

Group Robot Intervention on Paediatric Inpatients and Their Caregivers, Using 'New aibo' by Sony

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Research Article

Keywords: Artificial Intelligence, social robot, paediatric robot-assisted therapy, group robot intervention

Posted Date: July 29th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-569687/v1>

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Abstract

The study on robot-assisted therapy in a pediatric field has not been applied sufficiently in clinical settings. The purpose of this study is to explore the potential therapeutic effects of a group robot intervention (GRI), using dog-like social robot (SR) “*aibo*” in pediatric ward. GRI by *aibo* was conducted for those children with chronic illness (127 in total) who are hospitalized in National Center for Child Health and Development (NCCHD), and their caregivers (116 in total), from March to April 2018. The observer made structured behavioural observation records, based on which qualitative research on the features of their words and conducts were carried out. As a result, first, during the GRI, about 2/3 of total expression by children were positive, while about 1/4 were negative or inappropriate. On the other hand, as seen in the “change” group, those children who had originally responded with negative expression eventually came to express positive expression, while getting involved in a ternary relationship or participating in a session more than once. Secondly, as for the expression from the caregivers during the GRI, active expressions such as “participation” and “exploration” accounted for the 2/3, while 1/3 turned out to be rather placid expressions such as “watch over” or “encourage.” *Conclusion:* There has not been any precedent study on the features of words and conducts expressed by patients and their caregivers during the GRI by *aibo*. The outcome suggests that *aibo* could possibly be used as a tool for group robot-assisted therapy in the pediatric treatment setting.

What Is Known

□The study on robot-assisted therapy in a pediatric field, has only just begun.

□Though many kinds of social robot have been reportedly used so far, none has yet to be applied in clinical settings.

What Is New

□Our study revealed the features of words and behavior expressed by the patients and their caregivers, when dog-like social robot “*aibo*” was used for a group robot intervention in the pediatric ward.

□The outcome suggests that *aibo* could possibly be used as a tool for group robot-assisted therapy in the pediatric treatment setting.

Introduction

Hospitalization is a painful experience for children.¹ Becoming ill and hospitalized, children are disconnected from their familiar lives and lose their social ties.² These experiences could lead to feelings of loss of control and negative effects on a child’s natural development and their physical and emotional health.³ Although psychosocial support provided by health professionals such as child life specialists or nurses is necessary, it is limited in terms of human resources.⁴⁻⁵ In this context, Animal Assisted

Therapy,⁶ as a complementary and alternative treatment for pediatric inpatient settings, has already been implemented in some pediatric hospitals. Animal Assisted Therapy, however, has risks of infection, injury, bites or animal allergies. Hence the robot-assisted therapy had been developed and tested in elderly population, in which PARO, a baby seal-like social robot (SR), was offered to people with dementia. The result showed improvement in stress and anxiety as well as better communication skills.⁷⁻⁸ Still, the study on robot-assisted therapy in a pediatric field, has only just begun.^{3,9-11} Though as many as 26 different kinds of SR have been reportedly used so far,² none has yet to be applied in clinical settings.

“New aibo (Figure 1) (*aibo*, hereafter),” an Artificial Intelligence (AI) dog-like SR for household use, was released from Sony in 2018. *aibo* has distinctive characteristics of comforting effects due to its round dog-like appearance, interactive communication skills, and growth in response to human interactions. A study has been reported in which an old type AIBO was implemented into pediatric inpatient setting where the interaction between robots and humans was examined.¹² As for *aibo*, however, no study has ever been reported in the pediatric nor adult setting.

As a household product, *aibo* has distinctive traits of such as 1) comforting effect, 2) interactive communication skills, 3) growth in response to human reaction. It suggests that *aibo* may hold some therapeutic effects toward pediatric patients as well as their caregivers in the inpatient treatment setting. In order to answer this clinical question, we designed a pilot study to explore *aibo*'s potential effects. We conducted a robot-assisted intervention by *aibo* for the pediatric patients with chronic illness (127 in total) who are hospitalized in the National Center for Child Health and Development (NCCHD) and their caregivers (116 in total). Based on its result, we carried out a qualitative research on the extracted features of words and conducts expressed by the patients and caregivers.

Materials And Methods

1. Study Design: This pilot study is a prospective observational study which carries out a hypothetical search based, qualitative evaluation.
2. Participants: 127 children (0y 6 months to 13 years old) who were hospitalized in the Internal Medicine and Surgical wards of the NCCHD, and 116 caregivers were assembled as participants. The number of children who participated in single intervention was 1 to 15 (median 4.5), caregivers being 1 to 10 (median 4.5). The inclusion criteria was children who have been hospitalized for more than 48 hours. The exclusion criteria was children who were not considered to be well enough to play in the playroom, such as those who had infection, who were compromised, who needed rest, and who were medically at risk.
3. *aibo*: *aibo*, a household use SR released by Sony, is equipped with AI and has the following traits; for instance,

☒ Dog-like appearance and behaviour: A rounded shape that gives a sense of warmth, lively form with cuddly sweetness. It tries to interact with you, speaking with its eyes, making eye contact with you. Vivid, dynamic movement with a variety of lovely gestures.

☒ Communication: Curious *aibo* possesses feelings and desires, based on which it decides what to do, sometimes acting in unexpected ways. Through its eyes (camera) that recognizes the person or the place, *aibo* understands the people around it and changes its behaviour. It detects obstacles, steps or people, against which it tries to avoid or decides what to do. *aibo* has got ears to understand human words and is able to change its behaviour. It reacts to the human voice, perceiving where the sound comes from. *aibo* shows pleasure, when it is praised and stroked on those sensors on its head, chin and back.

☒ Growth: *aibo* could turn into a spoiled or a wild one, depending on the way people interact with. The more frequent it sees a particular person, it remembers that person, recognizing his/her face. If you teach *aibo* a funny pose or a dance, it is able to learn the new movement.

4. GRI by *aibo*

From March 14 to April 12 2018, 24 series of GRI were conducted for 30 minutes at a time during 14:00 to 15:30 in the playrooms of nine medical wards of Internal Medicine and Surgery, at NCCHD. One child psychiatrist or a clinical psychologist attended as an assistant and an observer (A/O). The size of the ward playroom is about 3 by 5 meters. At the fixed time, the A/O turned on *aibo* to begin the GRI. The A/O saw to it to ensure that no harm would be caused upon children, caregivers and *aibo*. At every session, the A/O explained to children and caregivers *aibo*'s basic movements, how to touch *aibo* to please him, and how to bring out songs, poses or dances that *aibo* expresses. The A/O observed the children and caregivers as they naturally played with *aibo*, and recorded their words and behaviour on the behaviour observation records (Figure 2). At the end of 30 minutes, the A/O made a statement such as "It's time for *aibo* to go to bed" and turned off *aibo*, stroking and wiping it with clean cloth to finish.

5. Qualitative examination

The 24 behavioural observation records obtained from 24 series of GRI, were sorted by sentences into ☒verbal / non-verbal expressions by children ☒verbal / non-verbal expressions by caregivers. Each sentence obtained was written out on a sheet, and named for relevant groups to be integrated.¹³

6. Ethical Consideration

In this study, although no informed consent had been obtained from the participants, due to the nature of the study, sufficient consideration was given so as not to identify a particular patient. Approval has been given by the Ethics Committee in NCCHD.

Results

Table 1 shows the date and time, number of children and caregivers who participated in each session. 24 behavioural observation records were collected from the 24 GRI sessions. Out of the 24 records, sentences regarding verbal / non-verbal communication by children and the caregivers were sorted and extracted. There were 140 sentences on children, and 43 on caregivers. The sentences on children were sorted according to a qualitative point of view into the following 9 categories: 1.'affinitive / positive / cooperative', 2.'empathy / comforting / healing', 3.'defensive / cautious', 4.'fear / anxiety', 5. 'dependent / dominant / one-sided', 6.'rebellious / aggressive', 7.'indifferent', 8.'rejective / crying', and 9.'change.' The examples of sentences assigned to each category are shown in Table 2. Figure 3 shows the breakdown of children's words according to the 9 categories. Among the expressions by the children obtained from the GRI by *aibo*, positive expressions such as 1.'affinitive / positive / cooperative', 2.'empathy / comforting / healing' accounted for roughly 2/3 of the total. On the other hand, about 1/4 of the total responses were negative or inappropriate such as 3.'defensive / cautious', 4.'fear / anxiety', 5.'dependent / dominant / one-sided', 6.'rebellious / aggressive', 7.'indifferent', 8.'rejective / crying'. In addition, 9.'change' accounted for about 1/10, which indicated those children who had originally responded negatively eventually came to express positive reaction, through observing the behaviours of others, getting involved with others, or participating in the session more than once. Figure 4 shows the result from ternary relationship, namely, "human-*aibo*-human" interaction. Of the positive expressions, ternary relationships in which a caregiver, the other child and A/O shared a pleasure were detected at a high proportion. In the category 'change', in particular, the ratio of the ternary relationship was high. Next the sentences on caregivers were sorted according to a qualitative point of view into the following 4 categories: 1.'participation', 2.'exploration', 3.'watch over', and 4.'encourage'. The examples of sentences assigned to each category are shown in Table 3. Figure 5 shows the breakdown of caregivers' words according to the 4 categories. Positive reactions such as 1.'participation' and 2.'exploration' accounted for 2/3 of the total, while placid reactions such as 3.'watch over', 4.'encourage' accounted for 1/3.

Discussion

This study is the first survey to report a qualitative research which was carried out on the extracted traits of words and behaviour expressed by the patients and their caregivers, when *aibo* was used for a GRI in the pediatric ward. Two points were identified. First, positive expression by children accounted for as much as 2/3 of the total. Besides, the children from 'change' group originally responded negatively but eventually came to express positive reaction, through getting involved in ternary relationship, or gradually getting accustomed to the session by participating more than once. Secondly, among the expressions by the caregivers obtained from the GRI by *aibo*, positive reactions such as 'participation' and 'exploration' accounted for 2/3 of the total.

First of all, in the GRI by *aibo*, positive expression by children accounted for as much as 2/3 of the total. Besides, the children from 'change' group originally responded negatively but eventually came to express positive reaction, through getting involved in ternary relationship, or gradually getting accustomed to the session by participating more than once. In a recent study, Haggable, a bear-shaped SR, Haggable on a tablet screen, and a bear shaped toy were offered to 54 hospitalized children as an interventional therapy.

Video monitoring analysis showed the children of 'SR' group expressed more of "joy" or "comfort", than of "sadness",⁵ which is similar to the study result we obtained. In another study, Nao, a humanoid SR, was implemented for hospitalized children, for the purpose of pain reduction as well as increasing joy and motivation for treatment. Although the number of cases were small, the study reported that Nao helped the children reduce their anxiety, anger and depression, playing a role as a good friend to encourage them.¹⁴⁻¹⁵ Becoming ill and hospitalized, children are disconnected from their familiar lives and lose their social ties.² In most cases, children may lose the precious opportunities to build ternary relationship, cooperative attention, imitation and so forth,¹⁶ all of which encourage the development of children. In our study, it is significant to point out that a certain number of children have experienced a scene to change their feeling into that of positive, through building ternary relationships, as seen in the 'change' group. It suggests that *aibo* could possibly be useful as a tool to help build ternary relationships that enhances sociality of children, which is often impaired in pediatric chronic hospitalization. Although there are various studies which examine the potential use of SRs in pediatric settings, the number of participants is small.² *aibo* was implemented into an inpatient treatment setting, whose effects were evaluated for 127 population. No such study has ever been reported in the pediatric nor adult setting.

Secondly, as for the expression by the caregivers in the GRI by *aibo*, positive reactions such as 'participation' and 'exploration' accounted for 2/3 of the total, while placid reactions such as 'watch over', 'encourage' accounted for 1/3. In the study in which PARO was implemented into pediatric inpatient setting, it was reported that when family members participated together, the higher the rate of improvement on a child's anxiety and pain.¹⁰ In our study as well, it was potentially significant for the children to see their caregivers participate positively. Furthermore, the caregivers of children with chronic illness tend to be more susceptible to mental distress such as anxiety or depression than the caregivers of healthy children.¹⁷ From caregivers' mental health perspective, in this study, it was noteworthy for the caregivers to have enjoyed themselves 'participating' in the *aibo* intervention, or to have communication with other caregivers to share the excitement into 'exploration.'

aibo is beneficial in making up for human resources as well as from the financial perspective. Moreover, for many pediatric patients, child life specialists are helpful in reducing the pain experienced during hospitalization.⁵ Service provided by human labor, however, has limits. For there is not enough child life specialist staff to offer help for every child in every opportunity experienced during hospitalization. SRs, including *aibo*, could fill the gap between the number of pediatric inpatient children in need of psychosocial care and the lack of human resources to support them.

Three aspects of limitation of study should be noted as shortcomings. First, in this study, age and gender of the participants were not accurately obtained. Secondly, neither multilateral, scientific nor quantitative evaluation was not made. Third, this report had no control group.

There are two findings from this world's first study which examined the potential effect of *aibo* onto the patients in inpatient treatment setting. Substantial expressions by the children obtained from the GRI by *aibo* were positive, while a certain number of children who had originally responded negatively eventually

came to express positive reaction, through building ternary relationships or gradually getting accustomed to the session by participating more than once, as seen in the 'change' group. Whereas much of the expressions by the caregivers obtained from the GRI by *aibo* were positive reactions such as 'participation' and 'exploration.'

Conclusion

This study is the world's first survey and report on the features of words and behavior expressed by the patients and their caregivers, when *aibo* was used for a GRI in the pediatric ward. The outcome suggests that *aibo* could possibly be useful as a tool for GRI in pediatric treatment setting. When conducting a robot-assisted therapy with *aibo* in the future, we plan to carry out a multilateral, scientific as well as quantitative evaluation with a biopsychosocial perspective.

Abbreviations

AI: Artificial Intelligence

A/O: assistant and observer

GRI: Group Robot Intervention

NCCHD: National Center for Child Health and Development

SR: social robot

Declarations

Acknowledgements

We thank all the A/O who completed the survey, Arisa Yamaguchi, MD; Yuki Sekido, MD; Moe Nakajima, MD; Hiromi Tsujii; Tatsuo Hikitsuchi; Akiko Nagira; Kazuko Matsumoto. We also thank Yuhei Yabe and Takeshi Katayama of Sony for assisting the GRI.

Funding

All phases of this study were supported by National Center for Child Health and Development, grant number 30-15

Conflicts of interest/ Competing interests

The authors have indicated they have no potential conflicts of interest to disclose.

Availability of data and material

The data that support the findings of this study are available from the corresponding author on reasonable request.

Code availability

Not applicable

Authors' contributions

Dr. Makino and Dr. Tanaka conceptualized and designed the study, collected data, conducted the analysis, drafted the initial manuscript, and reviewed and revised the manuscript. Dr. Tanaka supervised the analysis and interpretation, and critically revised the manuscript for important intellectual content. Dr. K. Nakamura and Ms. Hayakawa contributed to the study design and interpretation of data, and reviewed and revised the manuscript. Dr. A. Nakamura and Dr. Uchida contributed to the study design, and reviewed and revised the manuscript. Dr. Kasahara contributed to the conception and coordinating the project, and reviewed and revised the manuscript. Dr. Kato and Dr. Igarashi contributed to the conception and the planning the project, and reviewed and revised the manuscript. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Ethics approval

Approval was given by the Ethics Committee in NCCHD.

Consent to participate

No informed consent had been obtained from the participants due to the nature of the study. However, sufficient consideration was in place so as not to identify any particular patients.

Consent for publication

Not applicable

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Tables

Table 1: Date and Number of participants in GRI sessions

Date	Number of Children	Number of caregivers
2018/3/14	6	6
3/16	3	3
3/16	2	2
3/19	4	4
3/19	15	7
3/22	10	10
3/22	1	1
3/26	3	2
3/27	1	1
3/27	6	6
4/2	7	6
4/3	4	4
4/3	4	4
4/4	9	9
4/4	4	4
4/5	4	4
4/6	5	5
4/9	5	5
4/9	7	7
4/11	5	5
4/11	6	7
4/11	4	4
4/12	8	8
4/12	4	2

Table 2: Examples of sentences sorted into 9 categories

<p>1. Affinitive / Positive / Cooperative</p>	<ul style="list-style-type: none"> ☐ Strokes <i>aibo</i>. ☒ "Sing, <i>aibo</i>!" ☐ Keep Touching <i>aibo</i>, telling it to "Paw." ☐ Tries to associate with <i>aibo</i>, actively from the beginning. ☐ Calls out happily, "Ah! Here comes <i>aibo</i>!" ☒ "Bye bye, Thank you." ☐ Making eye contacts with his mother happily, looking at what <i>aibo</i> does. ☐ An elder child is gently encouraging a younger child who seems nervous.
<p>2. Empathy / Comforting / Healing</p>	<ul style="list-style-type: none"> ☐ Taking care of <i>aibo</i>. ☒ "<i>aibo's</i> gone to sleep." ☐ All are looking satisfied.
<p>3. Defensive / Cautious</p>	<ul style="list-style-type: none"> ☐ First session to participate. Looking at <i>aibo</i> from afar. ☐ Holding hands with her grandfather, observing <i>aibo</i> from afar. ☐ Touching <i>aibo</i> by using another doll as a mediator.
<p>4. Fear / Anxiety</p>	<ul style="list-style-type: none"> ☐ Two infants were timidly watching <i>aibo</i> from afar. ☐ Timidly trying to touch <i>aibo</i> from behind. ☐ Looking at <i>aibo</i>, the child hesitated and turned to the observer.
<p>5. Dependent / Dominant / One-sided</p>	<ul style="list-style-type: none"> ☐ Not able to wait for <i>aibo</i> to move in a slow action, try to make <i>aibo</i> move as she wishes. Tries to take <i>aibo</i> away from another child. ☐ Tries to keep <i>aibo</i> to herself. Tries to touch <i>aibo</i>, telling "Paw, paw."
<p>6. Rebellious / Aggressive</p>	<ul style="list-style-type: none"> ☐ Could not keep <i>aibo</i> to himself, said nasty words, got angry and left. ☐ Get angry at <i>aibo</i> for not turning around or not responding. ☐ When <i>aibo's</i> battery was out, all said in unison "Dead!Dead!"
<p>7. Indifferent</p>	<ul style="list-style-type: none"> ☐ Engaging in different activity near <i>aibo</i>. ☐ Moved toward a table to play board game. ☐ Looking at <i>aibo</i> from afar, seemingly not interested.
<p>8. Rejective / Crying</p>	<ul style="list-style-type: none"> ☐ When an observer or a nurse brings <i>aibo</i> closer, the child fears and cries out and did not stop crying at every trial.

	<ul style="list-style-type: none"> □When the baby reached out for <i>aibo</i>, <i>aibo</i> barked and the baby cried. People around the baby were appeased.
9.Change	<ul style="list-style-type: none"> □At first looking at <i>aibo</i> from afar, then with relief, gradually come closer happily. □At first looking from afar, then seems relieved to see other children and adults touching and talking to <i>aibo</i>, begins to touch. □Though scared at the 1st session, after participating more sessions, gradually got used to <i>aibo</i> and began to touch.

Table 3: Examples of expressions by caregivers sorted into 4 categories

1.Participation	<ul style="list-style-type: none"> □Enjoy innocently, saying “Uh-huh, amazing, Cute!” as such. □Associating with <i>aibo</i>, together with the child. □Excited together to see the interaction between the child and <i>aibo</i>.
2.Exploration	<ul style="list-style-type: none"> □Taking photos of the interaction between the child and <i>aibo</i> with a smartphone. □Having conversation with other parents, looking at the interaction between the child and <i>aibo</i> from afar. □Interaction between parents and grandparents are built, Getting to know and Exchanging words with one another.
3.Watch over	<ul style="list-style-type: none"> □Watch over the child and <i>aibo</i> in association, from afar. □Reserving her/himself from the child, watching over from afar. □Looking from afar, smiling.
4.Encourage	<ul style="list-style-type: none"> □Encourage the child to associate with <i>aibo</i>. □Encourage the angry child to try touching <i>aibo</i> again. □Warn the child not to handle <i>aibo</i> roughly.

Figures



Figure 1

aibo Specification. Product name: aibo, Model number: ERS-1000, Processor: 64 bit Quad-Core CPU, Display: 2 OLEDs(eyes), Sound: Speaker, 4 Microphones, Camera: 2 Cameras (Front camera, SLAM camera), Communications: Mobile Network Communication Feature (Data transmission) LTE, Wi-Fi IEEE 802.11 b/g/n (2.4GHz), Outside dimensions: Approx. 180×293×305mm, Weight: Approx. 2.2kg, Power consumption Approx. 14W, Battery duration: Approx. 2 hours, Recharge time: 3 hours.

Communication behavior observation record between *aibo* and Children

1. Date of observation:
2. Place / number of participants:
3. Participant Age / Gender:
4. Intervention Time:
5. Observation record
 - 1 Expression by children (Verbal / Non-verbal)
At the start of intervention

During Intervention

At the end of intervention
 - 2 Expression by caregiver

Figure 2

An assistant and observer records words and behavior expressed by patients and their caregivers during the GRI on the behavioral observation record.

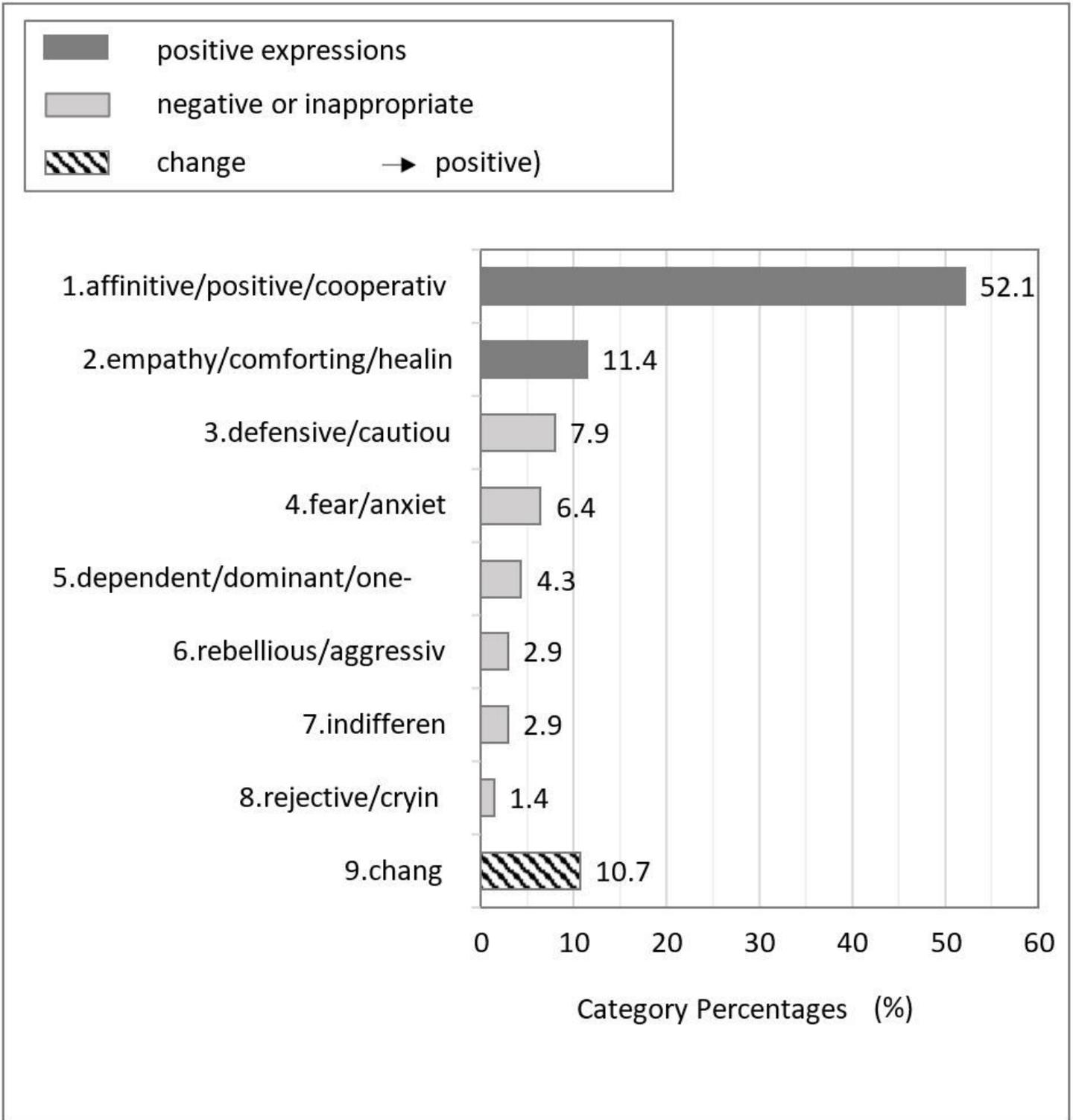


Figure 3

Children's expressions obtained from the group robot intervention by aibo. Out of the 24 records, sentences regarding verbal / non-verbal communication by children were sorted and extracted. There were 140 sentences by children. The sentences by children were sorted according qualitatively into 9 categories.

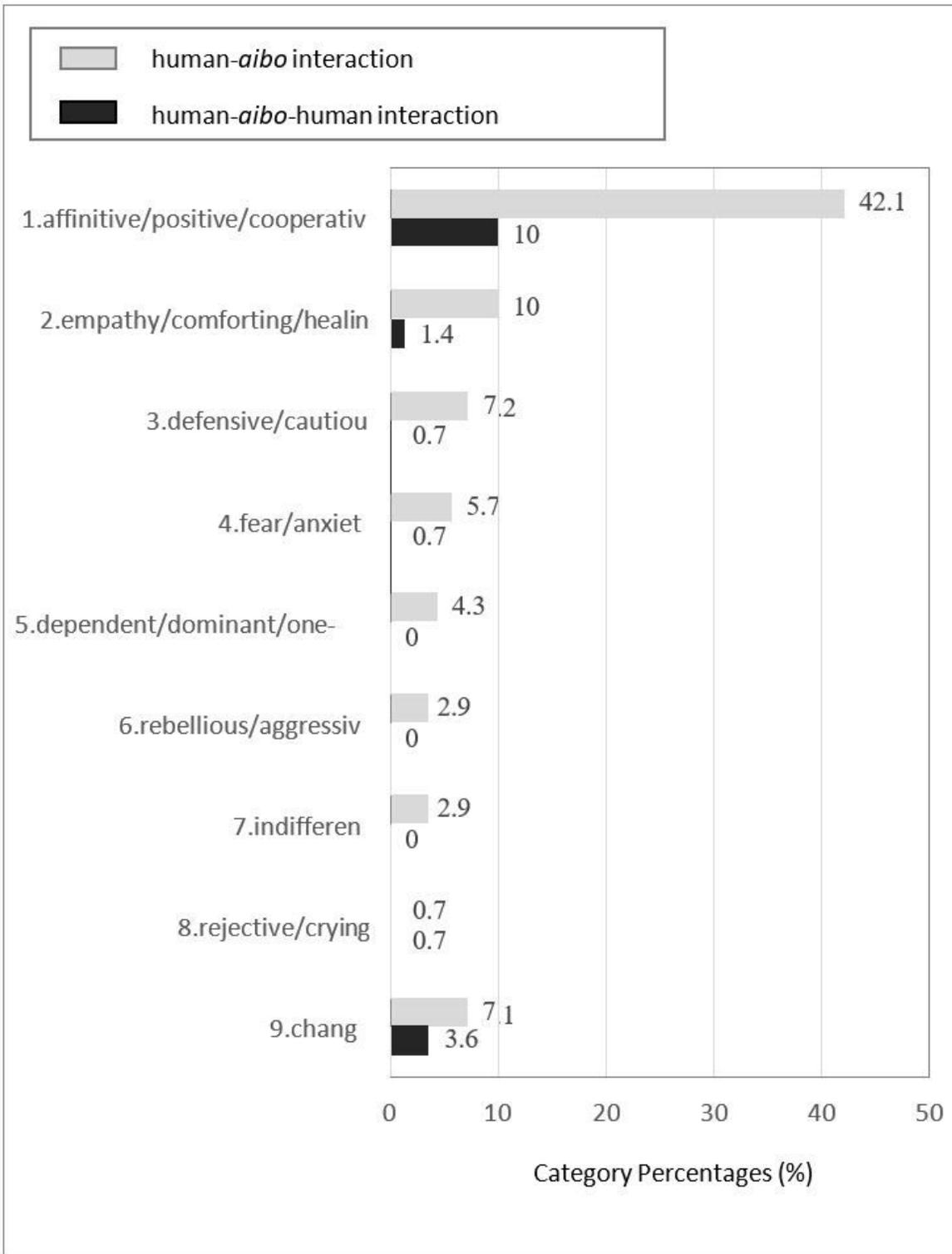


Figure 4

The percentage of ternary relationship, namely, “human- aibo-human” interaction.

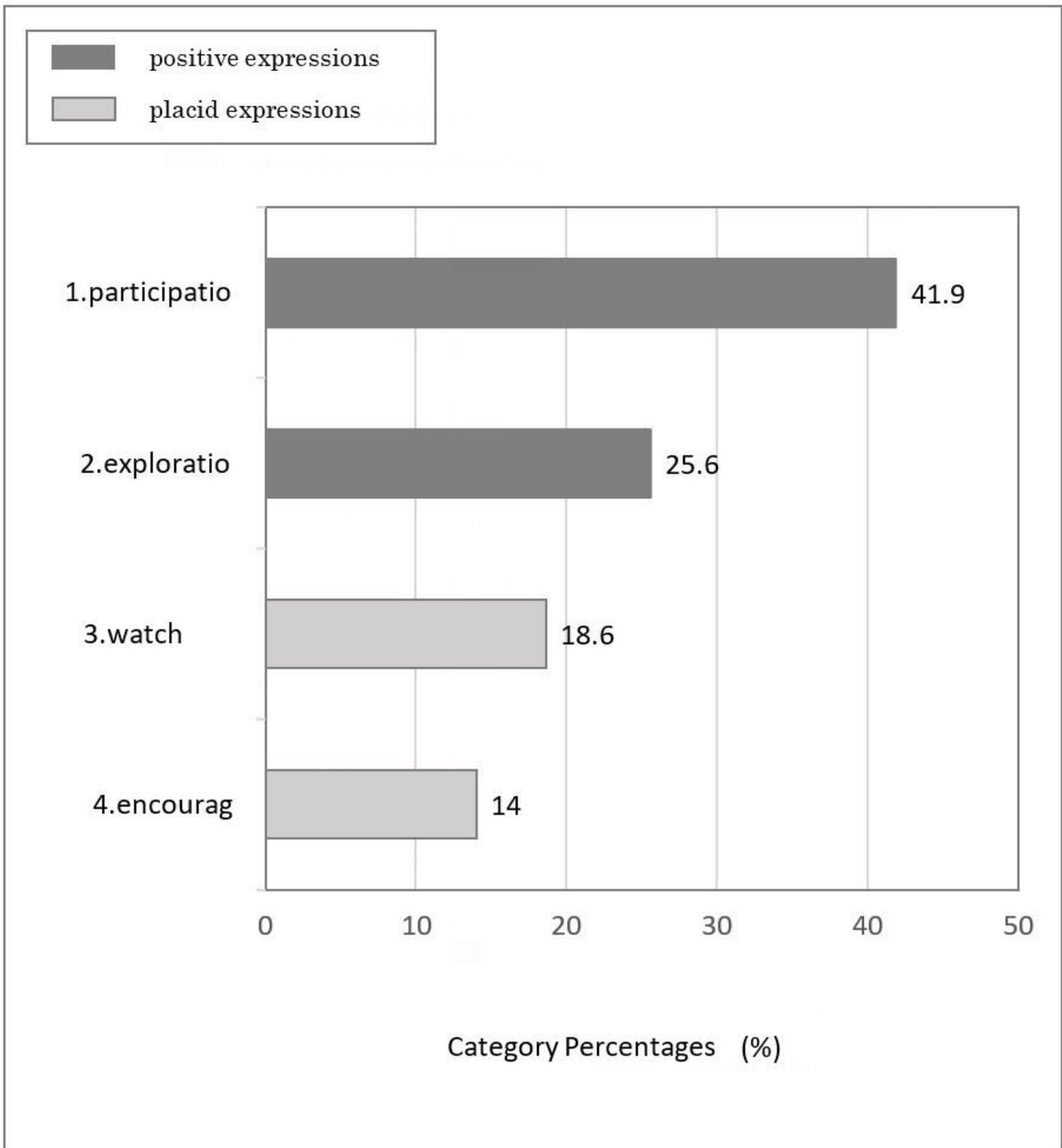


Figure 5

The caregivers' expressions obtained from the group robot intervention by aibo. Out of the 24 records, sentences regarding verbal / non-verbal communication by caregivers were sorted and extracted. There were 43 sentences by caregivers, which were sorted qualitatively into 4 categories