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Children and social robots: Inventory of measures for CRI research*

Chiara de Jong, Caroline van Straten, Jochen Peter, Rinaldo Kühne and Alex Barco

Abstract— As child-robot interaction (CRI) is still a young and rather dispersed field, it largely lacks conceptual and operational definitions of variables relevant to CRI. In our current study, we aim to develop and validate a set of standardized self-report survey measures relevant for CRI research. By means of these standardized self-report measures we hope to increase the conclusive power of individual studies and comparability across studies.

I. INTRODUCTION

Robots are no longer solely used for labor, but increasingly for social purposes [e.g., 11]. As social robots may impact many aspects of people's daily lives [e.g., 3] in the next decades, there is a need to study whether, how, and with which consequences humans interact with social robots. One primary group that is particularly important to investigate are children. Children are often targeted by the edutainment industry, and, given the enormous developmental differences between children and adults [e.g., 6], they may respond differently to robots than adults. Even though research on child-robot interaction (CRI) has produced important insights into children's interactions with robots, the field is still young and dispersed. As a result, it faces several methodological and theoretical challenges.

II. SHORTCOMINGS OF THE FIELD

In line with Eyssel's [9] observations about research on human-robot interaction in general, two extensive review studies on CRI that we recently conducted [8; 16] have pointed to various methodological challenges. One of the key challenges are the inconsistencies in conceptual and operational definitions of key variables. Specifically, the field largely lacks validated and standardized self-report measures of CRI for the use in surveys. Without such measures, the conclusive power of individual studies and comparability across studies is severely impaired.

III. CURRENT STUDY

Against this background, we aim to develop and validate a set of standardized self-report survey measures that are relevant for current research on CRI, such as, *animacy* [e.g., 2], *anthropomorphism* [e.g., 1], *social presence* [e.g., 13],

social support [e.g., 12], *closeness* and *trust* [e.g., 16], and *attachment* [e.g., 17]. As of March 2018, we are in the process of collecting data from about 80 children at two elementary schools in the Netherlands. The Ethical Board of the Faculty of Social and Behavioral Sciences at the University of Amsterdam has approved the study.

A. Sample

We recruited children from classes four, five and six (ages 8 to 11) to participate in the pilot study. We are targeting children in this age range rather than younger children, as by this age they are capable of participating in surveys. Moreover, children in our age range already master several social and relational skills, which are required for the meaningful investigation of some variables of interest (e.g., attachment and social support).

B. Components of the pilot study

After an in-class introduction of the robot and the procedure of the study, children interact with the NAO robot once. After the interaction, an interviewer conducts the questionnaire. At the end of all sessions, an in-class debriefing takes place on the nature of the study, as well as the workings of the robot.

C. Child-robot interaction

The interaction consists of a small introductory chat between the child and the robot, during which the robot asks several personal questions (e.g., "What is your favorite color?"). Subsequently, the child and robot play a guessing game. During this game, the robot makes several statements (e.g., "I am very good at mathematics"). The child then guesses whether each statement is true or false. To prevent children from feeling deceived by the robot [3], the robot never says anything that suggests human capabilities (e.g., it does not talk about feelings or preferences). In total, the interaction takes eight minutes on average. The whole interaction is based on a Wizard-of-Oz set-up, in which a researcher manually controls the robot.

D. Questionnaire

After the interaction, an interviewer conducts a questionnaire that addresses in total 17 variables related to

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CRI, including the aforementioned ones. Besides these central variables, we also assess psychological states when interacting with a robot (e.g., enjoyment, flow), children's cognitive development, use-intention, and personality to assess concurrent validity.

Whenever possible, the measures were based on existing scales and adjusted for the use in CRI and among children, for example by modifying the content and/or the wording of questions and items. Children answer questions on a five-point Likert scale ranging from "Totally true" to "Not true at all," visualized by bar charts as in Severson and Lemm [14]. Additionally, the interviewer asks several open questions to increase engagement, as well as to learn what motivates children's answers to questions that address key concepts.

E. Data analysis

After all data have been collected, we will use a four-step procedure to assess the quality of the measurement instruments. First, a confirmatory factor analysis is conducted for each measure. Model fit (χ^2 -difference test, CFI, SRMR) and factor loadings will be inspected to evaluate the measures' factorial validity [5; 10]. Second, we will assess if the measurement models function in the same way for girls and boys (i.e., metric and scalar invariance is tested) [15]. Third, as an indicator of reliability, Cronbach's [7] alpha will be calculated for each measure. Fourth, measurement validity will be assessed by inspecting correlations between the measures and related concepts (concurrent validity) [4]. The analyses will provide insight into the validity and reliability of our inventory for the assessment of child-robot interactions.

IV. CONCLUSION

Our work aims to take a first step toward solving certain methodological shortcomings of the relatively young field of CRI research. In the proposed study, our specific goal is to develop a set of standardized self-report measures for the investigation of CRI.

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