Patient Education and Counseling 92 (2013) 174–181

Contents lists available at SciVerse ScienceDirect

Patient Education and Counseling

journal homepage: www.elsevier.com/locate/pateducou

Using a robot to personalise health education for children with diabetes type 1: A pilot study

Olivier A. Blanson Henkemans [a,*], Bert P.B. Bierman [a], Joris Janssen [a], Mark A. Neerincx [a], Rosemarijn Looije [a], Hanneke van der Bosch [b], Jeanine A.M. van der Giessen [b]

[a] TNO Lifestyle, Leiden, The Netherlands
[b] UMC Utrecht, WKZ, Utrecht, The Netherlands

ARTICLE INFO

Article history:
Received 29 June 2012
Received in revised form 9 April 2013
Accepted 18 April 2013

Keywords:
Motivation
Knowledge
Self-management
Gaming
Self-determination

ABSTRACT

Objective: Assess the effects of personalised robot behaviours on the enjoyment and motivation of children (8–12) with diabetes, and on their acquisition of health knowledge, in educational play.
Methods: Children ($N = 5$) played diabetes quizzes against a personal or neutral robot on three occasions: once at the clinic, twice at home. The personal robot asked them about their names, sports and favourite colours, referred to these data during the interaction, and engaged in small talk. Fun, motivation and diabetes knowledge was measured. Child–robot interaction was observed.
Results: Children said the robot and quiz were fun, but this appreciation declined over time. With the personal robot, the children looked more at the robot and spoke more. The children mimicked the robot. Finally, an increase in knowledge about diabetes was observed.
Conclusion: The study provides strong indication for how a personal robot can help children to improve health literacy in an enjoyable way. Children mimic the robot. When the robot is personal, they follow suit. Our results are positive and establish a good foundation for further development and testing in a larger study.
Practice implications: Using a robot in health care could contribute to self-management in children and help them to cope with their illness.

1. Introduction

Children aged 8–12 with diabetes type I are encouraged to get involved in their diabetes management in order to minimise the impact of their illness on their short- and long-term health [1]. Diabetes self-management is positively associated with metabolic control and health-related quality of life [2–9]. It consists of monitoring carbohydrate intake, physical activity and blood glucose, recognising symptoms of hypo- and hyperglycaemia, and injecting insulin to regulate blood glucose levels accordingly. In children under 12, parents play a prominent role in diabetes self-management and children do not therefore experience significant problems. However, as children move towards autonomy during puberty, it is important that they become more skilled at self-management [10].

Knowledge plays an important role in diabetes self-management. Greater knowledge can contribute to more effective management, better adherence, and improved HbA_{1c} [11,12]. In turn, knowledge can be enhanced through education about self-management topics such as blood glucose monitoring, insulin replacement, diet, exercise, and problem-solving strategies [11].

1.1. ALIZ-E: personalised and long-term child–robot interaction

The European 7th framework (FP7) project ALIZ-E is looking at how personal robots can help children to cope with their chronic disease and improve their self-management through adaptive and long-term educational interaction (www.aliz-e.org). A recent study by an international research consultancy, Latitude, showed that children respond well to learning environments that incorporate robots [13]. A recent study has further shown that children, who are engaged in physical and verbal social behaviours with a humanoid robot, believe that the robot has mental states (i.e., is intelligent and has feelings) and is a social being (e.g., could be a friend, offer comfort, and be trusted with secrets) [14]. This suggests that children in general are likely to feel related or socially connected to humanoid robots. Other studies have shown that interacting with a personal robot can help improve learning. For example, Janssen et al. studied the effect of the personalisation of a

* Corresponding author at: Wassenaarseweg 56, 2333 AL Leiden, The Netherlands. Tel.: +31 0888 666 186; fax: +31 071 51 81 918.
E-mail address: Olivier.BlansonHenkemans@TNO.nl (O.A. Blanson Henkemans).

0738-3991/$ – see front matter © 2013 Elsevier Ireland Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.pec.2013.04.012

robot on children aged 9–10. They performed maths assignments in 3 sessions over a period of 3 weeks with either a robot that accompanied them to a group-based ceiling level or with a robot that accompanied them until they reached their personal ceiling level [15]. The personal robot showed interest in the child (e.g., remembered his/her name) and showed social behaviour at appropriate moments (e.g., was motivating when necessary). Both robots proved to be motivating and fun to use, but the personal robot generated more engagement. Other studies have shown the benefits of gaming for diabetes education. In their review, DeShazo et al. studied video game interventions for diabetes type 1, including quizzing, skill training and decision-making on PCs, smart phones and consoles. The authors found positive outcomes in knowledge, disease management adherence and clinical outcome [16].

1.2. Personal robot for developing diabetes self-management knowledge

On the basis of these studies, we developed a personal robot which contributes to children's diabetes knowledge by playing a game with the children. The robot plays a quiz with the child, with questions covering topics of interest to children (e.g., TV, maths, geography) and diabetes type I. Moreover, the robot is personal. In other words, it develops a user model and adapts the child–robot interaction accordingly.

The robot is a Nao, an autonomous, programmable humanoid robot developed by Aldebaran Robotics. As illustrated in Fig. 1, the child–robot interaction is based on an integrated system comprising different modules. These modules are: a dialogue model, user model and reasoning engine, a memory, and sensors for automatic speech and gesture recognition. In addition, the architecture includes different child–robot activities, such as playing a quiz, a dance or an imitation game.

The child–robot interaction is partly Wizard-of-Oz (WoOz). This implies that the robot behaves autonomously, but the researcher conducting the test partly simulates the dialogue model and the sensors. This includes telling the robot which phase of the interaction to start (in other words, introduction, explanation of the quiz, quiz, and closing) and communicates what the child is saying to the robot (for example, the child's name, questions asked and answers given). The two modules - the dialogue model and the sensors for automatic speech recognition – are currently being developed as part of ALIZ-e by the other project partners. Moreover, with the knowledge developed in our main study, we will contribute to the further development of the user model (in other words, what static and dynamic data does the robot need from the child in order to adapt its verbal and non-verbal behaviours and to contribute to long-term interaction).

1.3. Research question

This paper describes our first field study in a medical setting. Children aged 8–12 with diabetes interacted with a personal robot at different times and locations. The aim was to establish an empirical basis for the "learning by playing with a robot" approach and the effects of personalisation as a substantial step in the iterative development of the ALIZ-E robot. The issue we wished to address was: "How can a personal robot contribute to children's perceived enjoyment, motivation, and knowledge of diabetes?".

2. Methods

2.1. Participants

The participants were children (girls and boys) aged 8–12 with a diagnosis of diabetes type I dating back at least 6 months. Children with multi-morbidities were excluded. Participants were

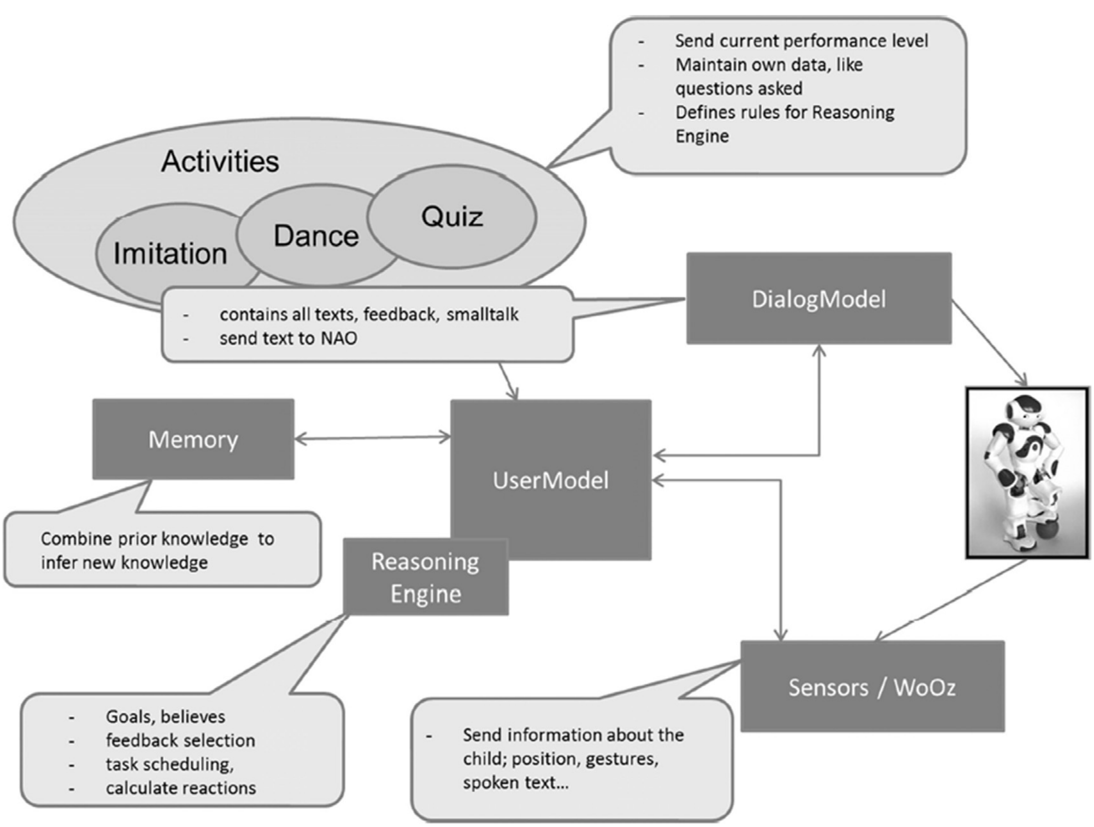

Fig. 1. Architecture for robot interacting with child during different activities, long term.