How do diabetic children react on a social robot during multiple sessions in a hospital?
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Abstract. In the European project ALIZ-e, many aspects of social robot interaction were evaluated, mainly with healthy children. In this paper, we take the lessons learned and apply them in a field experiment with diabetic children. The observations showed that a robot requesting help added to the bonding, that the children with diabetes acquired relevant knowledge, seemed to appreciate the robot more than the healthy children in earlier experiments and showed to have different profiles between them that set requirements for personalization.

Keywords: social robot, field testing, diabetes

INTRODUCTION
The European project ALIZ-e aimed at persistent long-term interaction of a robot for diabetic children in the age of 7-11. The project works on models and methods for robot’s interactive behaviors to achieve long-term interaction and support the development of self-management attitudes, knowledge, skills and behaviors (e.g., self-efficacy, education, bonding). Within this project experiments have been done with both sick and healthy children who use a robot that adapts to them on certain aspects (e.g., emotions influenced by child [1], keeping the activity challenging for each child [2]). This paper presents our lessons learned and an experiment conducted in the wild (i.e., the hospital): An evaluation of the prototype showing the envisioned interaction with children with diabetes in the course of 3 sessions.

LESSONS LEARNED AND IMPLICATIONS
The present experiment was the last experiment within the ALIZ-e project and thus incorporated the lessons learned from the previous 4 years and evaluated this with the intended users (children with diabetes). Lessons are: (a) children are able to recognize the emotions of a NAO robot [3], (b) personality is hard to take into account [4], and (c) that adapting robot state to the user [1], exhibiting thinking behavior [5] and remembering small facts [6] support positive interaction. Activities are more motivating when the activity is challenging [1] and it is possible to switch between activities [7]. Finally we saw that children are willing to disclose information about themselves [8] and most children like touching the robot [9]. Based on these results, an experiment was designed in which children performed multiple activities over various sessions from which the robot remembered some small facts in an enclosed environment (robot playground see Figure 1). Furthermore, during interaction the robot showed thinking behavior, emotions and interest in the child while also disclosing information about itself. Next to this the robot was dependent on the child to move from one point to another (walking or lifting). The general research aim was get insight into the child’s knowledge gain, activity preferences and profile characteristics for personalization.

EVALUATION
17 diabetic children in the age of 6-10 (M=8.24 yrs, SD=1.25 yrs) from the MeanderMC (Amersfoort, The Netherlands) participated in the experiment. We used tests (knowledge and self-efficacy), questionnaires (fun and self-determination) and observations (game preference, video and logging data) to quantify and qualify the interaction with the robot. Every child had three sessions of about an hour in the hospital with the robot. These sessions were at least 14 days apart. The first session started with the self-efficacy questions and a knowledge test containing 32 questions of which 8 were asked each session (24 in total and 8 as a reference). Then a short introduction about the activities was given. A trivial pursuit kind of quiz was played on a swiveling tablet that can turn towards the robot and the child, a sorting game which is played on a large horizontal placed touch screen on which the robot and child have to put pictures (pizza, broccoli) in the correct category (low/high carbohydrates) on one of the sides of the display and watching an educational video with the robot. Next to this, the robot was introduced as Charlie who is in training to become a diabetes pal. He knows a bit about diabetes, but also has to learn a lot. The children could walk with Charlie from one activity to another activity. In between the activities, Charlie asked some questions about how they deal with diabetes, but also...
about their hobbies. Then they started with the quiz. In the second session, the children could choose which activity they wanted to start with (quiz or sorting game), while in the last session there was only time for one. At the end of each session, questions about fun and self-determination were asked, and after the third session there was also a post knowledge test.

RESULTS
The knowledge test showed significant differences in knowledge acquired. A paired sample t-test showed a significant increase in knowledge from the pre to the post test for the first 24 questions (first session M=11.35, SE=0.77; second session M=13.7, SE=0.66; t(16)=5.6, p<0.001). The final eight questions (25-32) did not show significant improvement (first session M=5.94, SE=0.34; second session M=6.29, SE=0.44; t(16)=1.19, p=0.250).

No time-effects were observed for self-efficacy, fun and self-determination due to ceiling effects (high scores overall).

The children had the same preference for the sorting game as for the quiz. In the second session 9 of the 17 children chose the sorting game as their favorite and 8 chose quiz and they also agreed starting with this game. In the third session 8 children chose to play the sorting game and 9 the quiz.

After an analysis based on grounded theory [10] of the video and logging data 5 types of children were identified on which the robot could adapt its interaction in the future: 1) children who are confident about themselves and their illness, 2) children who feel excluded from the group, 3) children who are afraid to make errors, 4) children who feel uncomfortable with the situation and 5) children who are too young to play the activities and have meaningful robot interaction.

CONCLUSION AND DISCUSSION
With questionnaires it is hard to acquire useful data with young children, due to ceiling effects. Experiments over a longer period of time can solve part of this problem. Furthermore, observations provide useful information, but take a lot of time to analyze. However, the observations provided the insights that the children actually learn something from the robot and that their interaction is not distracting them from the subject matter. The user profiles provided a starting point to improve the user profiles and how the robot could adapt to certain user profiles. For example, Charlie could be more supportive with children who act a bit shy.

In general, we noticed that a robot that was not all-knowing and dependent on the child’s help (e.g., when falling or going to another activity) really evoked valuable behaviors and was appreciated by the children. We also saw that the minimal interaction with the experimenter and the shared space of child and robot created by the playground was beneficial for the child’s involvement. Furthermore, we observed that children with diabetes seem more inclined in bonding with the robot than healthy children as observed in previous studies (e.g. [1]). This could be inferred, amongst others, by the gifts the children brought. This could be because they normally feel outside the group. Finally, because the children were brought to the experiment by their parents who often waited in the same room as the experiment leader (outside the experiment room), we also got some idea about the home situation. In further research we will take the influence of the social environment on how a diabetic child deals with his/her illness more into account, i.e., the family life (home), the caretakers (hospital) and peers (diabetes camp).

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REFERENCES
7. J. Heeffer. Reasoning robots - knowledge structures and an introduction to agents. research project, Content and Knowledge Engineering, Utrecht University, February 2012.