

Robot-mediated therapy to reduce worrying in persons with visual and intellectual disabilities

Evelien van Wingerden¹  | Emilia Barakova²  | Tino Lourens³ |
Paula S. Sterkenburg^{1,4} 

¹Department of Clinical Child and Family Studies, VU Amsterdam, Amsterdam, The Netherlands

²Department of Industrial Design, Eindhoven University of Technology (TU/e), Eindhoven, The Netherlands

³TiViPE, Helmond, The Netherlands

⁴Bartiméus, Doorn, The Netherlands

Correspondence

Evelien van Wingerden, Department of Clinical Child and Family Studies, VU Amsterdam, Amsterdam, The Netherlands.
Email: e.van.wingerden@vu.nl

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Abstract

Background: The study explored the use of a robot-mediated therapeutic intervention in persons with visual and intellectual disabilities.

Method: Three robot-mediated intervention sessions were developed to teach three coping skills for worrying. Effectiveness was examined using a multiple-baseline case study design ($N = 7$). Baseline, pre-intervention and post-intervention assessments included social validity, severity of worrying (PSWQ-C-NL), and observations by caregivers (SDQ). Short checklists on worrying were repeated throughout baseline and intervention stages. Transcripts of the sessions were analysed for participants' emotional openness.

Results: Social validity was equally high before and after the intervention. The intervention did not impact the severity of worrying, although mentor caregivers reported a lower impact of personal difficulties for participants. We found no change in self-disclosure towards the robot over sessions.

Conclusions: The participants' positive responses warrant further exploration of using robot-mediated therapy for persons with visual and intellectual disabilities. Recommendations for additional adaptations are discussed.

KEYWORDS

e-health, intellectual disabilities, robot-mediated intervention, visual impairment, worrying

1 | INTRODUCTION

Increasing numbers of studies have investigated social robotics in mental health care, as described in recent reviews (Rabbitt, Kazdin, & Scassellati, 2015; Robinson, Cottier, & Kavanagh, 2019). To date, applications of robots in mental health care have been limited to the contexts of children's health, autism spectrum disorder and older adults with dementia. In such settings, robots are often used for stress reduction (Crossman, Kazdin, & Kitt, 2018; Dang & Tapus, 2013), to promote positive engagement in persons with dementia (Perugia et al., 2018),

to teach skills that may improve the social atmosphere at home and school (Barakova, Bajracharja, Willemsen, Lourens, & Huskens, 2015; Taheri, Meghdari, Alemi, & Pouretamad, 2018), or to assist with cognitive tasks (Tapus, Tapus, & Mataric, 2009). In addition to its instrumental use, a robot with a humanoid appearance and sufficient social cues during interaction can evoke an empathic connection, and thereby enhance positive learning experiences (Ghazali, Ham, Barakova, & Markopoulos, 2018; Robison, Mcquiggan, & Lester, 2009). This potential for social and empathic interaction between people and robots may enable the use of robots in psychotherapeutic contexts.

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In the present study, we explored the possibility of using social robots in therapeutic settings for persons with visual and intellectual disabilities. Compared to those without intellectual disability, persons with intellectual disabilities are prone to experiencing a situation as being more stressful (Janssen, Schuengel, & Stolk, 2002). Furthermore, visual impairment and intellectual disability each impede the recognition of others' emotions (Dyck, Farrugia, Shochet, & Holmes-Brown, 2004), as well as competencies related to self-perception and self-regulation (Nader-Grosbois, 2014). Therefore, persons with visual and intellectual disabilities may experience difficulties with stress and emotional regulation, resulting in worrying.

Treatment programmes for worrying or anxiety are often based on cognitive behavioural therapy to modify negative thought patterns (Hall, Kellet, Berrios, Bains, & Scott, 2016). However, the emphasis on cognition can present challenges for persons with intellectual disabilities (Oathamshaw & Haddock, 2006). There are several programmes for children or youths that combine simplified cognitive behavioural therapy exercises with additional methods, such as psychoeducation, mindfulness, or relaxation exercises (Oswald & Mazefski, 2006; Reyes-Portillo et al., 2014). Certain elements of these treatment programmes, such as psychoeducation or relaxation exercises, can be provided in a highly standardized form and may thus be suitable for robot-mediated delivery.

Robots have certain advantages over human conversation partners, particularly for persons who experience information-processing difficulties. Robots provide highly structured sessions that can be repeated as often as needed (Kim et al., 2014). Furthermore, robots produce fewer sensory stimuli compared to humans, which can be helpful for people who are susceptible to sensory overload. Finally, it may be beneficial that participants will not feel judged by a robot if many repetitions are needed, or when discussing sensitive issues. For example, some persons with autism spectrum disorder have been found to exhibit partiality towards robots (Kumazaki et al., 2018; Pennisi et al., 2016; Shamsuddin et al., 2012). At the moment it is unknown how persons with visual and intellectual disabilities will experience this type of interaction.

Several studies demonstrate how robots can assist in teaching children with disabilities. Hedgecock, Standen, Beer, Brown, and Stewart (2014) found that a humanoid robot helped children with profound and multiple disabilities, specifically with learning to recognize cause and effect and sense of direction. Regarding

social skills, Smeekens et al. (2018) observed that the addition of a robot increased the effectiveness of pivotal response treatment for training children with autism spectrum disorder to show fewer autism-related behaviours. Additionally, during sessions involving a robot, children with autism spectrum disorder exhibited an improved quality of social interaction with siblings and peers (Barakova, Bajracharya, Willemsen, Lourens, & Huskens, 2015; Huskens, Palmen, Van der Werff, Lourens, & Barakova, 2015); however, this effect was not sustained after the robot training.

To include robots in therapy, an existing therapy is typically adapted to be led or mediated by a robot (Costescu, Vanderborght, & David, 2017). Games and playful interactions are often used to limit the scope of the interaction, and to increase engagement with the therapy (Huskens et al., 2015; Kim et al., 2014). The robot's role might be to reward behaviour, provide cues, or provide an active element to learning. In many studies, robot participation has led to significantly higher rated engagement (Hedgecock et al., 2014; Van Straten et al., 2018). Overall, the available data indicate that robots can help clients to acquire or improve specific skills, if the interaction is properly designed and training is conducted over an appropriate time period.

1.1 | The current study

In the current study, we aimed to examine the effects of a short intervention intended to teach persons with visual and intellectual disabilities three different strategies to cope with worrying. In the intervention, participants were asked to help the robot apply these strategies, thereby implicitly internalizing the strategies.

The results of a previous pilot study confirmed that clients with visual and intellectual disabilities had positive initial responses to the robot, were able to engage in a meaningful conversation with the robot, and enjoyed the interaction (De Groot, Barakova, Lourens, van Wingerden, & Sterkenburg, 2019)

1. How do persons with visual and intellectual disabilities experience therapy sessions with a robot?
2. Can the robot assist in teaching persons with visual and intellectual disabilities useful coping strategies to reduce worrying?
3. Does the robot elicit empathy and emotion-related responses from the participants?

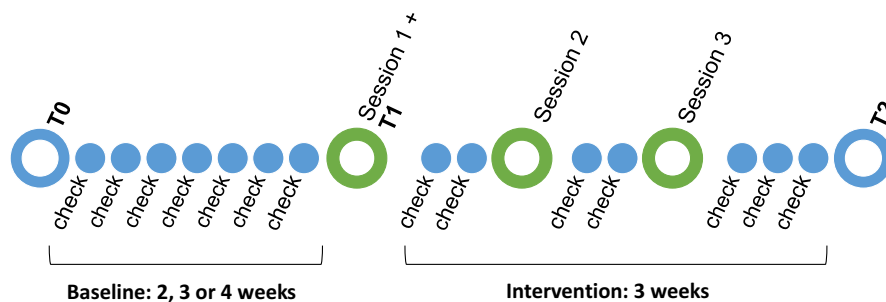


FIGURE 1 Timeline of measurements and intervention. Duration of the baseline phase (2, 3 or 4 weeks) was randomized. The intervention consisted of three weekly sessions for all participants. Checks were evenly distributed over the duration of each phase. T2 took place in the week following Session 3 [Colour figure can be viewed at wileyonlinelibrary.com]

2 | METHODS

2.1 | Design

We conducted a multiple-case study with a multiple-baseline design (Figure 1). This method allows replication of a result within a single participant as well as between-subject replication of the effect. The introduction of the intervention is staggered across time, to control for confounding variables that are time-related (Kratochwill & Levin, 2014; Onghena, 2005).

At the start of the intervention, all participants completed a set of questionnaires (T0). Following T0, the ten participants were randomly assigned to one of three groups, with a baseline phase lasting either 2, 3 or 4 weeks. During the week following the baseline period, participants completed a second set of questionnaires (T1) and started the intervention of 3 weekly sessions (Sessions 1, 2 and 3). During the week after the last session, participants completed the third and final set of questionnaires (T2). Between T0 and T2, participants received several phone calls per week to briefly assess the severity of their worrying on that day.

2.2 | Participants

All participants were affiliated with a care facility for persons with visual impairment. For this study, we selected persons with a tendency to worry but without severe psychiatric problems, such as depression or anxiety disorders. Other inclusion criteria were an age of 18 years or older, having a mild or moderate intellectual disability, and visual impairment but were not blind. Exclusion criteria were blindness, persons who were deaf or hard of hearing, had a chronic illness or were being treated by a psychiatrist.

Informed consent was obtained for 10 persons. Of these 10 persons, three were excluded during the baseline phase. These three persons found it too difficult to complete the questionnaires. They all had a moderate intellectual disability (IQ between 40 and 50) and were unable to reflect on their way of thinking and their own worrying. Adapting the paradigm to these persons' needs did not improve the quality of their responses. Furthermore, our experiences indicated that attending the session in the therapy room might be too overwhelming. For two of these persons, it was possible to bring the robot to their own homes with a caregiver present. During the home visit, one person completed only part of Session 1 before his attention wandered off. The other person participated in one complete session during the home visit, but could not respond to the more conceptual and reflective topics in the intervention. Both were thus excluded from the study. The remaining participants included five males and two females, each with a mild intellectual disability. Their ages ranged from 27 to 60 years ($M = 46.9$). Two had profound visual impairment, four were classified as having "low vision," and one participant had hemianopsia (loss of one half of the visual field).

2.3 | Data collection

2.3.1 | Social Validity questionnaire

At T0 and T2, a short social validity questionnaire was included to assess participants' expectations (T0) and experiences (T2) of the intervention. The questionnaire given at T0 included seven questions about the participant's expectations of the intervention itself and of the intervention's effects. At T2, these items were asked in an evaluative form, along with five additional questions focusing on separate elements of the intervention.

2.3.2 | Worrying

At T0, T1 and T2, the Dutch version of the Penn State Worrying Questionnaire for Children (PSWQ-C-NL, Chorpita, Tracey, Brown, Collica, & Barlow, 1997) was used to assess the severity of the participant's worrying. This questionnaire includes 14 items that are rated on a 4-point Likert scale (never, sometimes, often, or always). The questions address the amount of worrying, the number of topics, and the participant's control over worrying. Items in the questionnaire were discussed with co-researchers having a mild intellectual disability, and the phrasing was further simplified where needed. For example, the item "I notice that I have been worrying about things" was shortened to "I often worry about things" to reduce cognitive load. Items were scored as 0–3 by the participant and then summed to generate a total worry score. A total score of 16–18 is considered "at risk," and a score of ≥ 19 is considered "clinically elevated."

2.3.3 | Self-report checklist for worrying

Throughout the baseline and intervention phases, the participants' worrying was monitored through a series of phone calls (checks, see Figure 1)—seven during the baseline phase, and seven during the intervention phase. These calls were made in the late afternoon or evening. During each phone call, the researcher asked four multiple-choice questions about the participants' worrying on that particular day: *Did you worry today?*, *How much time did you spend worrying?*, *Were you able to stop the worrying?*, and *About how many things did you worry?* Berle et al. (2011) previously demonstrated the validity of using a similar questionnaire.

2.3.4 | Informant questionnaire

As a control to the self-report questionnaires, each participant's mentor caregiver was asked to complete the Strengths and Difficulties Questionnaire Informant report (SDQ-Dutch-i18+) in parallel with T0, T1 and T2. The SDQ is used to screen for internalizing and externalizing psychiatric or psychosocial problems. The

informant marks 20 items as *not true*, *somewhat true*, or *certainly true* for the participant, yielding a summed “total difficulties score” that ranges from 0 to 40. Additionally, an impact supplement was included, asking whether the informant thought the participant was worrying about something and, if so, what impact this situation had on the participant and on others, which yielded a total score of 1–10 (Goodman, 1999).

2.3.5 | Self-disclosure

Conversations between participants and the robot were video recorded and transcribed verbatim. Then these transcripts were analysed using LIWC2015 software (Pennebaker, Booth, Boyd, & Francis, 2015), a program designed for Linguistic Inquiry and Word Count. Specifically, we analysed the total number of words spoken, and the number of words spoken per section as an indication of involvement. Next, two independent coders manually coded the participants’ verbal responses for three categories: telling about a personal experience, using an emotion-related word or expression, and showing empathy towards the robot. Inconsistencies between coders were discussed until reaching agreement.

2.4 | Intervention

2.4.1 | Setup

In this study, a NAO robot from Softbank robotics was used as a conversational partner. This robot has a humanoid appearance and movements. The interactions were created within a digital environment which allowed a high level of control over the robot’s behaviour and the flow of the conversation. We applied an interactive conversation structure, which could follow different pathways depending on the participant’s response. The researcher selected the pre-programmed response that best fit the course of the conversation.

During intervention sessions, the robot was placed on a table in front of the participant and remained in a squatting position. For each session, three small objects were placed in front of the robot in the same order: a doll, green and red blocks in a transparent container, and a beach chair (Figure 2).

2.4.2 | Content

During the 3-week intervention phase, participants had a weekly conversation with the NAO robot. Every session followed the same structure; the session began with psychoeducation to explain the meaning of “worrying,” and then, the robot introduced a personal experience that it had been worrying about. Each week, the story became more serious and more personal—first, an outing to the zoo that was postponed; second an appointment that was cancelled at the last minute by a mentor; and finally bullying by peers. In each session, the robot and

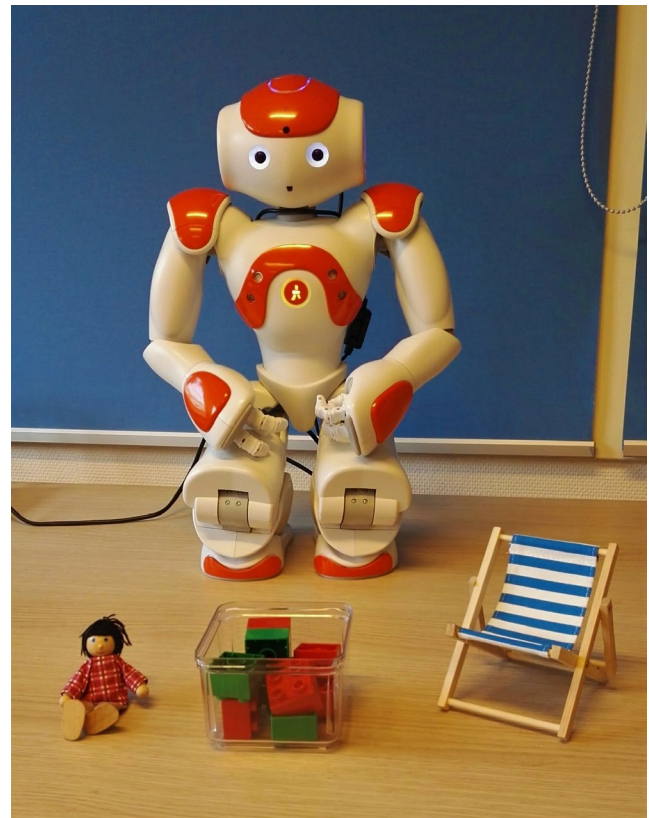


FIGURE 2 Setup of the three sessions. The robot was placed on a table in crouching position in front of a contrasting screen. The doll, blocks and chair were placed in front of the robot [Colour figure can be viewed at wileyonlinelibrary.com]

participant discussed how to use three coping strategies to reduce the experienced worrying about the problem. The participants were put in the position of the “helper” rather than the “learner” to boost their confidence and evoke an active mindset. This framework also prevented a negative perception of the exercises (i.e. as “childish” or “not necessary for me”) since they did it for the robot and not themselves.

The three coping strategies were linked to objects on the table. The first object was a small doll that represented “talking to someone.” The robot and participant discussed who to ask for help, and how to explain the problem. The second object was a container of green and red blocks, which was used to weigh the advantages and disadvantages of a choice that had to be made. The participant was encouraged to think of several positive and negative consequences of this decision, and to place a green block (positive) or red block (negative) on the table for each possible consequence. The robot made a decision based on whether more red or green blocks were present. The third object was a beach chair, representing a relaxation exercise. The robot demonstrated the exercise, and the participant was encouraged to join in. The exercise involved placing two hands on the chest and focusing only on breathing.

In addition to helping the robot cope with his worrying, participants were encouraged to tell about their own experiences solving similar problems. The robot’s responses to these experiences were rooted in the circle of security (Marvin, Cooper, Hoffman,

& Powell, 2002), an approach based on the attachment theory (Ainsworth, Blehar, Waters, & Wall, 1978; Bowlby, 1988). The robot acknowledged the participant's feelings and emotions.

2.4.3 | Adaptations

The robot's functions and conversation topics were first developed and discussed in the research team. We then obtained feedback from a group of caregivers who were not involved in the study. Next, two co-researchers who have mild intellectual disability provided feedback. After each step, adaptations were made, such that the robot's functioning and scripts would relate to the participants' level of functioning and life experience.

We accounted for the specific needs of participants with visual and intellectual disabilities in several ways. First, extra effort was made to programme the robot's tone of voice to be as natural as possible. The speech speed was slowed down to give participants enough time to process the words, and intonation was added to further promote comprehension. Second, the robot was brightly coloured and placed in front of a contrasting background. Gestures during the speech were predominantly wide arm movements, and the bright LED lights in its eyes turned different colours to amplify emotions. Additionally, the robot did not move around so participants would not have to keep track of its location during the conversation.

Before the first session, the robot introduced itself in a separate short conversation to let participants get used to his voice. They were reassured that the robot was also a bit nervous because he had not met many humans yet. This introduction served the secondary purpose of making the participants more lenient towards any mistakes or incongruent responses the robot might make.

To help the participants memorize the three coping strategies, each strategy was related to a tactile object. The three objects were on the table during each session. Additionally, each of the three conversations had an identical structure to allow the participant to internalize the flow of the conversation. Finally, the three coping strategies were explicitly repeated at several points in the conversations. At the beginning and end of each session, the participant was asked to explain the strategies.

2.5 | Procedure

Measurements were conducted by a master student and the main researcher, and phone call checks were conducted by the same master student and a healthcare psychologist intern. Intervention sessions were led by the main researcher. At T0, T1 and T2, questions were read to the participant and, when necessary, the response options were repeated. The secured online questionnaire (Qualtrics, 2019) provided answer options on a tablet screen with bright contrasting icons. Appointments for the T0 and T2 measurements took place at the participant's home, except for

one participant who preferred to meet in the therapy room. The three intervention sessions took place at the health centre of the care facility, as did the T1 measurement, which was conducted along with the first intervention session. Completing the questionnaires took around 30 min per appointment. Each intervention session also lasted around 30 min. The researchers followed a described procedure to ensure a consistent performance of all measurements.

The study was approved by the ethical commission of Vrije Universiteit, Amsterdam (VCWE-2018-130R1). Psychologists were available for the participants in case they experienced any negative consequences of participation. Researchers were also alert to the participants' well-being during the study. At the end of the study, all participants were asked to share their experiences and were informed about how the data would be reported.

2.6 | Data analysis

In addition to visual analysis of the results, we applied nonparametric Friedman analysis to detect changes in scores for worrying, reflective functioning, and problem behaviour at the group level. We also used a nonparametric Wilcoxon signed-rank test to assess any change in social validity of the intervention. To assess any within-subject change in worrying during the intervention compared to baseline, we used Non-overlap of All Pairs (NAP; Parker, Vannest, & Davis, 2011) on the self-report checklists. Significance of the NAP test indicates a clear effect, and an NAP of >0.65 denotes a clinically relevant effect, even if non-significant. Finally, Friedman's analysis was used to assess changes in the number of words and self-disclosure over sessions.

3 | RESULTS

3.1 | Social validity

Comparison of social validity at T0 ($M = 3.80$, $SD = 1.09$) and T2 ($M = 4.06$, $SD = 0.54$) by Wilcoxon signed-rank test did not show a significant change ($Z = -1.69$, $p = .09$). Interestingly, however, the mean score on the item "Do you worry a lot?" decreased from 4.7/5 at T0 to an average of 2.7/5 at T2.

At T2, participants answered additional questions about whether they liked the robot, and what they thought about the three coping strategies, on a scale of 1–5. All participants liked the robot ($M = 4.71$, $SD = 0.49$). Participants also highly rated the usefulness of the methods represented by the blocks ($M = 4.57$, $SD = 0.54$) and the beach chair ($M = 4.43$, $SD = 0.54$). When asked whether it was now easier to ask for help, three participants answered "probably not," one answered "probably," and three answered "certainly" ($M = 3.57$, $SD = 1.51$). Of the three who answered "probably not," all explained that it would be about the same as before.

Questionnaire	T0	T1	T2	$\chi^2(2)$
Worrying (PSWQ)	22.00 (4.04)	21.00 (4.48)	21.86 (4.51)	2.48 (n.s.)
Personal difficulties (SDQ)	12.50 (3.17)	13.29 (3.90)	13.38 (3.34)	0.96 (n.s.)
Impact score (SDQ)	1.67 (1.51)	1.33 (1.03)	1.00 (0.63)	0.50 (n.s.)

TABLE 1 Mean score and standard deviation per questionnaire at T0, T1 and T2. Results of Friedman test ($N = 7$)

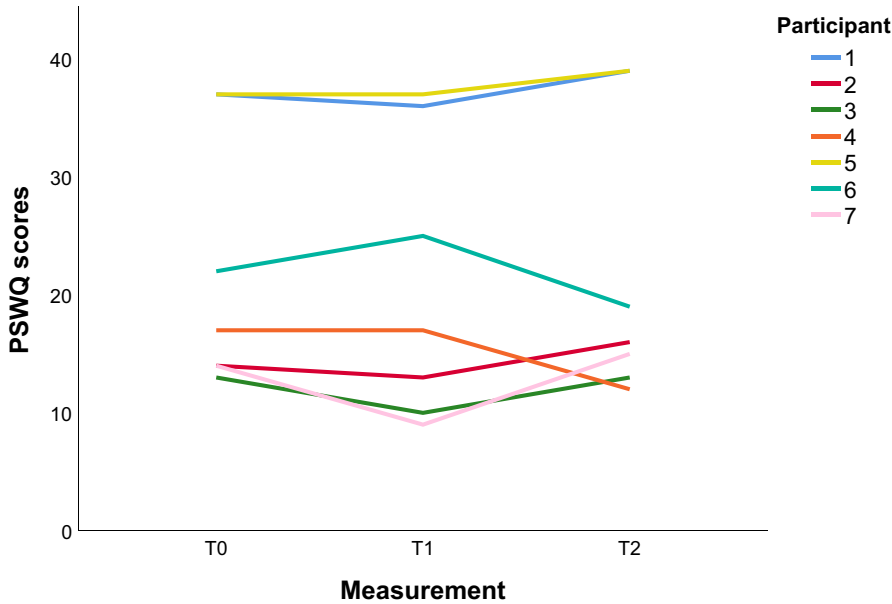


FIGURE 3 Sum scores on the self-report questionnaire for worrying (PSWQ) at T0, T1 and T2 [Colour figure can be viewed at wileyonlinelibrary.com]

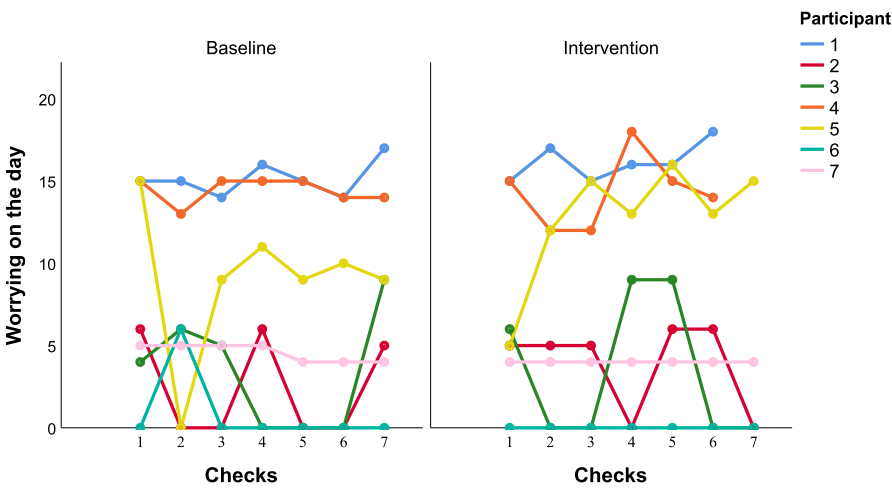


FIGURE 4 Sum scores per participant for the self-report checklist for worrying [Colour figure can be viewed at wileyonlinelibrary.com]

3.2 | Worrying self-report questionnaire and checklist

Table 1 displays the mean scores on questionnaires about worrying. None of the Friedman test results were significant, indicating no significant changes between the three measurements at the group level. This was also reflected in the individual scores.

PSWQ scores ranged between 9 and 39 and remained stable for all participants over time (Figure 3). Participants 1 and 5 scored higher than the other participants, with scores of 36–39 points on all occasions, indicating very high levels of worrying. Participant 6 scored

between 19 and 25, indicating elevated levels of worrying. The other participants scored between 9 and 17 points at all measurements.

Figure 4 presents a comparison of the worrying self-report checklist during baseline versus the intervention phase. Again, participants 1 and 5 indicated higher levels of worrying compared to the other participants. Participant 6 worried only incidentally throughout the study duration. None of the participants exhibited a significant change in worrying during the intervention phase compared to baseline. Only one NAP was clinically relevant: participant 7 reported worrying about fewer things during the intervention phase than during the baseline phase ($NAP = 0.79, p = .07$).

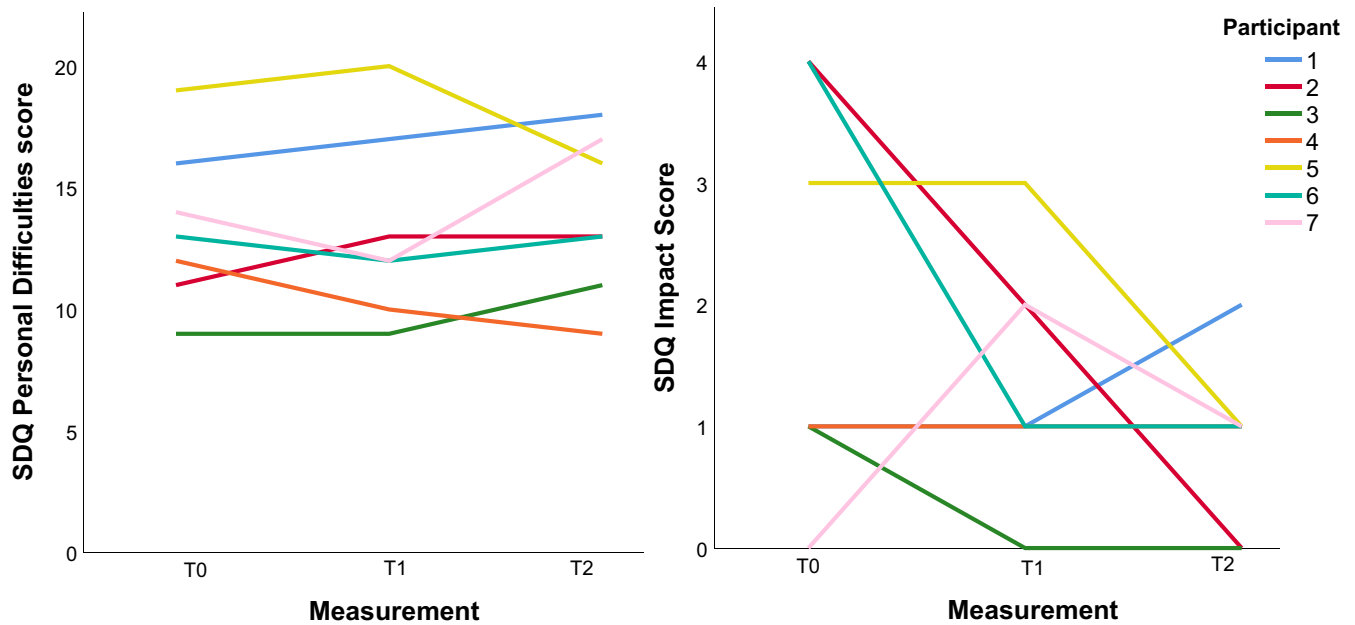


FIGURE 5 Scores on informant questionnaires (SDQ) with respect to personal difficulties of the participants (left) and the impact scores of personal difficulties (right) [Colour figure can be viewed at wileyonlinelibrary.com]

3.3 | Informant questionnaire

Scores for personal difficulties based on the informant questionnaire (SDQ) remained stable throughout the study for the majority of participants (see Table 1 and Figure 5). The personal difficulties scores for participants 1 and 5 can be considered “high,” which is in line with their PSWQ scores (Figure 3). Participant 7 showed a strong increase between T1 and T2 (from 12 to 17 points, which can both be classified as “slightly raised”). Participant 5 exhibited a strong decrease between T1 and T2, from 20 (considered “high”) to 16 points (considered “slightly raised”). The scores of the remaining participants were more stable, remaining between 9 and 13 points, which is “close to average.”

In all cases, the impact scores were between 0 and 4 out of 10. Ideally, this score should be 0. Although the analyses revealed no significant changes over time, Figure 5 shows that the range of scores decreased from 0–4 at T0, to 0–2 at T2. The impact score for personal difficulties, as reported by mentor caregivers, was equal or lower at T2 compared to at T1 for all participants, except participant 1.

3.4 | Self-disclosure

In each session, between 75% and 79% of the words spoken by the participant were spoken during the intervention proper (Table 2), while 21%–25% of the words were related to greeting the robot, choosing the next object, or rounding off the conversation. Comparisons across the three sessions included only the numbers of words spoken during the intervention. Participants 2, 3 and 5 talked more than average, while participant 7 spoke the fewest words due to the communication device he uses. The smallest numbers of words were spoken during psychoeducation, which was a very short section, and during the beach chair exercise. This exercise mainly

TABLE 2 Average of number of words spoken by participants per session, and during each part of the session. Average number of times participants tell about a personal experience, use an emotion-related word, or show empathy towards the robot ($N = 7$)

Number of words	Session 1	Session 2	Session 3	χ^2
Total conversation	386.57	401.14	394.86	0.29
Total meaningful	305.57	317.57	295.16	0.00
Words per sentence	6.34	7.01	6.81	2.00
Psychoeducation	41.86	61.71	30.00	1.14
Doll exercise	113.71	111.14	135.86	2.00
Blocks exercise	127.71	130.14	115.43	0.29
Beach chair exercise	26.00	16.17	16.83	4.00
Emotion-related words	2.43	1.29	1.43	0.82
Empathy shown towards robot	3.29	4.57	2.86	5.25 ^a
Experience shared	1.86	1.71	2.14	0.38

^a $p = .07$.

included the robot giving instructions and did not entail much interaction with the participants. Participants talked more during session 1, when the beach chair exercise was still unfamiliar. Interestingly, more emotion-related words were used in session 1 than in sessions 2 or 3. All participants expressed empathy for the robot when it was talking about its own problems. In some sessions, the test leader apologized on behalf of the robot for not giving a proper response in the conversation, to which the participants answered along the

lines of "That's OK." Finally, all participants shared personal experiences during the conversations. Their personal experiences mainly concerned conflicts or disappointments related to family members, caregivers, or people at work; finding it difficult to ask for help; and sometimes mental health problems or grief. At the group level, we observed no clear development in self-disclosure by participants.

4 | DISCUSSION

The present results provide valuable insights into the use of robot-mediated therapy for persons with visual and intellectual disabilities. From this short intervention, we detected no noticeable change in the level of worrying over time; however, the seven participants had positive responses towards the robot. Moreover, the participants felt like they worried less, and their mentor caregivers reported lower problem impact scores for their clients. These findings indicate that it would be valuable to further develop and investigate the use of robots in similar interventions for persons with visual and intellectual disabilities.

Our study revealed several positive aspects of the robot-mediated intervention. Most importantly, the participants liked the robot and verbally expressed to the researchers that they enjoyed their conversations. They were drawn into these conversations, showed empathy with the robot's problems, and were motivated to help the robot during the exercises. During the evaluation, all participants gave positive feedback regarding their conversations with the robot. Social validity remained high at the end of the study. Furthermore, we found that adding a short psychoeducation lesson was beneficial to the intervention. When asked to explain what worrying is, many could not give a definition or gave an incomplete definition. To these participants, the robot explained the meaning of the concept before continuing with the session.

The agreement between the questionnaires from participants and their mentor caregivers indicates that the results were probably reliable. Therefore, the lack of significant effects after the intervention may be attributed to two things. First, the intervention may have been too short to establish a real change in the participants' minds. The participants only had three conversations with the robot, which each lasted around 30 min, and there was no additional treatment by a therapist. Second, the questionnaires may have been insufficiently sensitive to detect small improvements in the participants, or the participants' disabilities could have led to an atypical answer pattern in the questionnaires. Despite careful rewording and simplification of the questions, participants still sometimes attributed different meanings to a word in a question, or could not distinguish between different options (e.g. "sometimes" and "often"). In some cases, participants seemed to continually select the last option that was read to them. These circumstances may have influenced their scores on the questionnaires.

During the sessions, the greatest level of interaction was observed during the doll and blocks exercises, while very little was said during the beach chair exercise. This does not mean that the beach

chair exercise was less effective or less useful. Participants visibly enjoyed simply following the robot's lead. Analyses of the conversations also revealed that the robot elicited some discussions of feelings and emotions from the participants. Participants shared their personal experiences during the sessions and also expressed empathy towards the robot. However, the results did not show a change in self-disclosure or emotion-related responses towards the robot over sessions.

This study highlights several points of attention for future similar interventions. Firstly, the communication by the robot must include enough opportunities to pause the speech output. This will both help participants process the information and give them the opportunity to respond. Second, instructions or questions from the robot must be extremely clear and concise and must be broken down into very small steps. Most of our participants needed help from the researcher to navigate through parts of the conversation. In some cases, this made the researcher a conversational partner, which was not the intention of the study. Although robots might be useful as a mediator rather than to completely replace the therapist, it would be interesting to explore how the facilitator's role can be minimized for specific exercises. Third, although most participants could name all three coping strategies them at the end of the third session, they had not yet internalized them. None of the participants reported using the strategies outside of their conversations with the robot. Moreover, although the robot asked for personal experiences with similar worrying situations, some participants did not understand how talking about the robot's problems could solve their own worrying. Others stated that they could not use the strategies at home because "they did not have the materials." This indicates that additional steps are necessary to help persons with intellectual disabilities generalize these lessons to daily practice.

With regards to this particular intervention, several improvements could be made to increase its effectiveness. First, the use of three common coping strategies for a very diverse population may be too generic. This could be remedied by having several variations of each type of exercise, enabling a personal fit to be made for each individual. Another improvement may be to focus more on the participants' personal problems, and to use their personal experiences to practice coping strategies. Additionally, it may be beneficial to involve parents or caregivers to help the person with intellectual disabilities in applying these strategies in their daily life (Feinstein, Fielding, Udvari-Solner, & Joshi, 2009).

The current study had several weaknesses, including its small sample size and the relatively short duration of the intervention. Studies including larger numbers of participants are necessary in order to draw conclusions about the effectiveness of robot-mediated therapeutic intervention for this specific target group. Additionally, in the present study design, each participant functioned as their own control. In future studies, the treatment condition could be compared with care as usual, or robot-mediated therapy could be compared with a human therapist to establish the incremental value of the use of robots compared to available methods (Diehl, Schmitt,

Vilano & Crowell, 2012; Huskens, Verschuur, Gillesen, Didden, & Barakova, 2013). Long-term follow-up measurements could be useful to address any sleeper effect.

5 | Conclusion

The positive responses of the participants in this study indicate that robot-mediated therapy may be valuable for persons with visual and intellectual disabilities when the format and content are tailored to their needs. The participants connected with the robot on an empathic level and were able to learn about coping strategies. Additional steps must be taken to improve effectiveness in daily life.

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ORCID

Evelien van Wingerden  <https://orcid.org/0000-0002-2256-8065>

Emilia Barakova  <https://orcid.org/0000-0001-5688-4878>

Paula S. Sterkenburg  <https://orcid.org/0000-0001-6014-7539>

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