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TSES-R: An Extended Scale for Measuring Parental Expectations toward Robots for Children in Healthcare

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ABSTRACT

There is a growing interest in implementing robotics applications for children in healthcare to provide companionship, comfort, education, and therapy. Parental expectations regarding robotics for young children play a critical role in influencing its development and acceptance. However, parental expectations are widely overlooked in HRI. Therefore, a better understanding of what parents of young children expect the robot to do in health-related interactions with robots is needed. To achieve this, we adopted the Technology-Specific Expectation Scale (TSES) [2] and added three more dimensions (i.e., assistive role, social-emotional, and playful distraction) to gauge users' expectations of robots in healthcare, resulting in TSES-R. This paper reports the development and reliability analysis of TSES-R. Furthermore, this paper presents the preliminary results collected from using the TSES-R with a sample of 31 families, which showcases how these outcomes could be helpful for future related studies.

CCS CONCEPTS

• **Human-centered computing**→ Human computer interaction (HCI)→ HCI design and evaluation methods

KEYWORDS

Child-robot interaction, robots in healthcare, parents, expectations and acceptance, TSES

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1 INTRODUCTION

Robotic technology has a clear edge for young users like children. First, robots for children can provide a highly engaging form of play therapy [6]. Second, the power dynamic in child-robot interaction allows children, especially those with Autism Spectrum Disorder (ASD), to exhibit behaviours and social skills that are more difficult to evoke when interacting with adults [10]. Last, robots can be programmed with personalised and adaptive behaviours to engage children and provide social empowerment in ways a companion animal can never achieve [6]. In recent years, robotics technology has received expanding attention for its potential impact on child users in healthcare settings. However, many previous works regarding robots for children have focused on concept design (e.g., [20, 28, 31]), technical development (e.g., [13, 14]), usability and feasibility evaluation (e.g., [16, 26, 27]), or clinic application (e.g., [1, 18]) of the robots. As a result, a more critical and broader understanding of the imaginaries, expectations, and concerns that stem from the robotic application is still lacking.

A better and more in-depth understanding of this matter from the parents' perspective is essential for three reasons. (1) Existing studies mainly emphasise the perspective of robot developers, healthcare professionals, and school-age children. Little is known regarding what features of healthcare robot is expected by parents of young children. (2) Parents are one of a select group of people who help young children make their first connections to the world they live in. The parents may influence their young children's judgment and acceptance of robots. (3) More specifically, parents are a vital part of the stakeholder network of such robotics applications in healthcare. They often are highly involved in the healthcare procedure of young children. Parents appear to play a crucial role in influencing the development and acceptance of this robotics application [4, 5].

A study [5] points out that little is known about how the parents rate the acceptability of using a robot within existing interventions and how this influences adherence, and proposes a method to measure the acceptance and accordingly increased acceptance. However, there has not yet been an instrument that can measure the parents' expectations towards robots for children in healthcare. This paper introduces the TSES-R, adapted from the Technology-Specific Expectation Scale (TSES), by adding three emerging dimensions (i.e., assistive role, social-emotional, and playful distraction) that are specific to robotics and are inspired by recent literature. Such a questionnaire may inspire future health domain-specific robot designs and warrants meta-analysis and comparisons among various studies. The following section reviews relevant literature from the three dimensions mentioned above.

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2 RELATED WORK

Robotics for healthcare is a rapidly growing field [6]. These applications have been explored in settings including hospitals, clinics, living-in-place facilities, and patients' homes [6], for which have capabilities from the three key dimensions as below.

2.1 Assistive Roles

One common use of robots to assist in therapeutic intervention is treating children with ASD [3, 9, 29]. Other cases used robotic therapy for paediatric rehabilitation in children with different special needs, such as intellectual disability [8, 9, 11], physical disability [15, 21], and cancer rehabilitation [1]. These assistive robot coaches were generally used for monitoring rehabilitation performance and providing feedback during healthcare.

2.2 Social or Emotional

Interacting with robots influences users' emotions and behaviours. For example, a study by [27] applied socially-assistive robots using empathy to reduce children's fear and pain during peripheral IV placement. In a study by [22], a Nao social robot was used to emotionally support children waiting for an emergency room procedure. Their results showed that children had a lower stress response when playing with this robot while waiting than in the other conditions. Similarly, another study by [19] using the Huggable robot for hospitalised children demonstrated that children tend to experience more positive affect, such as joyfulness and agreeableness, than the other conditions.

2.3 Playful Distraction

Distraction, as a crucial part of psychological intervention, has been used in managing children's procedural pain and distress. In line with this concept, robots have been used with certain pre-programmed playful behaviours to mitigate children's discomfort. For example, one recent study [26] involved social robots as a distraction method to reduce children's anxiety and discomfort during blood draw. Specifically, a study by [17] implemented distractions such as singing and dancing provided by a humanoid robot during subcutaneous port needle insertion. In another study [4], the robot engaged children in a game of blowing the dust off a rubber duck as an approach to distraction and relaxation.

3 TSES-R: A FURTHER DEVELOPMENT OF THE TECHNOLOGY-SPECIFIC EXPECTATION SCALE (TSES)

3.1 Introduction to TSES-R

The Technology-Specific Expectation Scale (TSES) [2] is a five-point Likert scale measuring users' expectations of interacting with social robots from the dimensions of capacity and fictional view. It has been tested in [2], showing this scale had a good level of internal consistency for the five items of the Capabilities dimension (α =0.770) and the five items of the Fictional view dimension (α=0.749). In Table 1, the first ten items are initially from the TSES, composed of the dimension of capabilities (C) and fictional view (FV).

Table 1: The scale of the Technology-Specific Expectation of Robots – R (TSES-R)

Item		
No	Dimension	Statement
1	FV	I think the robot will have superhuman capacities.
2	FV	I think the robot will be more than a machine.
3	FV	I think the robot will be able to perceive what my kid* is going to do before she/he does it.
4	C	I think my kid will be able to interact with the robot.
5	FV	I think the robot will be similar to the robots my kid sees in movies.
6	C	I think the robot will understand my kid's emotions.
7	C	I think the robot will be able to recognize when my kid looks at it or when his/her gaze shifts to something else.
8	C	I think the robot will have a sense of humor.
9	C	I think the robot will be able to understand my kid.
10	FV	I think the robot will be able to read my kid's thoughts.
11	S/E	**I think the robot will be able to express similar emotions as my kid.**
12	S/E	**I think the robot will provide emotional support to my kid.**
13	S/E	**I think the robot will provide accompany for my kid.**
14	S/E	**I think the robot will be able to become my kid's friend.**
15	PD	**I think the robot will sing nursery rhymes.**
16	PD	**I think the robot will play a game with my kid.**
17	PD	**I think the robot will dance in a funny way.**
18	AR	**I think the robot will provide information about my kid's medical treatment.**
19	AR	**I think the robot will demonstrate the rehabilitation exercise my kid needs to do.**
20	AR	**I think the robot will deliver feedback from the clinician to my kid.**

Annotation: **C** – Capabilities dimension (which refers to expectations towards robot's capabilities); **FV** - Fictional view dimension (which relates to the impression created mainly by sci-fi culture, such as movies and novels). **E/S** – social/emotional dimension (which serves expectations related to social or emotional aspects of interaction with the robot); **PD** – Playful distraction dimension (referring to the robot's behaviours to distract the user from unpleasant sensations); **AR** - Assistive role dimension (including robot's behaviours supporting accomplish specific tasks).

Based on this TSES, we developed TSES-R in our study to measure the parents' expectations of robots for healthcare. In our adapted version (as seen in Table 1), we referred to the original first ten items from TSES and additionally developed items 11-20 (items in bolded texts) for measuring the parents' expectations for a robot designed to help their kids in a healthcare setting from the *Social/emotional dimension* (**S/E**; item 11-14), the *Playful distraction dimension* (**PD**; item 15-17), and the *Assistive role dimension* (**AR**; item 18-20). The justifications for adding these three dimensions are driven by the related capabilities of current robotics technology reported in the literature (see above in sections 2.1-2.3 accordingly).

3.3 Reliability Analysis of TSES-R

The reliability analysis results indicated that the Cronbach alpha value for the whole TSES-R questionnaire was .897, which suggests very good internal consistency. Additionally, we found that the extended part (i.e., items 11-20) of TSES-R also had a satisfying internal consistency (α=0.877). To further understand how the **S/E**, **PD**, and **AR** are interrelated in this TSES-R, we performed a Principle Component Analysis (PCA). The Kaiser Meyer Olkin (KMO) value is 0.783 (and Bartlett's Test p=0.000), which indicates that the sampling is adequate and that the following factor analysis yields distinct and reliable underlying dimensions.

Table 2: Rotated Component Matrix

Item	Component (Rotation converged in 5 iterations)		
	1	2	3
14 (S/E)	**.824**	.302	.301
13 (S/E)	**.819**		
11 (S/E)	**.814**	.337	
12 (S/E)	**.744**	.316	
20 (AR)		**.894**	
19 (AR)		**.797**	
18 (AR)		**.696**	.367
15 (PD)			**.878**
16 (PD)		.305	**.807**
17 (PD)	.570		**.700**

As shown in Table 2, the rotated component matrix (provided by the Varimax with Kaiser Normalization rotation method) reveals that the latent constructs of the TSES-R are in line with the underlying constructs it is designed to measure, namely the respondents' expectations for robots in healthcare settings. Specifically, the cluster of bold items in the first component (items 11-14) turns out to be highly interrelated and has the potential to measure the Social/emotional dimension (α=0.869). At the same time, the cluster of bold items in the second component seems to be highly interrelated for measuring the Assistive role dimension (α =0.839). Finally, the bold items in the third component appear to be interrelated for measuring the Playful distraction dimension (α =0.800).

4 PILOT EVALUATION AND PRELIMINARY RESULTS

4.1 Pilot Evaluation of TSES-R

We handed out a survey including TSET-R and a few semi-structured questions to 31 fathers/mothers aged 31 to 44 (M=36.58, SD=3.79) currently living in the Netherlands. Most participants of the surveyed population identified themselves with Chinese cultural background (N=28), while a few identified themselves as Dutch (N=1) or Dutch-Chinese (N=2). Only 6 out of 31 participants had previous experience with a robot before our survey study.

We performed one-way repeated measures ANOVA with a Greenhouse-Geisser correction to examine whether parents' expectations towards robotics applications in healthcare differed significantly between the dimensions of fictional view (**FV**), capabilities (**C**), social/emotional (**S/E**), playful distraction (**PD**), and assistive role (**AR**).

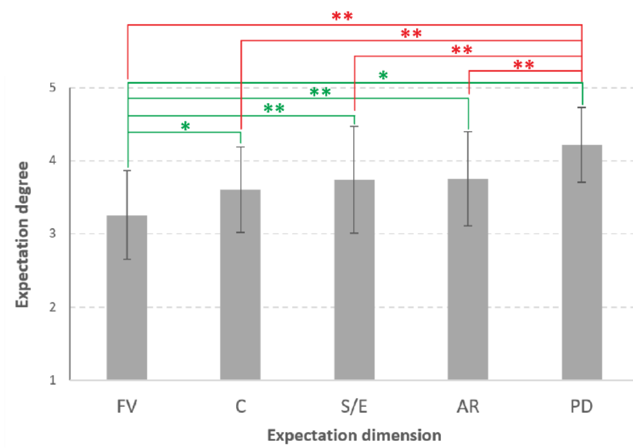

Figure 1: Mean of the parents' technology-specific expectation of robots in healthcare (score "1" as not at all, "5" as very much; * p <0.05, ** p <0.005)

4.2 Preliminary Results Suggested by TSES-R

As shown in Figure 1, the mean scores of parents' expectations from all five dimensions were above the median of 3. For example, except for the dimension of the fictional view (FV) (M = 3.26, SD = 0.61), all other dimensions reached relatively high scores: capabilities (C) (M = 3.61, SD = 0.59), social/emotional (S/E) (M = 3.74, SD = 0.73), assistive role (AR) (M = 3.75, SD = 0.64), and playful distraction (PD) (M = 4.22, SD = 0.51). Overall, this result would suggest that parents tend to have a positive belief and relatively high expectations of robots in general for healthcare.

A repeated measures ANOVA with a Greenhouse-Geisser correction determined that the parents' mean expectation differed significantly between the five researched dimensions ($F(3.407, 102.202) = 17.413$, p = .000). The post hoc analysis with a Bonferroni adjustment revealed that the parents' expectation about robots toward the **FV** dimension was significantly lower than the rest dimensions including **C** (-.348 (95% CI, -.664 to -.033), p = .022), **S/E** (-.484 (95% CI, -.784 to -.184), p = .000), **AR** (-.495 (95% CI, -.891 to -.098), p = .007), and **PD** (-.957 (95% CI, -1.332 to -.582), p = .000). Furthermore, our post hoc analysis also demonstrated that the parents' expectation about robots toward the **PD** dimension was significantly higher than the other four dimensions including **FV** (.957 (95% CI, .582 to 1.332), p = .000), C (.609(95% CI, .268 to .949), p = .000), **S/E** (.473 (95% CI, .140 to .807), p = .002), and **AR** (.462 (95% CI, .119 to .805), p = .003).

These quantitative findings demonstrated that parents are more likely to expect playful distractions (such as robots singing nursery songs, playing games with their children, or dancing in an amusing manner) than to anticipate the robot exhibiting abilities from science fiction. It is widely acknowledged that distraction can be used as procedural support to shift kids' focus away from uncomfortable feelings or the treatment itself [25]. Playful distraction activities similar to those listed in the TSES-R questionnaire have been found in previous studies [12, 30] to mitigate pain and distress in children.

5 DISCUSSION

Broadbent and colleagues have argued that a crucial factor still poorly understood is how healthcare consumers will respond to robotic applications [7]. Previous studies examining users' expectations of robots had a strong emphasis on employing measurements from interviews and questionnaires. For instance, the Knowledge, Attitude, and Practice (KAP) questionnaire was utilised in a recent study [23] to examine healthcare workers' expectations of the employment of robots in hospitals during the Covid pandemic. This KAP questionnaire used a mix of a five-point Likert scale and closed yes-or-no questions to understand respondents' prior knowledge and their attitude and perception about robots. This questionnaire specifically focused on respondents' expectations and preferences for the varying robotics application from telemedicine, disinfection, assistance, and general. While it helps map users' expectations to the application category of a robot, this questionnaire provides limited information on what specific features and behaviours a robot should have. Other related attempts (e.g., [4, 5, 24]) examined users' reactions, expectations and concerns about robots. For example. Song and colleagues examined the expectations of parents and music teachers toward social robots in music education. Beran and colleagues [4] used observational measures such as the duration of parents' and children's smiling behaviours, and children's crying behaviours were scored from the video recordings of the sessions. In addition, the parents gave feedback on what they expect from the robots in the future, but no specific questionnaire was used for that, which resulted in general answers. van den Berk-Smeekens and colleagues [5] pointed out that little is known about how the parents rate the acceptability of using a robot within existing interventions and how the design of the robot-assisted intervention relates to treatment adherence and acceptability. This study used a very practical approach – the parents were trained to perform the therapy that the robot was also performing by a therapist modelling the therapy techniques for the parents by controlling the robot. The parents were asked to complete the Session Rating Scale and Visual Analogue Scale (VAS) after each robot-assisted parent-child session. This study used validated scales that could evaluate the usefulness of the robot during the treatment sessions but did not provide the possibility of finding the future expectations of the parents for the robot.

To study what parents expect healthcare robots for children to do, we developed TSES-R, a five-point Likert scale questionnaire, for measuring users' expectations towards robots for healthcare. The proposed in the current paper TSES-R has advanced the original version of TSES [2] to capture users' expectations from three additional dimensions, including from the three emerging dimensions: (1) assistive role, (2) social/emotional, (3) playful distraction. Our reliability analysis indicated that the Cronbach alpha value for the TSES-R questionnaire was .897, which suggests good internal consistency. We recommend future research to use and validate this questionnaire in extended contexts and with more diverse respondents. For example, TSES-R can be used in other expectation studies with robots in the context of healthcare. In Particular, our development of the TSES-R would encourage future works in HRI and especially for those involving children to explore what different stakeholders (e.g., family members, healthcare professionals, robot developers etc.) would expect a robot for children in the healthcare context to do. In addition, future efforts could have a further focus on understanding and comparing how their expectations differed from each other groups. One potential limitation of the TSES-R concerns the selected dimensions reflected by the emerging applications in the literature. Given that robotics for healthcare is a speedily growing field, we encourage future research to pay attention to updating this version of TSES-R. Finally, one may argue that users' expectations might be biased by their attitudes. For example, one might desire something but not expect it to be realistic. We suggest future research using TSES-R for studying users' expectations to complementarily collect data regarding their attitudes to address this potential bias.

6 CONCLUSION

We introduced TSES-R, a five-point Likert scale questionnaire, as the first known instrument, for measuring parental expectations towards robots for healthcare from five dimensions. Reliability analysis of the construction of this questionnaire demonstrated good internal consistency. Furthermore, the preliminary results of involving 31 families in using TSES-R suggested that parents expect significantly more playful distractions, social-emotional support, and assistive roles provided by robots over the capacities described in science fiction. With this new instrument TSES-R, this paper aims to contribute to the inclusiveness of the HRI community by presenting findings regarding the parental expectations of robots for children and encouraging future studies to consider parental expectations in shaping robotics technology for children in healthcare.

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