

Analyzing Characteristics of Picture Books based on an Infant's Developmental Reactions in Reviews on Picture Books

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Abstract—Parents or child-care personnel generally read aloud to an infant, when infants who are not able to read characters read a picture book. Infants are able to perceive the contents of the book by listening to the voice and watching the pictures. Therefore, reviews for picture books have different characteristics than general book reviews. There are descriptions of an infant's reactions as well as descriptions of reviewer's impressions in reviews. We focus on descriptions of an infant's reactions, and analyze those extracted from reviews. Especially, in this paper, we study the relation between the contents of picture books and an infant's developmental reactions. More specifically, we select six typical expressions representing an infant's developmental reactions. Then, we analyze characteristics of picture books which have sufficiently high frequency of those six expressions representing an infant's developmental reactions. Moreover, we further examine which characteristics of each picture book actually contribute to letting infants show developmental reactions.

Keywords—picture books; review analysis; clustering; developmental reaction

I. INTRODUCTION

Educational books generally focus on a specific subject to be learned such as science and sociology. Picture books are, on the other hand, exceptional because they are efficient in infants' cognitive developments [1], having no intention on specific educational subject with their style of expressions, i.e., funny stories and pictures. Furthermore, readers of picture books are parents or child care personnel who make the book talk for infants who do not have sufficient literacy yet. Infants perceive and interpret incoming stimuli of the book talks and the pictures. Thus, considering such a situation, picture books are outstanding compared to other educational books, in that those who read them are separated from those who perceive them.

It is known in the research in the developmental psychology that infants express a variety of cognitive reactions to the

external stimuli in accordance with their developmental stage. Supposing that picture books work as those kinds of stimuli, it is also expected that infants might express the cognitive reactions when the stimuli of picture books are perceived. Further considering that infants are free from understanding the printed letters of picture books, this tendency might be amplified to some extent.

In order to examine how the stimuli of picture books induces a variety of reactions in infants, we take an approach of applying a text mining technique to a large amount of the reviews on picture books written by their parents or the childcare personnel. Reviews for picture books have different characteristics compared to general book reviews. There are descriptions of an infant's reactions as well as descriptions of reviewers' impressions in reviews. We focus on descriptions of an infant's reactions, and analyze those ones extracted from reviews. Especially, in this paper, we study the relation between the contents of picture books and an infant's developmental reactions. More specifically, we select six types of expressions representing an infant's developmental reactions. Then, we classify picture books according to the frequency distribution of those types of expressions representing an infant's developmental reactions.

The results of the classification show there exist picture books drawing active children's reactions and those that are not. These facts imply picture book drawing active reactions might have some advantageous factors in their directions. We compare picture books drawing active reactions and those that are not so as to specify the factors affecting the degree of children's reactions.

Section II introduces the source Web site of the reviews on picture books we utilize in this paper. Section III describes infants' reactions to picture books we examine in this paper. Section IV describes how we select those picture books we analyze in this paper. Section V analyzes the characteristics

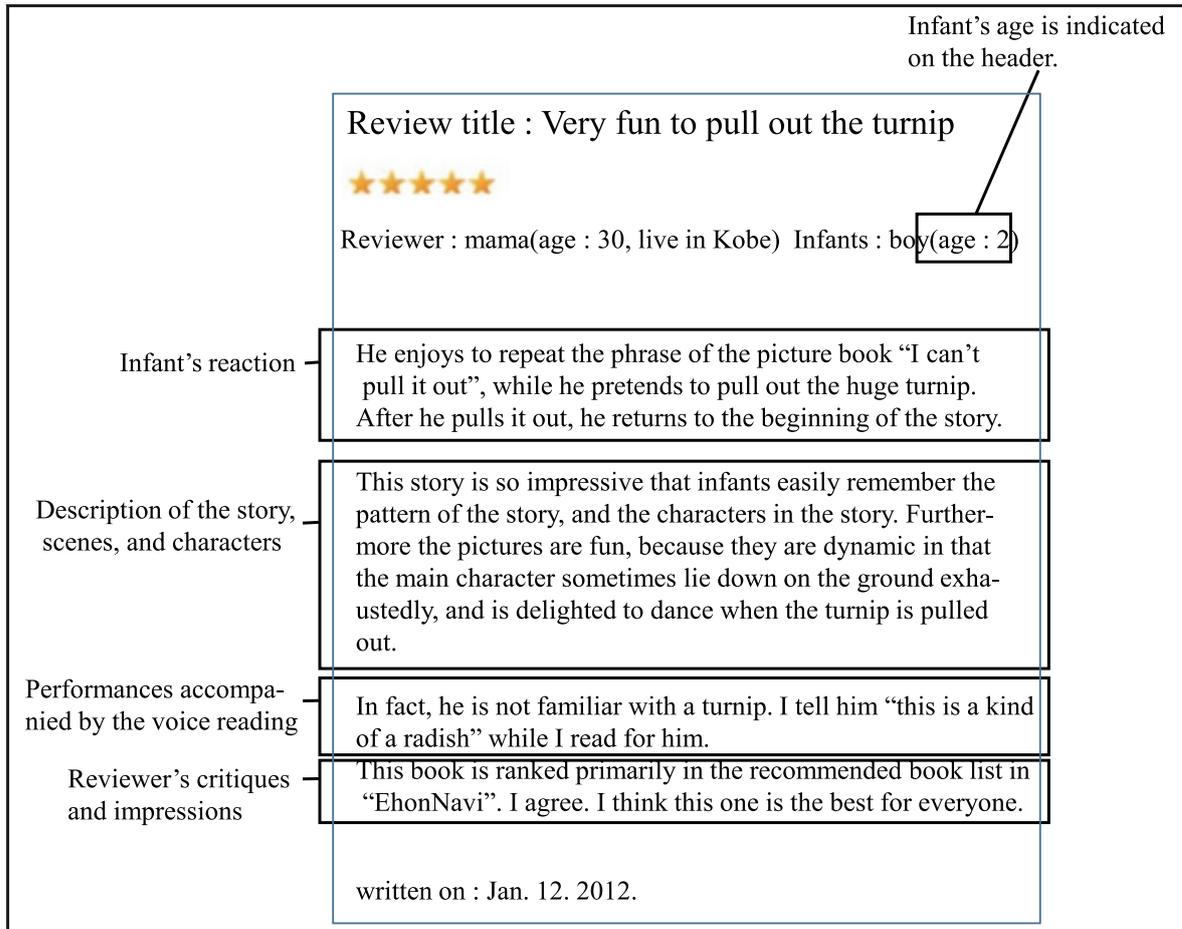


Figure 1. An Example of a Review of “The Giant Turnip”

of those picture books and finally Section VI concludes the paper.

II. THE WEB SITE SPECIALIZED IN PICTURE BOOKS

To analyze the infants' reactions, text data of reviews on picture books are collected from EhonNavi [2], a Web site specialized in picture books. EhonNavi provides information concerning picture books such as publishers, authors, outlines as well as a large amount of reviews written by the parents or child care personnel, where the numbers of the titles of the picture books included in EhonNavi amount to about 65,400. The number of the reviews amount to approximately 330,000 as of September 2016 (shown in Table I). Other than EhonNavi, popular Web sites with a large amount of book reviews include Amazon [3] and Booklog [4]. Out of them, EhonNavi has a unique characteristic in that its reviews tend to be elaborated, reflecting the reactions of those who make the books talk, as well as those who perceive them. Additionally, it is also the EhonNavi's characteristic 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 on EhonNavi for the analysis of this paper.

Figure shows an example of a 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 on EhonNavi include descriptions of book readers' reactions, mixed with infants' reactions. Since reviewers are book readers in all the cases, infants' reactions described in reviews are those observed by reviewers.

III. INFANTS' REACTIONS DETECTED IN REVIEWS ON PICTURE BOOKS

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 [5]–[8] and list them in Table II. In this table, we list those six types of reactions in the order 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 age tend to react automatically with their physical expression, such as pointing the fingers, or grasping gestures, meanwhile, those at their later 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.

Then, in order to collect typical expressions representing each of the six types of infants' reactions listed in Table II, we randomly picked 345 reviews from 16 titles of picture books. We manually examine those randomly picked 345 reviews and

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	65,400	1,100,000	420,000	332,000

(b) Distribution of the Numbers of Reviews according to Infants' Age

age of infants	0	1	2	3	4	5
number of reviews	7,820	14,802	24,794	29,538	26,123	21,585

collect typical expressions representing each of the six types of infants' reactions [9], [10]. In order to detect an infant's developmental reactions in reviews on picture books, Uehara et al. [9], [10] previously studied 10 expressions representing an infant's developmental reactions with frequency. Out of those 10 expressions, we focus on those that are more frequently observed, and allocate them to six types of infant's reactions as in the right hand side column of Table II.

According to the studies in developmental psychology [5]–[8], the infants' reaction “gaze at / stare hard / listen hard”, “point fingers”, and “pretend” are mostly observed around the age of 1, “imitate” around that of 2, “game of make-believe” around that of 2 to 3, and “enter into” and *empathy* around that of 3.

IV. SELECTING PICTURE BOOKS FOR ANALYSIS

Reviews including six expressions in Table II do not necessarily represent infants' reactions. Some of them represent their parents' reactions. In order to estimate the number of reviews which include six expressions representing infants' reactions only, we apply the following estimating procedure.

Let $f(b, a, e)$ be the frequency of an expression e out of the six expressions, in a title b and for an age a . Let $f_s(b, a, e)$ be the number of samples randomly selected from the reviews belonging to each $f(b, a, e)$. The maximum value of $f_s(b, a, e)$ is set to be 10. Out of them we manually count the number of reviews representing infants' reactions. Let $f_{sc}(b, a, e)$ be this number. Under these assumptions above, the estimated number of infants' reactions, $f_c(b, a, e)$ is expressed as the following formula.

$$f_c(b, a, e) = \frac{f_{sc}(b, a, e)}{f_s(b, a, e)} \times f(b, a, e)$$

We set a threshold on the outcome of the formula above to distinguish the picture books drawing active infants' reactions from the ones that are not. If applying formula above to any of six expressions belonging to a picture book results in the value ≥ 10 , the threshold, the picture book is recognized as the one drawing active reactions. And those picture books fulfilling this condition are classified into the set $B_{\geq 10}$ as follows.

$$B_{\geq 10} = \left\{ b \mid \sum_{a,e} f_c(b, a, e) \geq 10 \right\}$$

Meanwhile, picture books not fulfilling this condition are classified into the set $B_{<10}$ as follows.

$$B_{<10} = \left\{ b \mid \sum_{a,e} f_c(b, a, e) < 10 \right\}$$

We rank picture books in descending order of the number of reviews and select the topmost 100 titles, where the total number of the reviews of those 100 titles amount to around 27,000 (as of December 2014). Out of them, we found 45 titles fulfill the condition of the set $B_{\geq 10}$. 22 titles are internationally published, and these are the ones for our analysis. Meanwhile, we found 19 titles belonging to the set $B_{<10}$. 6 titles are the ones for our analysis which are also internationally published.

V. ANALYZING CHARACTERISTICS OF PICTURE BOOKS

We found each picture book belonging to either set $B_{\geq 10}$ or $B_{<10}$ above, shows different distribution patterns of frequency of the expressions described in Table II. We classify picture books based on the distribution patterns, then make comparison between the picture books belonging to set $B_{\geq 10}$ and the ones belonging to set $B_{<10}$ both of which are in the same characteristics of developmental reaction in Table II. By this comparison, we try to specify the factors contributing to the contrast in children's reactions,

A. Representation of Picture Books

Table III shows two examples of picture books both of which belong to set $B_{\geq 10}$. Both of the expressions, “enter into” and “empathy” form one category, because they represent the same developmental reaction as mentioned in Table II. The distribution pattern of two examples shows obvious difference. Apparently infants' reactions concentrate on “pointing fingers” in the case of Table III(a). Meanwhile, Table III(b) shows diversities in expressions. In order to specify an infant's expressions of each picture book, we set the threshold as below.

Threshold for specifying an infant's expressions:

The expressions with frequencies over 60 % of the number of most frequent expressions.

Taking Table III(b) as an example, the most frequent reaction is “pointing fingers”. Frequencies of both of reactions “gaze at” and “imitate” are over 60% of the number of “pointing fingers”, while frequencies of both of “pretend” and “game of make-believe” are under the value. Then, an infant's expressions are “pointing fingers”, “gaze at”, and “imitate”.

Meanwhile in the case of the picture books belonging to set $B_{<10}$, only the most frequent expression are used as an infant's expression.

B. Classifying Picture Books based on an Infant's Developmental Reactions in Reviews on Picture Books

Table IV shows the result of the classification based on an infant's expressions defined as above. Picture books with

TABLE II. INFANTS’ REACTIONS BASED ON THE THEORY OF DEVELOPMENTAL PSYCHOLOGY AND TYPICAL EXPRESSIONS

characteristics of developmental reactions	explanations and examples	typical expressions	
		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 / stare hard / listen hard
physical expressions mixed with verbal expressions	pointing fingers and making gestures in the 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.	pointing 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
game of make-believe	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.	5.	game of make-believe
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.”	6.	enter into or empathy

TABLE III. REPRESENTATION OF PICTURE BOOKS

(a) Where’s the Fish ?

age	gaze at	pointing fingers	pretend	imitate	game of make-believe	enter into + empathy	total
0	2	4	0	0	0	0	0
1	6	81	1	2	0	0	1
2	1	31.5	0	1	0	0	0
3	1	12	1	0	0	0	0
4	0	8.4	0	0	0	0	0
5	1	8.4	0	0	0	0	0
over 6	1	12	0	0	0	0	0
Total	11	148.9	2	3	0	0	1

(b) The Very Hungry Caterpillar

age	gaze at	pointing fingers	pretend	imitate	game of make-believe	enter into + empathy	total
0	<u>9.9</u>	1	0	0	0	0	10.9
1	4	<u>12</u>	0	4	0	0	20
2	2	6	2	<u>8</u>	1	0	19
3	2	2	0	1	1	0	6
4	0	1	0	1	0	0	2
5	0	0	1	4	0	2	7
over 6	1	1	0	1	0	0	3
total	18.9	23	2	15	2	0	60.9

multiple infant’s expressions belonging to set $B_{\geq 10}$ are classified into multiple categories. In such a case, the titles are attached with hyphenated number, as in the column “Picture Books Effective for the Reactions”.

Additionally, we make sub-categories under each expression as the column “The Intentions of Reactions” by manually interpreting contexts surrounding the expressions in the reviews. Followings are the explanations of each sub-category.

(a) “gaze at”

- onomatopoeia or simple illustration ... Infants are interested in Onomatopoeia or simple illustration.
- gazing at faces ... Infants are interested in faces on the picture books.
- colorful illustration ... Infants are interested in colorful illustrations.

(b) “pointing fingers”

- exploration ... Infants explore something by pointing fingers.
- finding correspondence ... Infants detect correspondence between narrations and the illustrations.

- selecting preference ... Infants point to their preference out from various kinds of illustrations.

(c) “imitate”

- imitating to eat ... Infants imitate to eat printed foods on the picture books.
- imitating character’s actions ... Infants imitate characters performance on the picture books.

(d) “game of make-believe”

- reproduction of the story ... Infants reproduce the story after he/she listened to picture book readings.

(e) “enter into, empathy”

- care about character’s situation ... Infants express their empathy for the characters’ painful situations.

“Ages” on the 3rd column represents the range of ages at which the frequency of each expression exceed 10, the threshold introduced in the previous section. The last column “Picture Books Ineffective for the Reactions” in Table IV are allocated ones from set $B_{<10}$ which evoke weak reactions. If there is no such picture book at all, the space is left blank.

TABLE IV. CLASSIFICATION BASED ON INFANTS’ DEVELOPMENTAL REACTIONS

an infant’s reaction	intentions of re-action	ages	picture books effective for the reactions	picture books ineffective for the reactions
gaze at	onomatopoeia or simple illustration	0~1	Chug-chug Train-1	
	gazing at faces	0~1	Smiley face-1 Peek-a-boo	Playing Peek-a-Boo
	colorful illustration	0~1	Little Blue and Little Yellow Good Evening Dear Moon-1 Won’t Go to Bed?-1 Very Hungry Caterpillar-1	
	others	0~1	The family of Fourteen Fix Breakfast-1	
pointing fingers	exploration	1~2	Quin and Peep Play Hide and Seek Where’s the Fish? Who Ate it? Miki’s First Errand-1	
	finding correspondence	1~2	Goodnight moon Where the Wild Things Are-1 Chug-chug Train-2 Very Hungry Caterpillar-2	Little Gorilla
	selecting preference	2	The family of Fourteen Fix Breakfast-2	The Blue Seed
imitate	imitating to eat	1~3	Smiley Face-2 Strawberries Guri and Gura Very Hungry Caterpillar-3	Guest of Guri and Gura Ghost Tempura
	imitating character’s actions	1~2	Won’t go to Bed?-2	
	others	1~3	The family of Fourteen Fix Breakfast-3 Good Evening Dear Moon-2 Blackie, the Crayon-1 The Magic Grove-1	
game of make-believe	reproduction of the story	2~4	The Gigantic Turnip The Magic Grove-2 The Three Billy Goats Gruff	I love to Take a Bath
	others	2~4	Blackie, the Crayon-2 Chug-chug Train-3 Won’t go to Bed?-3	
enter into, empathy	care about character’s situation	2~	Finding Little Sister Amy and Ken Visit Grandma Miki’s First Errand-2	
	others	2~	Where the Wild Things Are-2 Blackie, the Crayon-2	

C. Characteristics of Picture Books with Frequent Developmental Reactions of Infants

The fact that there are picture books in each sub-category in Table IV indicates that there exist types of picture books effective for infants’ reactions and types that are not so effective. We compare effective picture books and ineffective ones by each sub-category in Table IV to specify the features which might realize the gap of infants’ reactions. The comparison is limited to the sub-categories for which the column space “Picture Books Ineffective for the Reactions” is not blank. Followings are the results.

- 1) gazing at faces:
Effective picture books have a very simple style. For example, they contain scenes with repetitive peek-a-boo gestures. Meanwhile, an example of ineffective picture book has a pop-up that might draw the infants’ attentions on the pop-ups themselves. That is, the infants’ interests on the peek-a-boo might be interrupted by the pop-ups.
- 2) finding correspondence:

- Picture books effective for this reaction tend to illustrate objects with the straight forward styles, and corresponding texts appear with large and clear fonts. These styles might make it easier for infants to be aware of correspondence between illustration and the texts.
- 3) selecting preference:
In the case of effective picture books, a variety of characters and their actions seem to draw the infants’ attention, thereby encouraging them to express their preference by pointing fingers. Ineffective picture books tend to use the same characters and conventional actions throughout the story.
 - 4) imitating to eat:
Picture books effective for this reaction are a kind of food entertainment. Taking *Guri and Gura* as an example, scene of baking sponge cake are effective for raising infants’ expectations for eating. Also, next scene of sharing sponge cake among lots of animals depict deliciousness of sponge cake. Picture books

- not effective for this reaction do not have any kind of entertainment.
- 5) reproduction of the story:
Effective picture books in this sub-category comprise of scenes with repetitive rhythmical narration. This simple rhythm seems to help infants understanding stories impressively. On the contrary, ineffective picture books have been found to be composed of changing narrations with each scene without any rhythm.

VI. CONCLUSION

In this research, we classify picture books based on the types of infants' developmental reactions and try to specify the factors contributing to each active reaction. Analysis implies that infants' reactions vary depending on various features of picture books, such as clarity, rhythm, simplicity etc. Although the research samples are limited, these findings will contribute to constituting picture books so as to purposely draw specific reactions. To establish this knowledge, we will expand our analysis.

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