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Using a Daily Routine Game on the BLISS Robot for Supporting Personal-Social Development in Children with Autism and Other Special Needs

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Abstract: For autistic children and children with special needs, performing daily routine can be relatively difficult. Many parents have developed chronic stress as they have to confront inappropriate behaviors from their child. In this study, we developed a daily routine game on the BLISS robot and investigated the use of the daily routine game on the BLISS robot in autistic children as well as children with special needs. We hypothesized that by taking care of daily routine for the robot, children could aware and perform their daily routine better. This daily routine game included four sections: brushing teeth, taking a shower, having a meal, and packing a bag for school. Six children with autism and other special needs between 3 and 10 years old participated in this study. All children played this game with the BLISS robot twice. The experimental results showed that participants could improve their development in both language and personal-social skills. Almost all children (5 out of 6) learned the rules of games in the first round. When the robot makes a request, they can do missions of the game by responding to the request by themselves. All children appeared to enjoy playing with the BLISS robot. The personal-social development evaluated by parents showed significant improvement after the experiment ($p < 0.05$). Therefore, playing a daily routine game as taking care of the robot could promote children personal-social development.

Keywords: Child development, personal-social development, robot, daily routine game, autism spectrum disorder, children with special needs.

1. INTRODUCTION

Autism Spectrum Disorder (ASD) is a complex neurodevelopmental disorder [1]. The symptoms of ASD are characterized by impairments in social interaction, social communication, and stereotyped behaviors and restricted interests [2]. There are many possible causes of ASD, including some problems in neural systems, genetics, environment, and so on [3]. However, the absolute cause of this disorder is still unknown. The prevalence of ASD has been increasing worldwide. In the US, there was 1 autistic child in 150 children in 2000, but by 2014 the ratio had increased to 1 autistic child in 59 children [4]. In Thailand, the number of severe ASD was estimated at 9.9 per 10,000 in children aged 1 – 5 years [5]. The current treatment approach for this disorder is providing therapy to normalize social behavior and to support development in autistic children. The cooperation of children with autism is important for therapy to be successful. However, therapists have difficult times to keep the children engaging in a therapy session. Moreover, the number of therapists is still insufficient to meet the ever-growing demand.

Many research studies support the use of robots to enhance learning in children with autism [6]. The purpose of using robots is to assist therapists or parents in autism therapy. For example, KiliRo robot [7, 8], which is semi-autonomous parrot-inspired, was used for supporting learning and interaction of children with autism. It can increase the interaction of children and encourage them to communicate with others. Bharatharaj et al. [9] used the robot in music therapy. Their robot can assist the teacher in teaching children with autism about how to play a drum and xylophone. It was reported that children felt safe and happy when they played and learned with this robot. Labo-1 [10] is a mobile robot which children with autism can play the chasing game and interaction game. Their results supported that the robot could be used with autistic children for supporting in social responsibility by increasing the touch and eye contact. Another research study used the FACE robot [11] for training social skills in autistic children. Their preliminary results showed that children did not feel afraid of this robot. The robot can increase the social awareness of them.

Previous studies suggested that the robot can engage children with autism in therapy. Moreover, robots can support the development of the social skills of children by playing with them. However, the use of the robot for giving better practice in regular daily routine, which is vital for children with autism to live in real social life, remains unrevealed. It is relatively difficult for autistic children and children with special needs to perform daily routines by themselves. They tend to have inappropriate behaviors that interfere with participation in the daily routines with their parents [12]. Many parents were found to have chronic stress when they have encountered those scenarios every morning. In general, therapists advise using visual supports i.e., PECS (The Picture Exchange

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Communication System) to communicate with patients [13]. However, it is not attractive for some autistic children and accordingly ineffective for them. The parents must maintain the child's participation throughout the activity, so it could result in a stressful time. This highlights the necessity of alternative support that is more appealing and less labor intensive.

In this study, we designed and developed the daily routine game on the BLISS robot. The objective of this study is to investigate the use of the daily routine game on the BLISS robot for supporting personal-social and language development in children with autism and other special needs. We hypothesized that after children played this game with the BLISS robot, which is like taking care of the BLISS robot, children would learn to do the daily routine activities by themselves.

2. MATERIALS AND METHODS

In this study, we designed the system, as shown in Fig. 1. The BLISS robot was designed to be a mediator between the child and parent or therapist in a triadic interaction [14]. It is one type of therapies that previous studies used to improve social interaction for autistic children. The role of the BLISS robot in this study is like a pet that requests help from the child. The child plays the daily routine game with the robot by responding to the requests. The parent helps and supports the child during the activity. The BLISS robot responses according to the child's actions toward the robot.

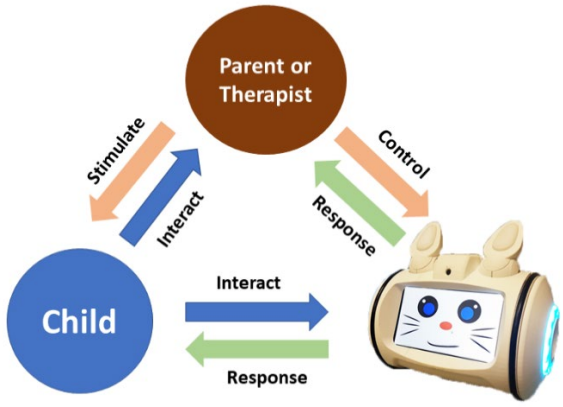

Fig.1 The system of BLISS robot.

2.1 Participants

Six children between the ages of 3 and 10 participated in this study. All participants are the students at the Play & Learn school by Krunong, Bangkok, Thailand. They were screened by a child psychologist before recruited in this study for confirming that all participants have either autism spectrum disorder or other special needs. The demographic data of the participants are shown in Table 1.

Table 1 The demographic data of participants.

No.	Gender	Age (Years)	Symptom
1	Male	10	Autism
2	Male	5	Autism
3	Female	3	Autism
4	Male	3	Autism
5	Male	6	Children with Behaviorally and Emotional Disorders
6	Male	9	Attention deficit hyperactivity disorder (ADHD)

2.2 The BLISS robot

In the previous study, our group developed the BLISS (Using Robot in Learning Intervention to Promote Social Skills for Autism Therapy) robot [15], which is a capsule-shaped mobile robot with two wheels as shown in Fig. 2(a). The BLISS robot version 1 looks like a toy. It can exhibit LED light and sound and can be used with other accessories, such as RFID cards and wireless remote control. After the study, we developed another version with human-like appearance [16] as shown in Fig. 2(b). The BLISS robot version 2 has almost the same all functions as version 1 but with a built-in computer for increasing the power of computation. The mobile application on tablets can be used to control it in autism therapy. We conducted a research study on the theory of mind [16] and found that children with autism who played with it could learn social skills such as the theory of mind and initiating communication to others.

(a) (b)

Fig. 2 The BLISS robot (a) version 1 (b) version2.

Nevertheless, intending to make the BLISS robot available to support every child with special needs, our group thought that both versions could be improved to have more degree of interactiveness with children. For this reason, we developed BLISS version 3 with the toy-like appearance, as shown in Fig. 3. It has an interactive touch screen for displaying face and interactively playing a broader range of games on the robot. This version includes two ears as additional mechanical outputs. We hoped that the interactive screen would allow the robot to attract the children. Additionally, this robot can collect every action which children touch on the screen.

Moreover, it can detect the emotion of children during playing games. All information is collected in the web database for monitoring the progress of children and analyzing child development by specialists.

Fig.3 The BLISS robot version 3.

2.3 Daily Routine Game

We designed the daily routine game for supporting child development. Children can play this game on the BLISS robot by using the interactive screen and RFID card. The daily routine game includes four sections of everyday activities: brushing teeth, taking a shower, having a meal, and packing a bag for school, as shown in Fig.4.

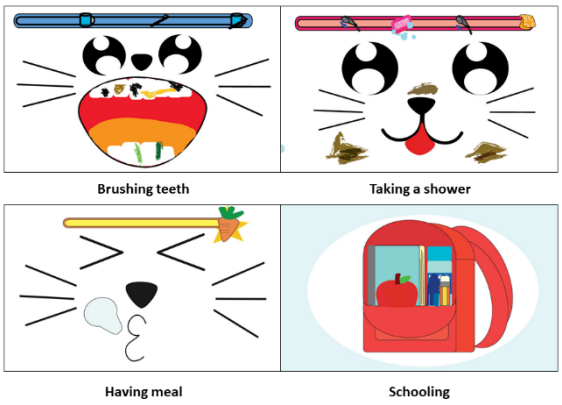

Fig.4 The example scenes on the daily routine game.

The daily routine game has six steps, as shown in Fig.5. Firstly, the robot says "hello" to greet the child and encourages him/her to play the game. When the child starts the game on the BLISS robot, the brushing part starts. He/she must do some missions according to BLISS's requests for cleansing its teeth such as washing mouth and brushing teeth. After the child completed the brushing part, taking a shower part follows. In this part, the robot requests him/her to help it bath, such as showering with water, soaping, and wiping. After that, he/she must feed some foods to BLISS's mouth in the third part. Finally, he/she helps BLISS to pack its bag in order to get ready to go to school. After all the parts are finished, the BLISS robot concludes the score of the game and says goodbye to the child.

The missions require the child to either use RFID cards or touch pictures on the screen. When the child does the mission correctly, the robot expresses positive reactions, including displaying green and blue color and saying "Very good" to the child. On the other hand, when the child does the mission incorrectly, the robot encourages them by expressing the purple color and saying "You can try it again". Every word for giving support and reward was suggested by a child psychologist to use with children with autism and other special needs.

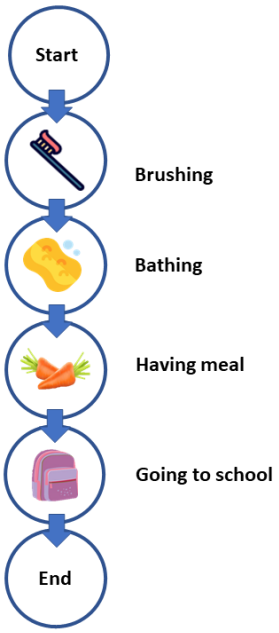

Fig.5 The steps of the daily routine game.

Table 2 The five scales in questionnaire for personal-social development.

Scale	Description
1	The children cannot do an activity by themselves.
2	The parent needs to take care of almost all steps.
3	The parent needs to assist some steps.
4	The parent needs to assist a few steps.
5	The parent does not need to assist the child.

2.4 Experimental Setting

This experiment was conducted at Play & Learn school by Krunong. In this experiment, we expected that after playing the daily routine game on BLISS robot, the children should be able to take care of themselves in their daily routine better. Therefore, before and after the experiment, the part evaluated the personal-social development of all children by using the questionnaire. This questionnaire has 5 issues involving general skills in daily life. The score for each issue was evaluated in 5 scales, as shown in Table 2. The score of each issue was summed and converted to report as a percentage.

Table 3 The five scores of the level of experimenter prompt.

Scores	Description
1	The experimenter holds the children's hand to answer the question.
2	The experimenter needs to help children by pointing out the answer.
3	The experimenter stimulates the children (e.g. "Pick up the card quickly") and repeats the question.
4	The experimenter repeats the question.
5	The experimenter does not need to help the child during the mission.

In language development, we expected that children would understand the rules of the game, the meaning of the robot requests and do missions by themselves. During the experiment, participants were tested for their language development by playing the daily routine game on the BLISS robot in 2 rounds (for the sake of comparison for the improvement between the first time and second time). The protocol was designed to be completed within 10 minutes per round. The experimenter explained the concept of games to all children in advance. The interval between rounds is around 5 hours. The second round started after the children finished lunch. We focused on the score that participants can correctly perform according to the robot request in this game.

During the game, the robot collected the scores in daily routine games of all participants. Moreover, the level of experimenter prompt recorded by the experimenter was used to analyze incorporated with the score of the daily routine game. The level of prompt was shown in Table 3. The experimenter observed the children during the task. If children cannot finish the task by oneself, the experimenter would provide the prompt according to Table 5. Every score of game and level of experiment prompt were summed and converted to report as a percentage. All data were evaluated and checked by a video recorded during the experiment. The example of a view in a video recording during the experiment was shown in Fig.6.

Fig.6 The example of a view in the video recorded during the experiment.

2.5 Data Analysis

A Wilcoxon Signed Ranks test, which is the non-parametric equivalent of the paired samples t-test, was used as the sample data are small and not normally distributed; they cannot be transformed to a normal distribution by means of a logarithmic transformation. This test was performed on the score of questionnaires for testing for differences in personal-social development between before and after the experiment. We also used the same statistical tool for testing the score in game and level of experimenter prompt between the first and second rounds.

3. RESULTS AND DISCUSSION

In personal-social development, we found that after children played the daily routine game with the BLISS robot, the score of personal-social personal and development (median=86) is increased from before playing with BLISS (median=76) as shown in Fig. 7. The results of the Wilcoxon signed rank test showed that there was a significant difference in personal-social development between before and after playing the game in the experiment (p=0.024). After children played this game, they could do many daily routine activities by themselves.

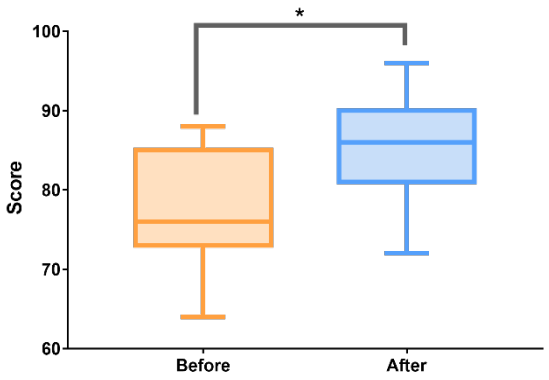

Fig.7 The scores on personal-social development before and after the experiment (* $p < 0.05$).

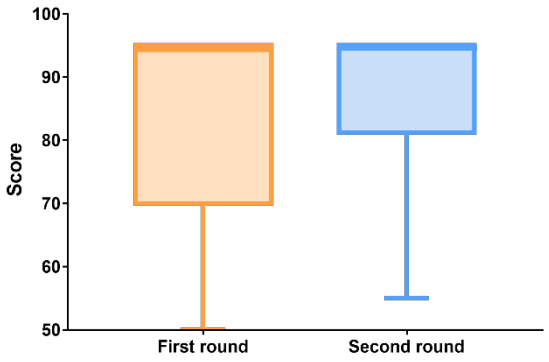

Fig.8 The scores on the daily routine game in the first and second rounds.

In language development, the results showed no significant difference between the score of the daily routine game in the first and second rounds (p=0.276). The scores in this game in the second round (median=95) were similar to the first round (median=95), as shown in Fig. 8. Almost all the children (5 out of 6) had good language skills before playing this game; they could understand the rules and respond to the requests in the first round. In the second round, two participants could improve their scores. It may indicate that this daily routine game on the BLISS robot has some potential benefit in language development for them.

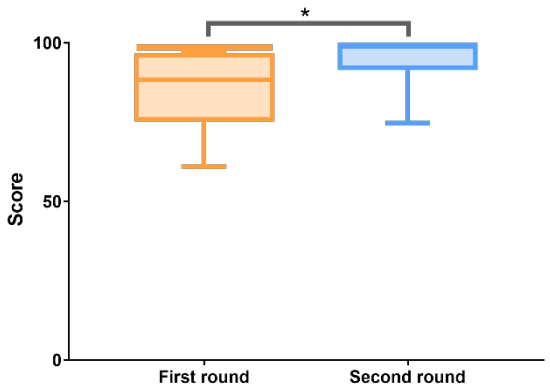

Fig.9 The level of experimenter prompt (* $p < 0.05$).

In term of the level of experimenter prompt, there was a significant difference between the first and second rounds of the daily routine game (p=0.028). The median of the level of experimenter prompt in the second round (median=88.42) is decreased from that in the first round (median=98.95), as shown in Fig. 9. The result showed that almost all children did not need assistance from the experimenter when playing this game with the BLISS robot in the second round. The results suggested that they could learn about the rule of the game quickly, right from the first round. By the second round, they used the RFID card and touched on the screen correctly by themselves.

4. CONCLUSION

In this study, we investigated the daily routine game on the BLISS robot for supporting personal-social and language development in children with autism and other special needs. The experimental results suggested that there was a significant difference in personal-social development between before and after playing the game. This game can help the children to learn about the regular daily routine. Additionally, all children have enjoyed this game with the BLISS robot. They reacted with positive emotions during the game. This game on the BLISS robot has a great potential benefit for child development. It could help therapists or parents reduce their workload when teaching children with autism and other special needs to do daily activities. Moreover, this game may be extended for teaching general children (at Kindergarten age) to take care of their daily routine by themselves. In the future, we will increase the number of participants to cover a broader range of children. In addition, we will compare the daily routine game with the training without the robot. Moreover, we will develop more games for supporting several skills in children. Not only for children, a robot could be used for reminding the elderly with dementia of their routine in a similar way to this study so that they could maintain their functions [17].

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