# Analyzing Developmental Characteristics of Infants' Finger/Hand Gestures
## — Text Analysis of Picture Book Reviews —

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## 1  Introduction

Gestures are very popular expressions that people around the world use in their daily life. Even animals of higher order use gestures.Among them,several important characteristics of the gestures have already been found in the previous work. In general, infants' gestures around the period of acquiring language are known to play a special role. In this respect, several important characteristics of the gestures have already been found in the previous work. In general, most of them have dealt with the gestures as classified patterns such as deictic gestures, iconic gestures etc.,but not the ones in practice. Gestures in practice appear as expressions using body parts such as fingers, hands,arms etc. These studies seldom introduce the gestures in the way they appear in practice, partly because of direct classifications by watching video taped infants' gestures without recording elaborated expressions of gestures.

This paper makes use of a large amount of texts written on the Web site specialized in picture books where gestures are described as infants' movements using body parts such as fingers, hands etc. Making use of these data, we try to extract infants' gestures in practice, especially the ones expressed with fingers and hands, and analyze their developmental characteristics. Finger/hand gestures are expected to have diverse variations. This paper mainly aims at studying these diverse variations of gestures which have been classified into just a few gesture categories in previous work.

## 2  Utilizing a Large Volume of Picture Book Reviews

To extract wide varieties of infants' gestures in their daily lives, we make use of a large volume of text data written on Web site specialized in picture books, Ehon Navi[1]. There, approximately 330,000 reviews of picture books are written. Most of the reviewers are parents with a little exception by child care persons etc. These reviews are found to include embodied infants' gestures exhibited during picture book readings by their parents.

Each review of EnonNavi. has infant's age printed on the header. And the body sentence is a kind of mixture of parent's impression, infants' reactions, or just the description of the story, etc. Thus, extracting infants' gestures out from the mixture is necessary for our analysis.

## 3  An Approach of Extracting Infants' Gestures from the Reviews

Uehara et al. [2] tried to extract infants' reactions out from the reviews of picture books. Their purpose is to analyze the frequencies of infants' reactions represented by specific words such as *"pointing fingers"* and *"game of make-believe"*. Searching for the reviews by these key words fulfills this purpose. Meanwhile, this paper tries to capture diversified expressions of gestures which cannot be determined by fixed key words. To cope with this issue, a technique other than that employed by Uehara et al. [2] is required to be introduced.

According to Wikipedia[2], gesture is defined as follows.

> *A gesture is a form of non-verbal communication or non-vocal communication in which visible bodily actions communicate particular messages, either in place of, or in conjunction with, speech. Gestures include movement of the hands, face, or other parts of the body.*

Gestures are characterized by movement of parts of a body as above. Based on this, the rule for extracting varieties of embodied gestures is set as follows.

**The Rule of Extracting Gestures**

1. Extracting first verb appearing after morphemes representing a finger of a hand.

2. The interval between the verb and the expressions of parts of a body is restricted to 10 morphemes.

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Table 1: Overview of the Numbers of the Reviews per Age

| Age | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| No. of reviews | 7,821 | 14,799 | 24,819 | 29,623 | 26,156 |

Executing the rule above brings about not only infants' gestures but also their parents' gestures etc. We manually distinguish infants' ones from those that are not.

# 4 Analyzing Infants' Finger/Hand Gestures extracted from Picture Book Reviews

This section shows the results of the execution of the rule above, then describes the classification procedure of the extracted infants' gestures. The classification is based on the gesture types that are generally agreed among previous work. This classification enables us to compare developmental feature of each gesture type with finger/hand gestures classified into it, and to examine if some of finger/hand ones show distinctive developmental features among the ones in the same gesture type.

## 4.1 Overview of the Extracted Data

Specifying infants' ages ranging from 0 to 4 results in retrieval of 103,218 reviews as in Table 1. Then, we extract both of finger gestures and hand gestures as in Table 1 by applying the rule above. The first lines of each of finger/hand gestures shows the numbers automatically extracted by the rule above. The second lines shows the numbers of infants' gestures based on manual separation.

Because total number of reviews belonging to each age is different with each other as in Table 1, each number in Table 2 should be normalized to compare the volume by each age. The third line shows the values after the normalizations.

## 4.2 Classifying Extracted Finger/Hand Gestures

The sentences surrounding extracted gestures above contain clues for classifying them into the gesture types defined in previous work. The types of gestures are in Table 3 which are generally agreed among the previous work [1].

We manually classified extracted gestures above into corresponding gesture type in Table 3. by interpreting the surrounding sentences. Table 4 shows the examples of manual classification. The actual sentences surrounding gestures' expression are in the column "Sentences surrounding gesture expressions" in the table, and classified gesture types are in the column "gesture type".

The first example depicts a scene an infant pointing at illustrated caterpillar by his finger.. Second example depicts an infant reaching for characters and touching them in a picture book by her hand. Apparently "deictic" is the relevant category for both of the examples by the description in Table 3. The third example is also classified into "deictic". The expression *"direct her hand toward"* depicts the same gesture as *"reaching out for"* in the second example. In such a case of different expressions depicting exactly the same gesture in action, we annotate them by typical expression such as *"reaching out by hands"* in the column "embodied gesture" of both of the second and the third examples. the column "finger/hand" represents the distinction between the finger gesture and the hand gesture. The first example belongs to finger gesture, while both of second and third examples belong to hand gestures.

The last example shows an infant's gesture expressing hot rice cakes baked on the iron plate by waving his hand. This gesture depicts the situation of baking rice cakes so that it is classified into "representational".

# 5 Analyzing Developmental Characteristics of Finger/hand Gestures

Classifying gestures in picture book reviews as the way in Table 4 enables two kinds of analysis in terms of developmental characteristics. One is the analysis of diversities. As described earlier, finger/hand gestures in picture book reviews are expected to be depicted in a manner of substantial diversities, enabling the pattern of diversities in accordance with developmental stages.

Another one is the analysis of frequencies. Ample variations of finger/hand gestures eliminate conventional restriction of analysis based on aggregated frequency by each gesture type, and enable elaborated analysis of fluctuations by each embodied gesture inside each gesture type. Hereafter, both of the analysis are described.

## 5.1 Diversity Analysis

Table 5 shows total variations of embodied gestures belonging to each gesture type. These figures are obtained by counting the variations of the column "embodied gestures" in Table tab:classification belonging to each gesture type.

Meanwhile, the variations of "embodied gestures" in Table 5 are counted by finger/hand classifications and by age classifications both of which are also indicated on Table 5. Figure 1 compares the ratios of the numbers of the variations of the finger/hand gesture types, setting total value of each age to 100%. Hand gestures show pretty much diversities than finger gestures. Especially at age 4, portion of hand gestures shows distinct expansion.

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Table 2: Statistics of the Frequencies of Finger/Hand Gestures per Age

(a) Finger Gestures

| age | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| finger gestures | 151 | 707 | 457 | 267 | 138 |
| infants' finger gestures | 75 | 606 | 356 | 147 | 71 |
| infants' finger gestures (normalized) | 198.0 | 845.3 | 296.1 | 102.4 | 56.0 |

(b) Hand Gestures

| age | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| hand gestures | 424 | 791 | 873 | 1027 | 856 |
| infants' hand gestures | 111 | 138 | 97 | 65 | 40 |
| infants' hand gestures (normalized) | 293.0 | 192.5 | 80.7 | 45.3 | 31.6 |

Table 3: Gesture Types of Infants

| Gesture Type | Description |
|---|---|
| rhythmic behavior | rhythmically repeating movements of hands etc. (e.g., banging objects) |
| deictic gesture | gestures trying to obtain or refer to something interesting. (e.g., pointing at objects, reaching out for objects) |
| representational gesture | gestures expressing characters or movements of objects (e.g., flapping hands for representing birds) |
| conventional gestures | signs agreed within the society or culture (e.g., a hand waving to say hello or goodbye) |
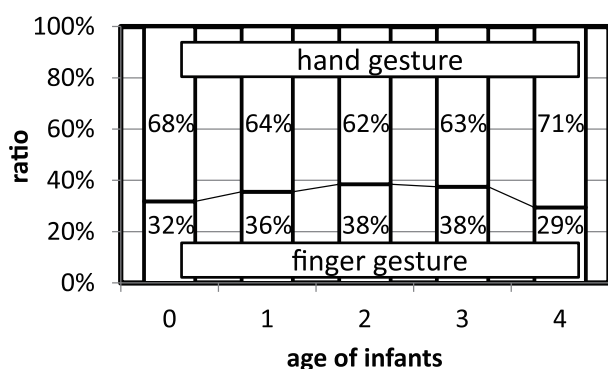


Figure 1: Ratios of the Numbers of the Variations of Finger/Hand Gestures per Age

## 5.2 Frequency Analysis

Figure 2 shows age distributions of embodied gestures classified as deictic and representational in Table 4 out from four gesture types. While both of them show coincidence of peaks, they show interesting contrasts with respect to their frequencies by each embodied gesture. *"Others (hand)"* and *"others (finger)"* in this figure are composed of varieties of gestures, where each of the individual gesture types has a relatively small frequency.

The Frequency of deictic gesture comprises of moderately diversified embodied gestures at age 0, however the frequencies afterwards exhibit monotonous diversities dominated by pointing gesture. Meanwhile frequencies of representational gesture remains to be diversified until age 4. Additionally looking into comprising embodied gestures reveals different patterns of their frequencies. Taking *"eating with hands"* as an example, it peaks at age 1 accompanied by slight decline at age 2, then shows strong decline afterwards. Meanwhile, *"tracing shapes by fingers"* indicates different patterns. It emerges as if it takes over *"eating with hands"* and peaks at age 3.

Figure 3 shows the age distributions of finger gestures and hand gestures where pointing gesture is excluded, because the values are overwhelming. This graph indicates that hand gestures are used more frequently than finger gestures except in case of pointing. And the portion of hand gesture at age 0 is overwhelming, then sharp decline at age 1 followed by gradual recovery towards the later ages. To obtain developmental implications, we need elaborated analysis of embodied gestures constituting the graphs.

## 6 Conclusion

In this paper, we extract a large volume of infants' gestural expressions in use from picture book reviews, and try to extract the developmental characteristics. Our approach deals with gestures as the form of expressions by body parts. This is a novel approach comparing with previous developmental studies all of which have used conceptually classified gesture types. The results imply the following developmental characteristics.

Table 4: Examples of Classification into Gesture Types

| reviews surrounding gesture expressions | age | finger/hand | embodied gesture | gesture type |
|---|---|---|---|---|
| *Now my son points at the caterpillar saying "Ah !"* | 1 | finger | pointing | deictic |
| *My 0 year old daughter seems to be attracted by pretty characters, and reach her hands out for them.* | 0 | hand | reaching out by hands | deictic |
| *My son loves the scene of "hand", and tries to touch it by directing his hands towards it.* | 0 | hand | reaching out by hands | deictic |
| *My 1 year and 8 months age son pretends to bake rice cake by waving his hands expressing it is very hot.* | 1 | hand | waving hands | representational |

Table 5: Numbers of Variations of Embodied Gestures in Each Gesture Type

| | rhythmic | reaching | pointing | representational | conventional | total |
|---|---|---|---|---|---|---|
| finger gestures | 0 | 5 | 1 | 14 | 2 | 22 |
| hand gestures | 3 | 6 | 1 | 38 | 8 | 56 |
| total | 3 | 11 | 2 | 52 | 10 | 78 |
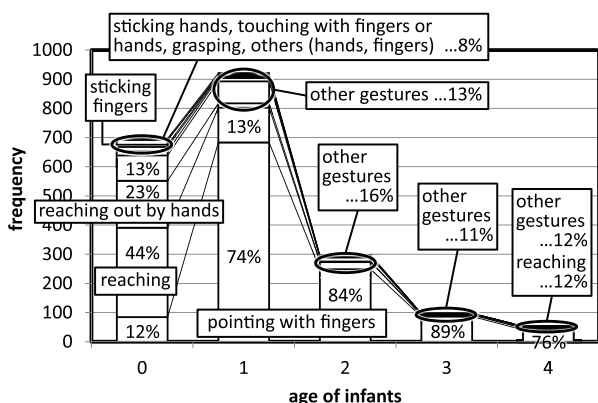


(a) Deictic Gesture
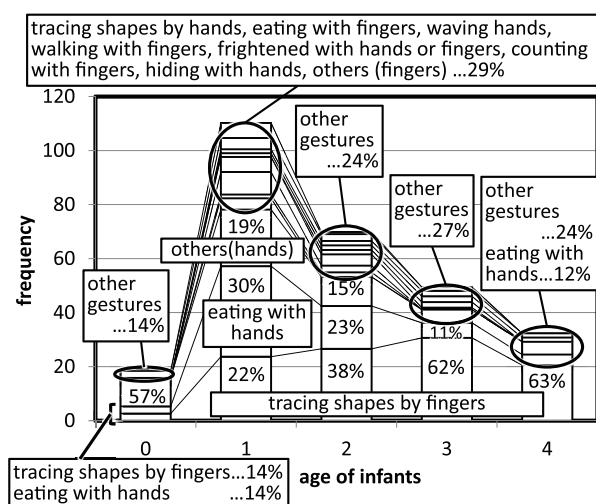


(b) Representational Gesture

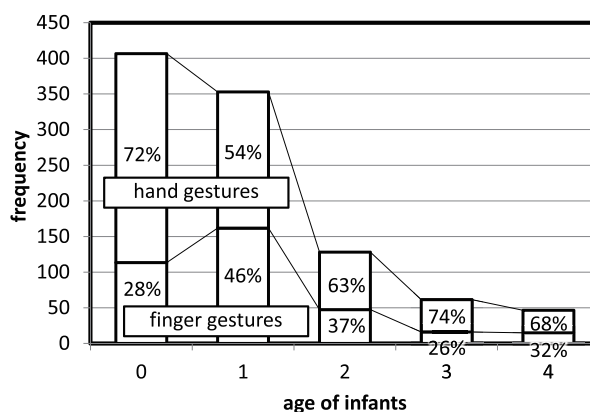Figure 2: Gesture Type Distributions of Embodied Gestures per Age



Figure 3: Frequency Distributions of Finger/Hand Gesture Types (except pointing) per Age

1. Infants use more diversified hand gestures than finger gestures throughout the range of ages.
2. Infants show distinctive variations to express representational gestures especially by using their hands.
3. Frequent gestures in practice for representational gesture are changing in accordance with infants' development.

Further work includes interpreting obtained gestural characteristics.

# References

[1] N. C. Capone and K. K. McGregor. Gesture development: a review for clinical and research practices. *Journal of Speech Language and Hearing Research*, Vol. 47, No. 1, pp. 173–86, 2004.

[2] H. Uehara, M. Baba, and T. Utsuro. Analyzing an infant's reactions in reviews on picture books based on developmental psychology. *International Journal of Signal Processing Systems*, Vol. 4, No. 4, pp. 311–317, 2016.