

Child-robot interaction mediated by building blocks: From field observation in a public space

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Abstract

This study attempts to describe children's behaviors from the viewpoint of microscopic adjustment of actions when they encounter an oddly shaped robot, called 'Muu.' We investigated this through field observation at a workshop in a children's museum. Various aged children and their parents participated in the workshop together. They were instructed by an experimenter to play with building blocks while talking with Muu. As a result, it was found that the children and the robot could establish rich communications with each other not when the children evaluated Muu's behavior but when Muu evaluated the children's works. This indicates that the robot could become an 'other' that might interact with children mediated by the building blocks, whereas many children and parents treated it as a 'toy', just as the building blocks were considered merely 'objects' during interaction.

1. Introduction

How do children behave toward robots, especially a robot that asks to communicate with them? Do they gather around the robot because of its novelty but then soon lose interest? Or would such a robot become an object to which the children attached themselves? This study investigates how a robot should be put to practical use in a social organization from the viewpoint of systems engineering and also considers the development processes in human communications.

A developmental psychologist, L. S. Vygotsky attempted to investigate children's mental processes experimentally. In that study, the researcher intensively confused the subjects (children) in their communications and left them alone in a situation without a parent's support, which they usually received. Then the children became upset and struggled to understand the meanings

of the things in front of them by themselves. Vygotsky revealed from this experiment that children have faint but ceaseless mental activity, which is normally buried in the parent's supports[1]. He called their development of such activities 'The Zone of Proximal Development. [2]' Harold Garfinkel, who was originator of Ethnomethodology, implemented a series of 'breaching experiments' in order to find a method to construct 'seen but unnoticed' reality in daily life[3]. This attempt disrupted the general ideas held in daily life by artificially making a situation that betrays 'background expectancies' such as rules or social common sense, which are not explicitly visible because they are naturally and tacitly shared by people.

A communication robot sometimes confuses our natural human communications, since it looks neither mechanical nor the same as a human. The authors intend to clarify the process of development in human communications by investigating the behaviors of children and their parents in front of the robot, which is the very research theme of Vygotsky and Garfinkel. The communication robot 'Muu' used in this study has restricted capability in its functions so as to construct meanings of things through communications with others (humans). The authors call this type of design method the 'minimal design of relationship.'

2. Method

2.1 Observation conditions

This experiment was implemented in the field at a workshop in a children's museum, 'Kids Plaza OSAKA,' for three days in June 2004. This paper reports the results of a two-day observation period under the same experimental conditions.

2.2 Participants

A child and his/her attendants (usually parents of the child) were regarded as a team for this experiment. Teams participated in the experiment by interacting with Muu in order of their arrival. The total number of participants was 69: 30 teams from 42 children and 27 attendants. The children's ages varied from two to twelve.

2.3 Experimental setup

The experimental setup was located within the facility and surrounded by partition walls. The setup is composed of a low table, 120 cm square, on which Muu and a basket full of toy blocks were placed.

In this study, the behaviors of Muu are regulated as follows.

Linguistic behavior: The Wizard of Oz method was used. That is, Muu was controlled to speak the appropriate words, selected from 150 prepared words, according to the interaction with the subject. The subjects were not informed of this fact. They seemed to guess that Muu autonomously and spontaneously spoke by itself. The contents of its speech were divided into different categories: One is concerned with toy blocks, for example, "Pile on a red block, please." Another involves evaluation of the child's work, for example, "It's cool, isn't it?" Another category is for compliments or chiming in, for instance, "I see."

Non-linguistic behavior: Muu was controlled to generate some slight rolling and pitching motion of its body and to move about 20 cm forward and backward. Muu was also controlled to move its body corresponding to the expressions, "Hello," "Good bye," and so on.

2.4 Observation procedure

Observation was implemented in the following way.

- (1) Let the children who want to interact with Muu stand in a line in order of arrival.
- (2) Induce the first child in the line and his/her attendants to enter the test field, ask his/her name, and tell him/her while pointing at Muu "This is Muu. It seems he wants to ask of you to build up the toy blocks while speaking with him. Will you help him to build up the toy blocks? Please ask him 'Say, what?' if you cannot clearly hear Muu's words."
- (3) Recede to the side and begin to observe the interactions among the child, attendant, and robot. The time period for one interaction session was limited to about 5 minutes. Two video cameras captured the experiments, with the agreement of the participants. One camera was installed to the right-front of the subjects and the other was set to the

left-rear of the subjects to record an elevated view of the experimental field.

2.5 Analysis

In this study, the situation of talking with the robot confused most children and attendants. However, a few cases showed rich and natural human-robot communication. This section focuses on three typical cases of 'good' communication. In order to distinguish between the former cases and the latter ones, the Conversation Analysis method was used as a qualitative evaluation for the in-depth study of behavior in context. An ethological analysis method was also exploited in handling the video recordings of the children's play: gaze and timing of movements were incorporated in an index of social interaction.

3. Results and Discussions

This study focuses on the interactions of children aged more than 5 years (23 teams). This policy is supported by the fact that only the participant teams that include children aged over 5 years showed spontaneous speech directed toward Muu. Accordingly, this age is regarded as the threshold for children to begin interacting with others independently of their parents, in spite of being under the influence of parents.

3.1 Most observed interaction cases

In the type of interactions most often observed, the children built with the toy blocks to temporarily satisfy Muu's requests. In these cases, they seemed to have no clear of what they should build. After once following Muu's requests, the children piled on the toy blocks in their own way without taking notice of Muu. Most attendants ordered the children to speak to Muu when they were independently playing with the toy blocks. If the children still did not speak to Muu, the parents induced them to speak about themselves to Muu by saying words such as "Ask him how old he is." Due to the limitation in Muu's capacity of speaking words (150 words), inappropriate responses from Muu to participants' words were sometimes observed. For example, when the child received the same words from Muu as in a previous situation, he/she pointed out that fact by saying in amazement "Hey, you said the same words before." On the other hand, when Muu made adequate responses, the parents complimented Muu with such expressions as, "You are cool", "You are so cute", "You must be so wise", and so on.

3.2 Rich and natural communication cases

In three cases, the subjects had such a clear concept of their work that it was easily observable, and these were obviously different from most other cases observed. Furthermore, in these three cases, natural communications were observed between the subjects and Muu. These three cases are described in detail below.

3.2.1 Case 1: Subject A (aged 6) and her father

In this case, it was observed that subject A began speaking spontaneously. Although she would not talk to Muu at the beginning of the experiment, through the encouraging advice and interventions of her father, she started communicating. The difference from most cases is that, in case 1, the father built with the toy blocks in himself and induced his daughter to join to build them, without compelling her to speak to the robot. At the beginning of the interaction with Muu, subject A noticed that Muu was slightly moving; however, she did not spontaneously speak to Muu, but just repeatedly glanced at Muu. On the other hand, her father himself began to build with the toy blocks, and informed her of what Muu had said, for example, “He said feels so cool!” as if interpreting Muu’s words whenever Muu used the evaluating words for their works. Subject A repeated Muu’s words such as “Feels so cool!” loud enough to let her father and Muu hear the words. In the meantime, her father suggested that she built the blocks closer to Muu, saying “Closer is better for Muu.” Subject A accepted the suggestion. Subject A and her father began to build with the blocks closer to Muu’s eye. Meanwhile, Muu said the evaluating words for their work, “That’s cool!” Subject A guessed that her work was highly evaluated, however, her father insisted that the evaluation was for his work, not for hers. Then, subject A looked at Muu for a while, read Muu’s expression, and finally was convinced that her father’s claim was right. After that, she gave up using ambiguous words that might be taken the words for both her father and Muu. Instead, she began to frequently direct words to Muu asking for an evaluation of her father’s work, such as “How do you feel about this one?” and “How about this?” (Fig. 2).

3.2.1 Case 2: Subject B (aged 7) and his father

Subject B accomplished two-person interaction with Muu beside his father but without permitting his father’s intervention, in contrast to the case of subject A, who began to spontaneously speak to Muu with the support of her father. The interaction in this case continued in a

style characterized by the subject piling on the blocks one by one while asking about Muu’s intentions. For example, his question to Muu at the beginning, “Hey! Which block should I use first?” typically shows this style. Gazing at Muu, conducting conversation, and piling on the blocks are repeated in order. Subject B asked questions while looking at Muu, and he received some responses from Muu (Fig. 3). If he could not hear Muu’s words, he again asked Muu with the word “Eh?” while gazing at it. When he guessed Muu’s words, he turned his eyes to the basket of blocks, found the block that Muu pointed out, and placed it in the way Muu commanded. After that, he again looked at Muu and asked what to do next. This case of interaction continued by repeating the steps of communication and piling on blocks. In this case, the utterances of subject B and Muu never overlapped, as if they were making a certain communication rhythm; this was quite different from most other observed interactions. Interestingly, his father’s utterance sometimes overlapped Muu’s. Subject B made replies only to Muu’s words, not to his father’s. However, he did not ignore his father’s intention. For example, when he was asked to pile on a red block, he looked up at his father. This behavior is unprecedented among his behaviors, in which he gazed at only Muu or the toy blocks. At that time, their work of toy blocks was piled so high that if they continued to pile on the blocks as instructed by Muu, it might fall down. This implies that the subject had to find a new way to overcome the situation. After that, subject B began to tell his intentions or suggestions to Muu, for example, “How about this way?” The concept of subject B was consistent from the start to the end, which was that he decided to build the work that Muu intended on behalf of Muu. He paid attention to Muu’s intention and carefully piled on the blocks one by one. This behavior was not observed in the other subjects. The role of his father was to keep his eyes on his son and to give suggestions when his son had some trouble with the work. As in case 1, the father’s words were directed toward the concept of the work, such as how to build with the blocks, and not toward compelling his son to speak to Muu or to evaluate Muu’s behavior such as “This robot is cool” or “This one is smart!”.

3.2.1 Case 3: Subject C (aged 11)

In this case, it was observed that subject C came to clarify the concept of the work by referring to Muu’s evaluation during interactions. This subject had the habit of talking to himself very loudly, as if addressing Muu. At the beginning of the interactions, he repeated mumbled expressions like “I can’t guess”, “I’ve no idea”

and so on, which expressed that he had no idea about the concept of the work. Then, he received a comment from Muu, “You are such a funny guy, aren’t you?” After a moment, he muttered, “He said I am so funny, or something like that,” and began to laugh. When he received the comment from Muu “A poor hand!”, he burst into laughter and broke the work down into many pieces, saying “A poor hand! Come on! What are you talking about?”. After the accident, subject C silently continued to build up the blocks. During the construction, although he received several comments from Muu such as “I see” and “That’s cool,” he made nearly no reply, except for rare giggling. The shape of the toy-block work was gradually tuned, and at nearly the end of the given time, it became clear that subject C intended to make a toy-block robot (Fig. 4). At that time, Muu spoke something but it was lost in the surrounding noise. Then he promptly asked Muu in a loud voice, “Eh? What?”; Subject C seemed eager to know Muu’s evaluation of his work.

4. Conclusions

It was clarified that children and the communication robot ‘Muu’ were able to establish rich and natural communication with each other not when children evaluated Muu’s behavior but when Muu evaluated the children’s works. In order to retrieve an appropriate evaluation, it was necessary for the children to produce an utterance in any way and to provide a trigger for Muu to converse, for example, by talking to themselves in a distinct tone, repeating Muu’s words, and so on. The role of the communicative children’s parents was to arouse their children’s interests in their work, to induce them to begin speaking voluntarily, and to construct communications or conversations toward accomplishing results. As future study, we are planning to provide an environment for human-robot interactions from a global viewpoint, ranging from the development of the system to a method for teaching subjects. Such an environment will produce more substantial results and build upon the knowledge obtained in this study.

References

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Fig. 1: Experimental setup



Fig. 2: Case 1 “How about this?”



Fig. 3: Case 2 “Build with this block? This way?”



Fig. 4: Case 3 A toy-block robot under construction