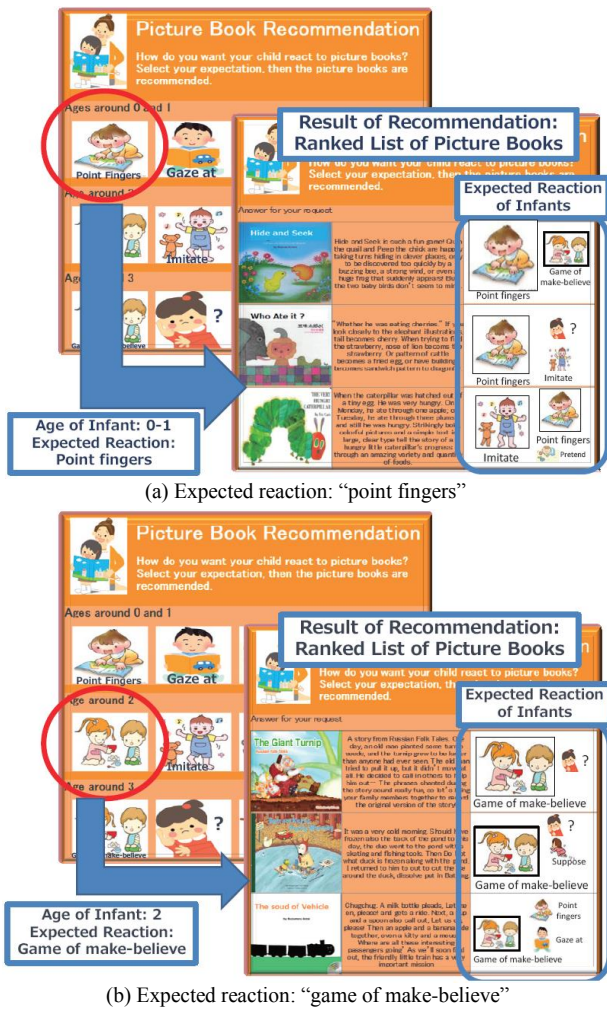

(a) Expected reaction: "point fingers"

(b) Expected reaction: "game of make-believe"

Figure 9. Examples of recommending picture books based on an infant's expected developmental reaction.

VI. RECOMMENDING PICTURE BOOKS BASED ON AN INFANT'S EXPECTED DEVELOPMENTAL REACTION

All the analyses in the previous section indicate that each picture book has its own pattern of infants' reactions. Based on this finding, we developed a picture book recommendation framework which recommends picture books that are ranked according to the degree of expected

developmental reactions by infants. Fig. 9 shows two examples of recommending picture books based on an infant's expected developmental reaction using the proposed framework. In this framework, as shown in the left half of the figure, one can specify the age of the infant as well as the developmental reaction he/she expects from the infant by selecting the icon of the expected developmental reaction that are listed in the part of the age of his/her infant.

Then, as shown in the right half of the figure, the framework shows a list of picture books that are ranked according to the degree of expected developmental reactions specified by the user. For example, Fig. 9(a) shows the case when the user specifies the ages 0 and 1 as well as the reaction as *"point fingers"*. Then, the framework presents "Hide and Seek", "Who Ate It?", and "The Very Hungry Caterpillar" as the topmost three candidates that are ranked in descending order of the frequency of the reaction *"point fingers"*. Similarly, Fig. 9(b) shows the case when the user specifies the age 2 as well as the reaction as *"game of make-believe"*. Then, the framework presents "The Giant Turnip", "Bam and Kero's Frosty Morning", and "The Sound of Vehicle" as the topmost three candidates that are ranked in descending order of the frequency of the reaction *"game of make-believe"*.

VII. CONCLUSION

Descriptions in reviews on picture books can be categorized into several types of reactions both by book talkers as well as by infants. Through manual categorization of the descriptions in reviews, we found typical expressions that appear with distinct frequency in accordance with each reaction type. Thus, typical expressions can be considered as representing reaction by infants. Based on this finding, we selected several typical expressions presumably appear in the respective age specific reactions asserted by developmental psychology. Then, we analyzed the distribution of those expressions according to the infants' age in reviews and concluded that those expressions represent infants' reactions in the way coincident with respective age specific reactions asserted by developmental psychology.

Based on the findings, we analyze the distribution of the typical expressions within the reviews on each title of picture books, and found that the picture books for the infants in their very early stage tend to show higher frequency with the typical expressions peaking at lower ages, vice versa. Qualitative analysis implies that these differences of the distributions are induced by the characteristics of the picture books such as phrases, rhythms, and pictures which differ by the recommending ages. Based on the result of this analysis, we proposed a framework of recommending picture books which accepts the age of an infant and an expected developmental reaction as its input, and as its output, gives a list of picture books that are ranked according to the degree of expected developmental reactions by infants.

According to developmental psychology, infants show variety of reactions depending on incoming stimuli. Book

talks work as these kind of stimuli. Naturally, the stimuli differ depending on the characteristics of picture books, which lead to the difference of reactions. In this paper, the relation between the characteristics and the reactions are limited to a few qualitative analyses. Future works include analyzing the characteristics of picture books themselves so as to enable predicting reactions by infants even without any review information.

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