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Age-based differences in preferences and affective reactions towards a robot's personality during interaction

Juan Martínez-Miranda [a, *], Humberto Pérez-Espinosa [a], Ismael Espinosa-Curiel [b], Himer Avila-George [a], Josefina Rodríguez-Jacobo [b]

[a] CONACyT - CICESE-UT3, Andador 10 #109, Ciudad del Conocimiento, Tepic, Nayarit, Mexico
[b] CICESE-UT3, Andador 10 #109, Ciudad del Conocimiento, Tepic, Nayarit, Mexico

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ABSTRACT

The design and use of social robots addressed to the children population is a growing research field. The understanding of how the children react, or what are their preferences towards a robot with different styles of interaction is an important aspect to maximise the construction of a social bond between the robot and the child. In this paper we describe an experiment to assess these affective reactions and preferences based on an age-based stratification. A Wizard-Of-Oz scenario was used to design a playing mission where the child guides the robot, via voice commands, through a maze while collecting sweets and avoiding obstacles. Every participant interacted with two robots during the session. Two types of personalities were modelled in the robots with the same physical appearance: the agreeableness, and its opposite, disagreeableness personality trait. A total of 174 children between 6 and 11 years old took part in the experiment. The data about the affective reactions and preferences of the children towards the robots were collected through a multiple choice questionnaire. Significative statistical differences based on the age were found in the self-reported information provided by the children. These differences were noticeable in the youngest children (aged 6–7) with respect to the rest of the participants.

1. Introduction

1.1. Social robots

Some years ago, the development of robots for industrial applications such as manufacturing, assembly, packing and transportation had the main objective to release human operators from dangerous, risky or repetitive tasks. Different research areas including kinematics, motion planning, and the employment of different control and artificial intelligence techniques contributed to the achievement of this objective (Garcia, Jimenez, Santos, & Armada, 2007).

In more recent years, the main aim of a new generation of robots is to act as partners, assistants or companions of humans sharing a common place e.g. in a domestic home environment. This objective has fostered the collaboration between different disciplines such as psychology, linguistics, sociology, ethology and others in order to design better social robots that facilitate a continuous and long-term interaction with humans. These studies are the basis of a relatively new field of research known as Human-Robot Interaction (HRI) where the -verbal and non-verbal- interaction with people is a *defining core ingredient* (Dautenhahn, 2007).

Important efforts in the design and development of social robots are dedicated to provide them with assistive capabilities to support people with special needs such as older adults. Another relevant set of target users that offers opportunities and challenges in the development of these robots are children (Belpaeme et al., 2013). In this line, social robots have been used for the study of child development (Michaud et al., 2005) or rehabilitation (Plaisant et al., 2000), child education (Kennedy, Baxter, & Belpaeme, 2015); as facilitators for autism therapy (Dautenhahn, 2007; Kozima, Nakagawa, & Yasuda, 2005), autism diagnosis (Scassellati, 2005); support the writing of a diary in children with diabetes (van der Drift, 2013); and as mediators for children interviews (Wood et al., 2014).

1.2. Child-robot interaction

The increasing interest in the use of social robots that act as

* Corresponding author.
E-mail address: jmiranda@cicese.mx (J. Martínez-Miranda).

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peers of children has fostered the development of studies to identify relevant characteristics associated with child-robot interaction. These studies include for example how children attribute features of friendship to a robot (Beran & Ramirez-Serrano, 2011); the influence of culture (individualistic vs. collectivistic) in child-robot interactions (Shahid, Krahmer, & Swerts, 2014); the effects produced in the children when a robot displays familiarity (through verbal communication) during interactions (Kruijff-Korbayova et al., 2015); the evaluation of children's expectations (before) and subsequent satisfaction (after) the interaction with a robotic tutor (Alves-Oliveira et al., 2015); or the children's perceived support from an empathic robot (Leite, Castellano, Pereira, Martinho, & Paiva, 2012).

Most of these studies are performed involving children in specifics age ranges mainly depending on the interaction characteristics under analysis. Some studies are concentrated in early childhood involving participants of 12 or 18 to 24 month-old (Michaud et al., 2005; Tanaka, Cicourel, & Movellan, 2007); some others recruit participants in a small age range (e.g. between 4 and 5 (Lemaignan, Fink, Mondada, & Dillenbourg, 2015) or between 14 and 16 years old (Alves-Oliveira et al., 2015)). When the objective of the study is to identify the relevant characteristics that a robot should have to promote a positive and long-term relationship with children, it usually involves participants with a larger age range (e.g. 5 to 16 (Fior, Nugent, Beran, Ramirez-Serrano, & Kuzyk, 2010); 5 to 12 (Kruijff-Korbayova et al., 2015); or 8–12 years old (Barakova, Bajracharya, Willemsen, Lourens, & Huskens, 2015)). The recruitment of participants form different ages in these studies helps to identify those characteristics in a robot behaviour that are suitable to build a positive relationship and that are acceptable at different ages of the children.

Nevertheless, a drawback of the studies that assess robot-children interaction involving participants at all ages of middle childhood (approximately ages 6 to 11) without an age-based stratification, is the missing of relevant information produced by the developmental changes produced at different ages. Middle childhood is characterised by striking cognitive, psychological, and social changes (Eccles, 1999) that can influence children preferences and attitudes towards a social robot. The assessment of a *good relationship* with a robot could be different in children at the age of 6 than children at the age of 11.

1.3. Purpose of the study

In this work we describe a study performed with the objective to identify whether there are statistically relevant differences in the *preferences* and *reactions* of children at different ages towards an assistive robot. Thus the participants in the study were stratified according to their age in groups of 6–7; 8–9 and 10–11 years old. We have designed a scenario where the child interacts with a robot to guide it through a maze while collecting sweets and avoiding some obstacles. Based on a Wizard-of-Oz experiment, we have modelled in the robot two types of interaction styles (i.e. *personalities*). Each personality generates different behaviours (dialogues and actions) as response to the instructions provided by the child using voice commands.

Using a questionnaire administered to each child after the interactive session with the robot, we have collected subjective information that was statistically analysed to get evidence about:

1. Whether the children, at all ages, clearly identify the two different personalities modelled in the robot taking into account that both personalities are embodied in the same appearance.
2. What are the most common *emotional reactions*, reported by the children, elicited by the robot's behaviour according to the different modelled personalities, and whether there are differences in the emotional reactions reported by the different age groups.
3. *Which of the two modelled personalities is the preferred (i.e. the adherence to one or another robot)* by the children at different ages to continue interacting in further sessions.

The answers to these questions would be useful to better understand the preferences of children at different ages towards social robots and what particular features produced from interactive scenarios should be careful considered when designing assistive or companion robots addressed to the children population. Design decisions that take into account children's age-related particularities will contribute to maximise the positive effects and long-term use of this type of systems. The remaining of the paper is organised as following: Section 2 presents some of the related work. The description of the experiment is described in Section 3. Section 4 presents the obtained results while Section 5 describes a discussion on those results. Finally, Section 6 presents some conclusions.

2. Related work

A key aspect in long-term interactions between robot and child is the creation of a social bond that facilitates the acceptance of the robot in daily life activities and makes children feel more comfortable with it (Belpaeme et al., 2012; Veenstra & Evers, 2011). One aspect that contributes to form such a social bond is the emotional reactions modelled in the robot as response to child's inputs. These emotional reactions can be conveyed through a combination of gesturing with a set of utterances and the execution of specific tasks. There are an important number of studies that analyse the influence of the robot's emotional behaviour and personality traits (or the lack of them) in the preferences of the children.

The study presented in (Woods, Dautenhahn, & Schulz, 2004) was focused in how children evaluate different physical appearance of robots related to distinct *personality* and *emotional traits*. The experiment consisted of displaying 5 robot images (e.g. human-like, animal-like or machine-like) to children and completing a questionnaire for each image to collect their perceptions of different robot attributes. A total of 159 children between 9 and 11 years old participated in the study. Some findings reported in this study were that children rated as the most *aggressive* and *angry* robot those with machine-like appearance and those with pure animal-like appearance were rated as the *happiest* robots. Also, animal-machine and human-machine were rated by children as being the most *friendly* robots.

A related but more recent study is presented in (Cohen, Looije, & Neerincx, 2014) where the objective was to analyse if children correctly recognise the emotions expressed in two different robotics systems: a humanoid (without facial features) and a cat-like (with facial expressions) robots. Fourteen children within the age of 8–9 were involved in the experiment. Self-reported data were collected through questionnaires filled by children regarding what emotions (*happy*, *sad*, *anger*, *fear*, *surprise* and *no emotion*) they thought the robots expressed during the sessions. The reported results indicate that the emotion recognition rates for the two robots were high and only for the emotion *sad* the recognition was significantly higher for the cat-like robot. These rates of emotions recognition were higher when shown within context, in a story-telling session, than those without context. These expressions were also better recognised when shown a week later during a second interaction. Given the high rates of emotions recognition in the two robots, the authors conclude that facial features are not crucial to express emotions in a robot and that body movements