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Physiotherapists' Acceptance of a Socially Assistive Robot in Ongoing Clinical Deployment

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***Abstract*— We report on physiotherapists' acceptance of a Socially Assistive Robot (SAR) as a therapeutic aid for paediatric rehabilitation. The SAR is undergoing in situ evaluation while being deployed as part of the clinical care of paediatric rehabilitation patients at the Royal Children's Hospital in Melbourne, Australia. The robot is equipped to lead rehabilitation sessions of up to 30 minutes under the guidance of a therapist, and without technician support or Wizard-of-Oz operation. In this paper we report on quantitative and qualitative data collected from 8 therapists participating in our study across 19 rehabilitation sessions. Data were collected after each therapy session. Our results show our system achieves a high degree of acceptance, particularly with respect to its perceived usefulness, and ease-of-use. Moreover, multiple sessions operating the SAR appears to strengthen positive perceptions of our system.**

I. INTRODUCTION

Rehabilitation outcomes rely critically on patients adhering to a prescribed program of exercises. However, rehabilitation exercises are often challenging, uncomfortable and repetitive, and this presents challenges for both therapists and parents of young rehabilitation patients.

Socially Assistive Robots (SARs) [1] are being considered in different healthcare scenarios to assist patient care and recovery. Their role is typically to improve the emotional and cognitive state of patients, and/or their engagement in a treatment program through appropriately designed socially-engaging interactive behaviours. Paediatric rehabilitation has received particular focus in recent years [2], [3], [4], [5], [6], with a growing body of evidence suggesting SARs offer potential benefits for patients undergoing intensive rehabilitation. However, no formal study has yet been conducted to evaluate the acceptance of such systems in the ongoing rehabilitation programs. Systems tested to date have primarily used Wizard-of-Oz controlled interactions and/or have focussed on specific aspects of rehabilitation, rather than on full session delivery using the robot. Moreover, few groups have considered the needs of on-going SAR deployment in clinical settings for which SAR integration and acceptance by hospital staff is crucial [7].

Our software prototype for the NAO robot leads entire rehabilitation sessions without teleoperation. It instructs and demonstrates the correct execution of therapist-configured exercises, and it motivates and emotionally supports patients as they undertake each session [8].

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In this paper we evaluate physiotherapist acceptance of a stand-alone robust SAR in ongoing clinical deployment [9] through survey and observational data collected from 8 therapists (6 fully qualified physiotherapists, 2 physiotherapist trainees) across 19 sessions. As physiotherapists are primary users of the system and hold a professional duty of care for patients, we report specifically on their perceptions of our SAR prototype as a therapeutic aid, with focus on perceptions of usefulness, usability and trust. We also report feedback regarding deficits and possible improvements in the current system.

II. PREVIOUS WORK

A number of groups have considered the design and evaluation of SARs in paediatric rehabilitation. Plaisant et al. [10], for example, followed a participatory design approach to develop a SAR to support rehabilitation by motivating children through storytelling. The 'Cosmobot' robot [11] uses teleoperated interaction and accelerometers attached to children's arms, and was tested with 6 children with Cerebral Palsy (CP). The humanoid 'KineTron' [12] robot was also tested with 6 children with CP across 5 to 7 sessions. The authors note potential benefits for motor training when using humanoid robots. Several researchers have considered the use of NAO humanoid robots to assist children in paediatric rehabilitation. Vircikova and Sincak [2] report improved compliance in a study involving both patients and students at a high school. NAO robots have also been adopted as a proof-of-concept robot coach for physical activity and rehabilitation, evaluated with 14 typically-developing children and 11 children with CP [3]. Two patients with CP underwent rehabilitation with an adapted NAO, completing 3 different exercises once per week during 8 weeks [5]. The authors noted potential benefits for improving motor function in children with CP. NAOTherapist [6] utilises a RGB-D camera to assist upper-body paediatric rehabilitation. The system was evaluated with 117 healthy school children, however to date has only been evaluated with 3 patients. The authors report that the system is engaging and useful for rehabilitation purposes. Instead of using a 3D imaging camera, Guneysu and Arnrich [4] use inertial measurement units attached to the children's arm and chest to measure their performance. Their system was tested with 14 normally developed children and these participants reporting enjoyment when interacting with the robot.

Few studies to date have specifically addressed the needs of integration with clinical practice, or focussed on the

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utilisation of a stand-alone SAR to deliver whole sessions of rehabilitation without additional sensors.

III. THE STUDY

In partnership with Melbourne's Royal Children's Hospital, we have been developing and evaluating a prototype SAR, targeting the prescribed rehabilitation program of young patients predominantly diagnosed with cerebral palsy. We have previously reported the design of our SAR for rehabilitation [9], developed in situ at the hospital. Here we briefly describe the prototype system, and outline the current study methodology.

A. The SAR system

The prototype SAR, a NAO robot, has been adopted to assist physical lower limb rehabilitation programs, with built in extensibility to support other rehabilitation exercise needs in the future. The SAR fulfils the role of motivator and demonstrator, as well as general companion for patients as it leads patients through whole sessions of rehabilitation. The system operates semi-autonomously under the guidance of the therapist or supervising adult. Patients and supervising adults interact with the SAR via simple verbal statements, as well as through tactile sensors. Interactions include confirming readiness to continue with an exercise or activity (via speech or head-taps), adjusting exercise speed (via head-taps), and pausing the SAR's program execution.

Statements have been scripted in consultation with therapists, with instructional and motivational utterances delivered at strategic points during exercise execution. No Wizard-Of-Oz control is used during the session.

The SAR offers 12 different exercises from a lying down position, a sit-to-stand exercise, and a game-play activity (to improve mobility) in which the robot issues instructions to the patient to collect and bring back particular toys. Due to physical design constraints, the SAR requests assistance when unable to reach particular postures, or place auxiliary aids (e.g., a support under the robot's knee). In this case the SAR provides clear audible instruction to the operator as to what is required [13]. A full description of the SAR is provided in [8].

B. Trial Environment

Sessions were conducted in a consultation room (the Participant Room). Observing researchers were located in an adjacent room (the Researcher Room) observing the session through the one-way mirror (Figure 1).

In this study, patients, physiotherapists and the SAR always stayed in the Participant Room. Parents observing the session chose together with their child where to observe the session. Two observing researchers were present for all sessions in the study.

C. Participant Recruitment

Patients, parents and therapists were all formally recruited to participate in this study, with ethics clearance obtained from both partner institutions. The inclusion criteria for patients was that they had been prescribed rehabilitation program consistent with the SAR's predominantly lower-limb exercise capabilities, based on physiotherapist clinical judgement.

Once participant consent was obtained, physiotherapists scheduled a rehabilitation session with the robot and their treating physiotherapist. If the treating physiotherapist was a member of the research team, the research team member operated the SAR for the patient but no data from the therapist was recorded. After completing a session, participants were given the option to participate in another session the following week. Patients participated in a maximum of 3 sessions.

D. Session Procedure

A research engineer was responsible for system setup prior to patient arrival. A physiotherapist research team member gave a brief introduction of the SAR to the participating physiotherapist. The researcher explained that the robot would follow the prescribed program autonomously, but would occasionally request help as required, and request head button taps to confirm readiness at various stages. Participants were also told the system was capable of recovering from falls without intervention. Once running, the robot indicated readiness by stating: *"I am going to wait until someone taps my head."* At this point all research team members left the room.

E. Data Collection

During the session software logs recorded information about the system performance. Observations were also gathered via annotations by researchers. After each session, participating physiotherapists were asked to fill in a questionnaire to capture their immediate perceptions of the SAR. The survey was composed of the following parts.

1) Acceptance Questionnaire: A modification of the 'Acceptance of an assistive social robot' questionnaire, developed by Heerink et al. [14] for the aged care environment, was included in the survey.

Table I shows acceptance survey questions asked to physiotherapists. The questionnaire is divided into different categories: Anxiety (ANX1, ANX2), Attitude (ATT), Facilitating Conditions (FC), Intention to Use (ITU), Perceived Adaptability (PAD), Perceived Ease of Use (PEOU), Perceived Usefulness (PU), Trust (TR) and Social Influence (SI). We have divided the Anxiety category into two parts to better understand the extent to which participants are anxious about the robot itself (eg., safety), or their ability to use the system without background knowledge (eg., risk of breakage, or usage error). Questions used a Likert scale response format (*Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree*) and were presented in randomised order.

2) Open Questions: Open-ended feedback was obtained from therapists to comment on possible system improvements, the most useful roles, any issues or problems encountered during the session, and patient compliance and emotional state during the session.

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Fig. 1: Study setting. Left image: Participants' room with a one-way mirror. Right image: Researchers' observation room.

TABLE I: Acceptance questionnaire for physiotherapists.

Construct	No	Question
ANX1	1	I would be afraid to make mistakes using the robot
	2	I would be afraid to break something when using the robot
ANX2	3	I find the robot scary
	4	I find the robot intimidating
ATT	5	I think it's a good idea to use the robot
	6	The robot would make therapy sessions more interesting
FC	7	I have everything I need to make good use of the robot
	8	I know enough of the robot to make good use of it
ITU	9	If I have access to the robot, I think I'll use it during the next therapy sessions
	10	If I have access to the robot, I am certain to use it in the next therapy sessions
	11	If I have access to the robot, I'm planning to use it during the next therapy sessions
PAD	12	I think the robot can be adaptive to what I need
	13	I think the robot will only do what I need at that particular moment
	14	I think the robot will help me when I consider it to be necessary
PEOU	15	I think I will know quickly how to use the robot
	16	I find the robot easy to use
	17	I think I will be able to use the robot without any help if I have been trained
	18	I think I will be able to use the robot when there is someone around to help me
	19	I think I will be able to use the robot when I have a good manual
PU	20	I think the robot is useful to help in paediatric therapy
	21	It would be convenient to have the robot for therapy sessions with kids
	22	I think the robot can help me with many things during paediatric sessions
SI	23	I think the staff would like me using the robot
	24	I think parents would like me using the robot
	25	I think patients would like me using the robot
	26	I think it would give a good impression if I should use the robot
TR	27	I would trust the robot if it gave me advice
	28	I would follow the advice the robot gives me

IV. RESULTS

Between August 2016 to November 2017, 8 physiotherapists (6 fully qualified physiotherapists, 2 physiotherapist trainees) were recruited to deliver therapy with the SAR to volunteer patients under their care. During this time, the 8 therapists completed a total of 19 surveys, after each rehabilitation session. All physiotherapists were female. Two surveys were collected from physiotherapist A; 4 from physiotherapist B; 3 from physiotherapist C; 4 from physiotherapist D; 2 from physiotherapist E; 2 from physiotherapist F; and 1 for each physiotherapist G and H.

A. Survey Responses

We report only results of the questionnaire constructs that obtained a Cronbach's alpha reliability measure [15] equal to or greater than 0.7. On this basis, the ANX2 category was excluded, with responses indicating universal *Disagreement/Strong Disagreement* across all user groups to the question of participants fearing the robot. ATT, PAD and SI did not meet the reliability threshold, and so were also removed.

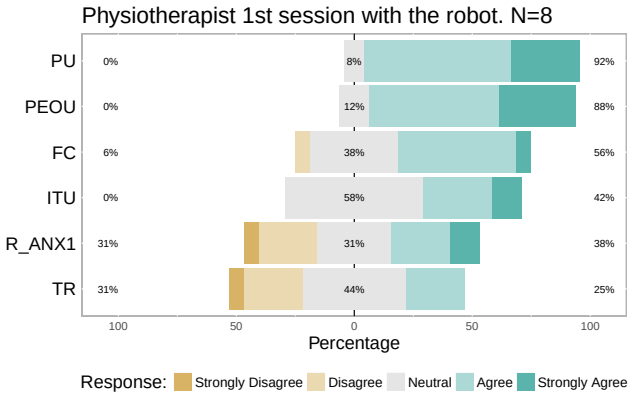

Fig. 2: Physiotherapists Acceptance questionnaire results after 1st session operating the robot. Anxiety reversed (R_ANX1), Facilitating Conditions (FC), Intention to Use (ITU), Perceived Easy of Use (PEOU), Perceived Usefulness (PU), Trust (TR)

1) Physiotherapist Acceptance: Figure 2 shows Acceptance questionnaire responses provided by 8 participating physiotherapists after their first experience with the robot. Participants' responses are grouped by category, with each row showing the percentage of responses for each category. Negative responses are represented on the left of the graph, and positive on the right. Note that Anxiety (ANX1) responses have been reversed to alogn postive and negative sentiment with other categories.

Figure 2 shows physiotherapists overwhelmingly agree that the SAR is useful in their sessions (PU) and easy to use (PEOU), with 92% and 88% of the responses indicating agreement to these assertions respectively after first use. Facilitation Conditions (FC), examining the extent to which therapists felt equipped to use the SAR effectively, obtained 56% positive responses (*Agree/Strongly Agree*) from therapists delivering therapy with no training. However, therapists

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reported a more divided response to questions of their Intention to Use (ITU) the SAR in future sessions. While no one disagreed, the most prominent response was neutral, at 58%, while the remaining 42% either agreed or disagreed.

Trust (TR) and Anxiety (ANX1) generated the most polarised responses. After first use of the SAR, 31% of responses indicated some level of distrust and anxiety, with a similar percentage indicating some level of trust and no anxiety.

Of particular interest was the evolution of therapist perceptions of the SAR after multiple uses. Of the 8 therapists, 6 participated in a further two or more sessions with the robot, in which survey data continued to be collected. While all therapists were invited to continue, two therapists were unavailable for further participation.

Figure 3 shows the physiotherapists' perceptions over multiple sessions, plotting the mean response to each category of questions after each session. Each graph represents a different construct in which physiotherapists responses are calculated individually. *Strongly Disagree* responses are represented with 1, *Strongly Agree* responses with 5.

Figure 3e shows that the physiotherapist's Perceived Usefulness (PU) of the robot shifts slightly to the negative. However, it is still the most positive category with most of the responses above 3 (*Neutral*). A majority of responses to the system's perceived ease-of-use were *Agree*/*Strongly Agree*, with only one physiotherapist (PT B) providing a *Neutral* response after their fourth session (Figure 3d).

All physiotherapists but one (PT D) expressed being more equipped to use the robot effectively (FC) after two sessions compared to only one session. Notably, PT D already agreed they felt equipped, and maintained this rating throughout the 4 sessions they conducted with the SAR. Four of the therapists responded with *Neutral* or *Agreement* to statements of their intention to use (ITU) the system in future sessions, however, two therapists (PTs B and E) reported mostly *Neutral* or *Disagree* responses across their sessions (4 and 2 sessions respectively).

Three therapists indicated reduced feelings of Anxiety (ANX1) after using the system in multiple sessions. Only one therapist (PT F) indicated a substantial increase in anxiety after two sessions, while all others remained largely stable. Results overall show Trust (TR) in the system slightly increases after using it multiple times, however most of the evaluations oscillate between between *Neutral* or *Disagreement*.

2) Open Questions: A thematic analysis [16] was also performed on open ended question responses in the 19 surveys collected. When physiotherapists were asked what they thought was *missing in our SAR system to be a useful and legitimate aid*, nine survey responses mentioned Flexibility/Adaptability. Examples of desired flexibility included: the robot being able to adapt to the present scenario or patient condition, allowing therapists to alter the exercise order, or to divert from the set program. Five surveys also stated Monitor/Feedback, such as the robot being able to evaluate the patient's performance and provide feedback accordingly.

Therapists were asked to list *the most useful role of the robot*. *Demonstrator* is the most mentioned role, appearing in 12 survey responses. Therapists commented that patients can visualise the correct performance of the exercises with clear verbal instructions from the SAR. *Motivator* was mentioned in 10 surveys, reporting that the robot provides some fun, and visibly increases the patient compliance and participation. One physiotherapist states that most of the physiotherapist's work in the hospital is keeping the child interested and motivated. The *Companion* role was mentioned twice, with respondees noting that the SAR maintains "a good pace" for the patient when doing the exercises.

A diversity of responses were received when therapists were asked *Which is the most important feature that should be fixed or implemented*. Physiotherapists mostly reported about system or hardware failures during the session. The four issues noted were: more battery life, the hip was cracking (part replacement), the robot recovering from falls, and failure with an exercise demonstration (due to the motors overheating). Flexibility/Adaptability was mentioned in 3 survey responses to this question, including statements indicating a desire for increasing the variety of motivation statements; improving the communication with the patient; and providing more information such as a list of exercises to do in the session.

Physiotherapists were also asked to *rate the patient in the session*. Fourteen surveys reported positive reactions to the patient's performance during the session, with statements such as the child enjoyed the session, the patient participated well, the patient was motivated/engaged/compliant during the session. In 4 surveys, therapists also compared the patient's attitude to previous sessions without the SAR. One survey reported that the patient was more focussed, compliant, and focused when using the SAR. However, negative patient reactions were also reported in 3 survey responses, with expressions like: very poor patient compliance; patient seemed a bit anxious, and the patient said the robot "was creepy".

V. DISCUSSION

In this study we seek to evaluate the level of acceptance of the proposed SAR prototype for paediatric rehabilitation in the context of full clinical deployment in a busy children's hospital. We thus focus specifically on the perceptions of therapists who hold primary duty of care for patients, and who have used the SAR to deliver rehabilitation sessions.

A. Physiotherapist Acceptance

Perceived Usefulness (PU) provides the most direct measure of the SAR's effectiveness in the rehabilitation sessions it led. Physiotherapists rate the system's usefulness overwhelmingly positively, with several therapists noting observed improvements in exercises completed by patients known in general to be resistant. Qualitative feedback rated very positively the demonstrator and motivator role of the robot.

Figure 3e does indicate a marginal drop in positive responses for Perceived Usefulness, with PTs B and C

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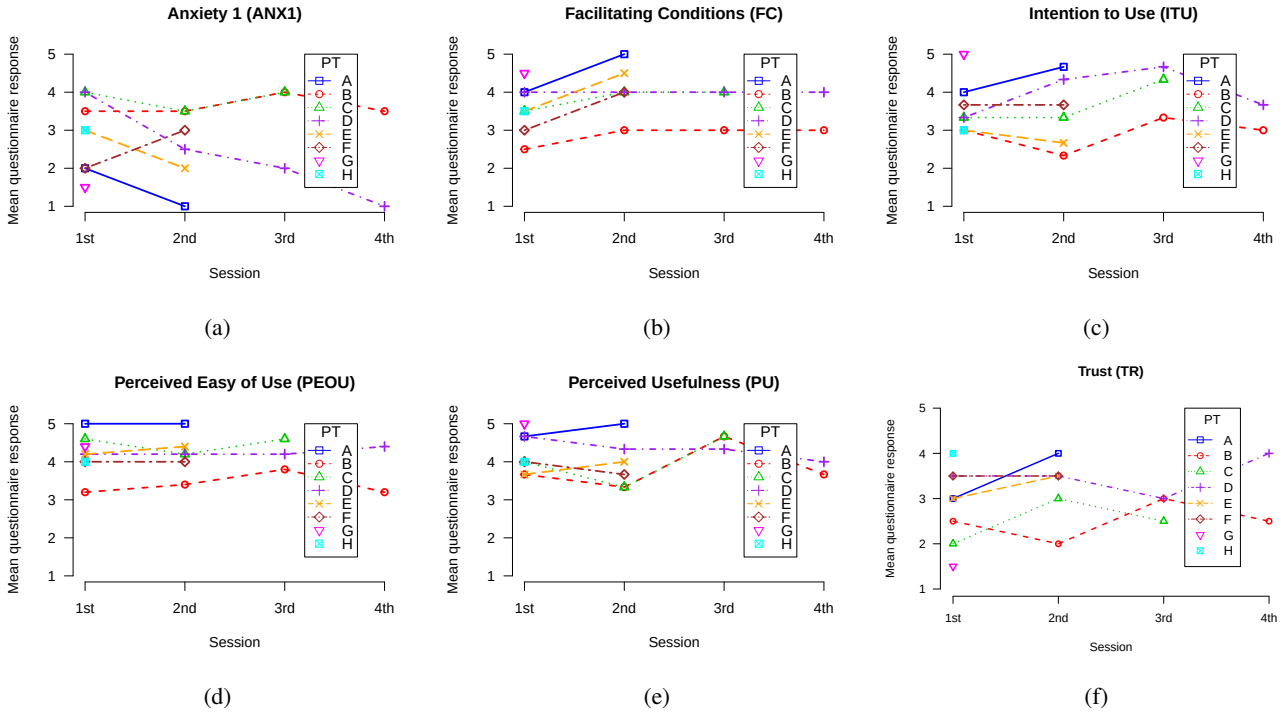

Fig. 3: Acceptance questionnaire results per physiotherapists (PT) over time. (a) Anxiety (ANX1), (b) Facilitating Conditions (FC), (c) Intention to Use (ITU), (d) Perceived Easy of Use (PEOU), (e) Perceived Usefulness (PU), (f) Trust (TR). Mean questionnaire response: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree.

downgrading their response to *Neutral* after the second session. Observation notes indicate both repeat sessions with these therapists involved negative patient emotions during the session. The SAR's lack of responsiveness to such events may have contributed to a reduction in PU responses

The high rating of the system's usability by physiotherapists (PEOU) provides compelling evidence for the system's successful integration with therapist needs. This is further supported by the minimal training provided to therapists, involving a 5 minute introduction to the system delivered by a physiotherapist team member. Thus, no specialised technical knowledge of the system was required to operate the system, or train others to operate the system. Notably, the Facilitation Conditions (FC) category reflects a less conclusive result after the first session, with just under half the responses indicating some doubt as to whether they felt sufficiently equipped to use the SAR effectively. Encouragingly however, responses shift to agreement for almost all therapists after multiple uses, suggesting successful experiences using the SAR reinforces therapist confidence in effectivelu using the aid.

Compared with PEOU responses, therapists express less certainty on questions of their intention to make use of the system, most of their responses are neutral after their first use, and the range of responses change between strongly agree and disagree after multiple sessions. The weaker positive responses to these questions are likely reflecting the inability of therapists to configure the SAR for their patient's session without technician support.

Therapist responses to questions of trust are most polarised. Arguably the survey questions on this topic do not properly capture the most relevant interpretation of trust for this application: that therapists trust the robot to deliver the correct advice to patients. However, the questions do capture broader perceptions of therapists regarding the SAR's design as a care delivery system. Encouragingly, results in Figure 3f suggest trust in the SAR's instruction improved over repeat sessions.

As with trust, Anxiety (ANX1) reflects mixed views. Questions of safety in the presence of the robot were universally positive, however ANX1 reflects anxiety with respect to possible breakage or operation failures. Most negative responses from physiotherapists were to the question '*I would be afraid to break something when using the robot*', suggesting therapists saw the SAR as expensive and fragile. In general, multiple uses of the system reduces anxiety, suggesting experience assists in allaying these concerns. However, the third session of PTs B and C, and the second session for PT F show an increment in anxiety (Figure 3a). Observational notes indicate that the instructions of the SAR confused PT B during the session, and PT C had a system motor failure (overheating).

B. Implications for SARs in Health Care

We have previously argued [8] that the in situ design and development of our SAR has been central to the high degree of patient and therapist engagement achieved. The results

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presented here suggest this engagement has also delivered a prototype that is acceptable to therapists as part of clinical practice. The emphasis on robust performance over ambitious artificial intelligence has contributed to the system's successful integration. While clear deficits have been observed in the system, perceptions of its usefulness, and its usability support design decisions that place robustness and ease-of-use (including setup) as primary objectives to expedite its deployment in clinical care. This in turn has allowed data collection from patient sessions to occur in a continuous and ongoing fashion, informing the design and scope of further artificial intelligence developments. We argue that such a model of development of SAR's may easily be translated to other health care domains, where similar benefits may be realised.

C. Limitations

As an in situ evaluation, our data collection and analysis is necessarily limited in the generalisations it can support. Recruitment of participants in particular has been necessarily biased towards patients seen by their participating therapists to gain benefits from its use. This may influence perceptions of usefulness, though it could also be argued that such case-base choices reflect more accurately how therapeutic aids are selected by therapists.

The current study is not a clinical trial and thus cannot provide conclusive statements regarding actual therapeutic benefits attributable to the SAR. A randomised controlled trial remains future work for the project to assess patient outcomes.

VI. CONCLUSION

We have presented the data collected from physiotherapists during the in situ evaluation of a prototype SAR for paediatric rehabilitation. With a focus on evaluating the SAR's acceptance for ongoing clinical deployment, we have reported on therapist perceptions of the robot after 19 rehabilitation sessions. Analysis of survey results reveals overall positive perceptions of the SAR as a therapeutic aid, with particularly strong results for the SAR's perceived usefulness and usability. Data gathered after multiple sessions indicates these positive perceptions remain stable over time. These results provide strong support for the SAR's successful integration and acceptance by the primary duty of care to the patients it seeks to assist. More generally, this success highlights further benefits gained from an in situ design process focussed on patient/therapist and parent engagement as a driver for the development and deployment of SAR's in health care settings.

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REFERENCES

[1] M. J. Matarić and B. Scassellati, *Socially Assistive Robotics*. Cham: Springer International Publishing, 2016, pp. 1973–1994. [Online]. Available: https://doi.org/10.1007/978-3-319-32552-1_73

[2] M. Vircikova and P. Sincak, *Experience with the Children-Humanoid Interaction in Rehabilitation Therapy for Spinal Disorders*. Berlin, Heidelberg: Springer Berlin Heidelberg, 2013, pp. 347–357. [Online]. Available: https://doi.org/10.1007/978-3-642-37374-9_34

[3] M. Fridin and M. Belokopytov, "Robotics agent coacher for cp motor function (rac cp fun)," *Robotica*, vol. 32, no. 8, pp. 1265–1279, 2014. [Online]. Available: https://doi.org/10.1017/S026357471400174X

[4] A. Guneysu and B. Arnrich, "Socially assistive child-robot interaction in physical exercise coaching," in *2017 26th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, Aug 2017, pp. 670–675. [Online]. Available: https://doi.org/10.1109/ROMAN.2017.8172375

[5] N. A. Malik, H. Yussof, and F. A. Hanapiah, "Potential use of social assistive robot based rehabilitation for children with cerebral palsy," in *2016 2nd IEEE International Symposium on Robotics and Manufacturing Automation (ROMA)*, Sept 2016, pp. 1–6. [Online]. Available: https://doi.org/10.1109/ROMA.2016.7847820

[6] J. C. Pulido, J. C. González, C. Suárez-Mejías, A. Bandera, P. Bustos, and F. Fernández, "Evaluating the child–robot interaction of the naotherapist platform in pediatric rehabilitation," *International Journal of Social Robotics*, vol. 9, no. 3, pp. 343–358, Jun 2017. [Online]. Available: https://doi.org/10.1007/s12369-017-0402-2

[7] B. Mutlu and J. Forlizzi, "Robots in organizations: The role of workflow, social, and environmental factors in human-robot interaction," in *Proceedings of the 3rd ACM/IEEE International Conference on Human Robot Interaction*, ser. HRI '08. New York, NY, USA: ACM, 2008, pp. 287–294. [Online]. Available: https://doi.org/10.1145/1349822.1349860

[8] F. Martí Carrillo, J. Butchart, S. Knight, A. Scheinberg, L. Wise, L. Sterling, and C. McCarthy, "Adapting a General-Purpose Social Robot for Paediatric Rehabilitation Through In Situ Design," *ACM Trans. Hum.-Robot Interact.*, vol. 7, no. 1, pp. 12:1–12:30, May 2018. [Online]. Available: https://doi.acm.org/10.1145/3203304

[9] ——, "In-Situ Design and Development of a Socially Assistive Robot for Paediatric Rehabilitation," in *Proceedings of the Companion of the 2017 ACM/IEEE International Conference on Human-Robot Interaction*, ser. HRI '17. New York, NY, USA: ACM, 2017, pp. 199–200. [Online]. Available: https://doi.org/10.1145/3029798.3038382

[10] C. Plaisant, A. Druin, C. Lathan, K. Dakhane, K. Edwards, J. M. Vice, and J. Montemayor, "A storytelling robot for pediatric rehabilitation," in *Proceedings of the Fourth International ACM Conference on Assistive Technologies*, ser. Assets '00. New York, NY, USA: ACM, 2000, pp. 50–55. [Online]. Available: https://doi.org/10.1145/354324.354338

[11] A. J. Brisben, C. S. Safos, A. D. Lockerd, J. M. Vice, and C. E. Lathan, "The CosmoBot System: Evaluating its Usability in Therapy Sessions with Children Diagnosed with Cerebral Palsy," 2005.

[12] V. Kozyavkin, O. Kachmar, and I. Ablikova, "Humanoid social robots in the rehabilitation of children with cerebral palsy," in *Proceedings of the 8th International Conference on Pervasive Computing Technologies for Healthcare*, ser. PervasiveHealth '14. ICST, Brussels, Belgium, Belgium: ICST (Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering), 2014, pp. 430–431.

[13] F. Martí Carrillo, J. Butchart, S. Knight, A. Scheinberg, L. Wise, L. Sterling, and C. McCarthy, "Help me help you: A Human-Assisted Social Robot in Paediatric Rehabilitation," in *Proceedings of the 28th Australian Conference on Computer-Human Interaction*, ser. OzCHI '16. New York, NY, USA: ACM, 2016, pp. 659–661. [Online]. Available: https://doi.org/10.1145/3010915.3011858

[14] M. Heerink, B. Krose, V. Evers, and B. Wielinga, "Measuring acceptance of an assistive social robot: a suggested toolkit," in *RO-MAN 2009 - The 18th IEEE International Symposium on Robot and Human Interactive Communication*, Sept 2009, pp. 528–533. [Online]. Available: https://doi.org/10.1109/ROMAN.2009.5326320

[15] L. J. Cronbach, "Coefficient alpha and the internal structure of tests," *Psychometrika*, vol. 16, no. 3, pp. 297–334, Sep 1951. [Online]. Available: https://doi.org/10.1007/BF02310555

[16] V. Braun and V. Clarke, "Using thematic analysis in psychology," *Qualitative Research in Psychology*, vol. 3, no. 2, pp. 77–101, 2006. [Online]. Available: https://doi.org/10.1191/1478088706qp063oa