Using a Personal Social Robot as a Nutrition Coach

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Abstract

Childhood overweight and obesity represent an alarming problem worldwide. In Italy, approximately 21% of children are overweight or obese, with strong consequences both at health and social levels. The importance of the problem rises the need for policies aimed at preventing pediatric overweight and obesity. Game-based nutritional learning is an effective approach to enhance children's knowledge, behavior, and healthy dietary habits. Therefore, playful, and creative methodologies should be included in nutritional education programs for children. Among novel technologies, humanoid robots have a special appeal for educational purposes. In this paper, we present our first prototype in which the social robot Alpha Mini is used as a personal persuasive technology in the context of nutrition. In particular, in the context of the HERO project, we are developing an application with the main aim of using a combination of social robotics and serious games to support nutrition education and self-awareness trying to change wrong attitudes in children. To investigate the appropriateness of the approach a Wizard of Oz study was performed, showing interesting results in terms of engagement, motivational strength, trust, and recall of relevant information.

Keywords

Social Robots, Coach, Persuasive Technologies

1. Introduction

Childhood obesity is a growing problem in the world. More than 35 million children under the age of 5 and about 340 million children and adolescents aged 5-19 are overweight or obese. In the context of the HERO (Healthy Eating RObot) project, we want to investigate the effect of personal social robotics as a persuasive technology.

Persuasive Technologies (PT) are intentionally designed to change people's attitudes or behaviors without coercion or deception, acting therefore upon users' beliefs always in an atmosphere of free choice. According to their functional roles [1], PT can be categorized into tools, media, or social actors – or as multiple categories at once. As tools, PT can increase people's ability to perform a target behavior by making it easier. As media, PT can use both interactivity and narrative to create persuasive experiences that support behavior change or attitude. PT can also function as social actors, indeed when perceived as social actors, computer products can leverage principles of social influence to motivate and persuade people [1]. In this context, we expect human-like social robots to have a positive persuasive effect by exploiting both social and conversational capabilities.

Social robots are physically embodied, autonomous agents that communicate and interact with humans on a social and emotional level. Due to their ability to enable natural interaction, social robots have a great potential for helping people in their daily activities by providing assistance and information possibly personalizing their behavior to the user [2]. Then we can say that a social robot includes in its definition all the aspects of Fogg's Functional Triad [1] namely the notion of social actor and the notion of tool and they represent also powerful media since through dialogues,

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narrative, and game-based approaches they may create a persuasive user experience [3]. Several research works have investigated the effect of social robot characteristics on persuasion [4]. For instance, in [5], the effect of non-verbal behavior on persuasion has been explored. In [6] the results of an experimental study investigating the application of human persuasive strategies to a social robot have been explored. Moreover, since the intervention planned in our project is directed towards children, we leverage the attractive power of social robots for behavior change, since this technology has been shown to elicit engagement and trust [7,11].

To this aim, we performed a preliminary study on the appropriateness of the approach based on the Wizard of Oz (WOZ) technique [16]. In the study, we employed the Alpha Mini robot [15] a personal robot. Even if the study was performed with a limited number of participants (5 children), results show an overall positive engagement, children felt positively motivated and there was a high level of trust and recall of information conveyed by the robot.

2. HERO: Healthy Eating RObot

The HERO robot behavior will be personalized to the child's user profile and the level of healthy eating acting as a motivating technology. To achieve this aim, we are developing the following functionalities (see Figure 1 for an overview):

- *Data gathering from different and heterogeneous sources*: besides wearables, smartphones, and other sensors, the robot itself, through its camera, microphones, and sensors, will be used as a non-intrusive tool to collect data about nutrition habits, mood-related behavior, and so on.
- *Health behavior tracking*: the child's lifestyle will be monitored through dialog and collected data. HERO will stimulate the child to talk about the experience with food using techniques typical of narrative medicine. HERO will integrate connections to sensors or will use its own camera for food detection and intake estimation and for tracking the physical activity automatically. Moreover, sleeping will be also monitored through sensors, since the quality of sleep is related to obesity and food intake.
- *Engaging psychophysical coaching*: HERO will use appropriate personalized strategies to increase awareness and motivation in children through dialog and serious games.
- *Emotion and Mood analysis*: It is well known that there is a strong relationship between food and emotions. In particular, emotional eating, defined as 'eating in response to emotions'[13] can be seen as a coping mechanism during moments of stress, in which people try to through their troubles away with comfort foods, rich in sugar and fat. Then eating in response to negative emotions is one of the causes that predispose an individual to obesity [13]. Therefore, it is of fundamental importance to endow HERO with the capability of understanding the affective state of the child and learning the relation with the child's behavior.
- *Holistic User Profile*: in the Knowledge Base of the coach, a representation of the user based on the different features that can describe the child, such as her interests, level of physical activity, habits, mood, social connections and so on. These features can be inferred by gathering and merging information coming from diverse sources. The profile is available then available to the coach for personalizing the intervention.

To achieve these goals, HERO has to be embodied in a robotic body that allows to implement the above-mentioned functionalities and, in addition, it should be not too expensive. For this reason, we have decided to investigate the potentiality of Ubtech Alpha Mini in this application context [15].

The Alpha Mini robot is a humanoid small portable robot (about 24 cm tall), that can capture speech through its microphones, talk through its speakers, move, and recognize faces, which allows him to smoothly follow the person he's currently interacting with, and some objects. He is fully programmable using the Android SDK. It can be also programmed, at high level, using a Scratch-type block interface with a mobile app (Figure 2b-c) [14].

Besides the available functionalities, we are implementing the coaching module that starting from the analysis of user behavior and affective state (facial expressions, voice prosody, verbal component of the communication, gestures, and posture), will use a dialogue management module to handle the personalized motivational dialogue with the user.

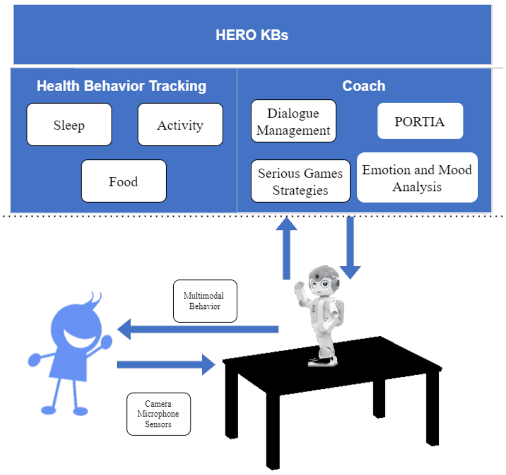


Figure 1: An overview of the HERO Architecture.

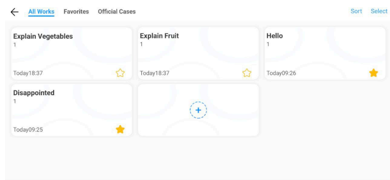
To generate the personalized persuasion and motivational strategy, we will adapt and use the PORTIA model [8], which allows reasoning on the potential strength of alternative persuasive strategies for a given user, in order to select the most appropriate one and combine rational and emotional modes of persuasion, according to the theory of a-rational persuasion. It is used to reason about the user's presumed characteristics to infer the presumed user's goals and importance given to certain beliefs. This information is used to adapt the persuasion attempt to the user by deciding the items to mention in the dialog.

In previous work, we performed a study in the healthy eating scenario, with the Pepper robot providing healthy eating advice in two different settings non-personalized vs. personalized condition [9,10]. Results showed that significant differences occurred in terms of satisfaction and helpfulness. Moreover, the adapted condition was perceived as significantly more persuasive and reliable. The obtained results were encouraging and paved the way to support the persuasive impact of a social robot acting as a personal nutritional coach.

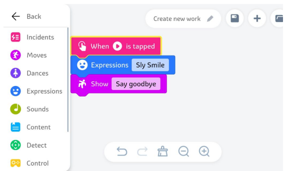
2.1. Wizard of OZ

Before implementing all the functionalities to handle interaction in the wild with children, we decided to investigate whether the designed approach was accepted by children. To this aim, we simulated HERO behaviors using a Wizard of OZ (WOZ) approach [16]. A WOZ constitutes a prototyping method that uses a human operator (i.e., the wizard) to simulate system functions that have not been implemented yet. In language-based interaction scenarios, like the ones envisioned by HERO, WOZ is usually used to explore user responses and the consequent handling of the dialogue, to test different dialogue strategies or simply to collect examples of dialogues needed to train the dialog management component.

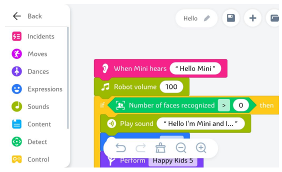
In order to help the wizard follow a systematic interaction path, we created some scripts based on Scratch [14] to be used through a mobile app interface (see Figure 2b,c). These predefined multimodal behaviors allow the wizard to select an answer to a study participant to be sent to the robot that will play it (Figure 2a). To control and limit the interaction in the WOZ study, we focused on the importance of eating, as a snack, fruits, and vegetables to provide the body with vitamins and minerals.



(a)



(b)



(c)

Figure 2: An example of the Alpha Mini App Interface (a) to create easily multimodal behaviors designed with Scratch (b and c).

The dialog was simple, and it was previously designed by a human nutrition coach: after the presentation and greeting phase, the robot explained the benefits of eating fruits and vegetables on health.

The study involved a group of 5 children (3 males and two females) from 6 to 10 years old. Each of them came in our lab in which the organizational issues followed the governmental/institutional regulations for public health to prevent the spread of COVID19.

After receiving the consent of the children's parents, and a short explanation describing the purpose of the experiment, every child interacted with HERO embodied in the AlphaMini. Using the WOZ interface, the wizard, the same expert in nutrition who designed the dialog, previously trained on the use of the app, handled the dialog with the children. At the end of the interaction, each child filled out a simple post-test questionnaire aiming at assessing, besides an overall evaluation of the *user experience* with the robot (Q1-3), the easiness of *understanding* the content of the dialog (Q4), the *motivational strength* of the messages (Q5), the level of *trust* in the robot (Q6-7) on a scale from 1 to 5. Moreover, we tested the level of *recall* about information provided through the dialog (R1-2) where the child had to indicate whether the statement was true or false.

The statements in the questionnaire were the following:

- Q1. I was able to interact with the robot
- Q2. Interacting with the robot was engaging
- Q3. The system had an adequate response time
- Q4. It was easy to understand what the robot was saying
- Q5. What the robot said to me motivated me to eat more fruit and vegetables during the day
- Q6. I think that what the robot was saying was true
- Q7. The information that the robot gave to you was reliable

Recall Questions:

R1. According to what the robot told you, eating fruit and vegetable can:

1. boost immunity and improve the body's ability to fight diseases [True][False].
2. aid in the proper function of the digestive system and prevent constipation [True][False].
3. help in preventing cardiovascular diseases [True][False].

R2. Fruits and vegetables contain:

1. Fiber [True][False].
2. Vitamins [True][False].
3. Proteins [True][False].

We analyzed the results of the post-test questionnaire data and, even if the number of participants was small, the interaction with the robot received an overall good evaluation in terms of *user experience* (4 on average). Results in terms of *understanding* the content of the dialog were also good (4 on average). An interesting result is the one related to the *motivational strength* that was 4.6 on average maybe due also to the novelty aspects related to the use of the robot [12], then it would be interesting to understand if these effects remain also in the long-term interaction. It was interesting to notice that all the children involved in the study trusted what the robot was telling them (5 on average). As far as the recall is concerned, 4 children answered correctly to the first question (R1) while only 3 children answered correctly to the second one (R2) with an overall recall rate of 70%.

3. Conclusions and Future Work

Our long-term research goal is to develop a Personal Persuasive Social Robot in domains such as nutrition, wellbeing, and health for helping people in changing their wrong attitudes and habits. In the HERO project, we are focusing on childhood obesity. To this aim, we are developing a nutrition coach to be embodied in the Alpha Mini Social Robot. As a preliminary investigation, we run a simple experiment in our lab based on the Wizard of Oz technique. Even if performed on a small number of children, results suggest that the robot was perceived positively in terms of user experience and motivational strength. In particular, all children believed what the robot was telling them. As far as the retention of the learned information is concerned, the children remembered most of the information conveyed during the dialog.

In a future experiment, we will better explore these results with a larger sample and more ad hoc measures, also by considering other behavioral measures. These preliminary results are encouraging us in continuing investigating on using social robots in this domain by comparing this technology to other media and also to humans (i.e. parents, teachers).

4. References

[1] B.J. Fogg. Computers as Persuasive Social Actors, Ubiquity, 10.1016/B978-155860643- 2/50007-X. (2011).

[2] S. Rossi, F. Ferland, A. Tapus.User profiling and behavioral adaptation for HRI: A survey, Pattern Recognition Letters, 99: 3-12, 2017.

[3] E. Vlachos, H. Sch¨arfe (2014) Social Robots as Persuasive Agents. In: Meiselwitz G. (eds) Social Computing and Social Media. SCSM 2014. Lecture Notes in Computer Science, vol 8531. Springer, Cham.

[4] M. Hashemian, A. Paiva, S. Mascarenhas, P. A. Santos and R. Prada," The Power to Persuade: a study of Social Power in Human-Robot Interaction," 2019 28th IEEE International Conference on Robot and Human Interactive Communication (RO-MAN), New Delhi, India, 2019, pp. 1-8.

[5] V. Chidambaram, Y.-H. Chiang, and B. Mutlu. 2012. Designing persuasive robots: how robots might persuade people using vocal and nonverbal cues. In Proceedings of the seventh annual ACM/IEEE international conference on Human-Robot Interaction. ACM, 293–300

[6] K. Winkle, S. Lemaignan, P. Caleb-Solly, U. Leonards, A. Turton and P. Bremner. Effective Persuasion Strategies for Socially Assistive Robots, 2019 14th ACM/IEEE International Conference on Human-Robot Interaction (HRI), Daegu, Korea (South), 2019, pp. 277-285.

[7] Castellano, G., De Carolis, B., D'Errico, F. et al. PeppeRecycle: Improving Children's Attitude Toward Recycling by Playing with a Social Robot. Int J of Soc Robotics 13, 97–111 (2021). https://doi.org/10.1007/s12369-021-00754-0

[8] B. De Carolis, I. Mazzotta. A user-adaptive persuasive system based on 'a-rational' theory. Int. J. Hum.-Comput. Stud. 108: 70-88. (2017)

[9] Berardina Nadja De Carolis, Francesca D'Errico, Nicola Macchiarulo: 'Keep the user in mind!' Persuasive effects of social robot as personalized nutritional coach. PSYCHOBIT 2019

[10] B. De Carolis, N. Macchiarulo, G. Palestra. Soft Biometrics for Social Adaptive Robots. In International Conference on Industrial, Engineering and Other Applications of Applied Intelligent Systems, pp. 687-699, Springer, (2019).

[11] Bainbridge, W.A., Hart, J.W., Kim, E.S. et al. The Benefits of Interactions with Physically Present Robots over Video-Displayed Agents. Int J of Soc Robotics 3, 41–52 (2011).

[12] A. Rossi, S. Moros, K. Dautenhahn, K. L. Koay and M. L. Walters, "Getting to know Kaspar : Effects of people's awareness of a robot's capabilities on their trust in the robot,"IEEE RO-MAN,2019, pp. 1-6.

[13] N. Michels, I. Sioen, C. Braet, G. Eiben, A. Hebestreit, I. Huybrechts, B. Vanaelst, K. Vyncke, S. De Henauw, Stress, emotional eating behaviour and dietary patterns in children, Appetite, Volume 59, Issue 3, 2012, ISSN 0195-6663.

[14] https://scratch.mit.edu/

[15] https://www.ubtrobot.com/products/alpha-mini?ls=en

[16] Aaron Steinfeld, Odest Chadwicke Jenkins, and Brian Scassellati. 2009. The oz of wizard: simulating the human for interaction research. In Proceedings of the 4th ACM/IEEE international conference on Human robot interaction (HRI '09). Association for Computing Machinery, New York, NY, USA, 101–108.