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Social Adventure:
Designing Interactive Smart Speaker Social Skills Games for People With Intellectual Disabilities

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ABSTRACT

Social environments can be challenging for people with intellectual disabilities. These challenges impact a person's social inclusion and participation in their communities. Social skills development requires training and practice, but training is often time-limited, costly, and hard to access. However, games on smart speakers provide interesting opportunities to improve training access, motivate self-directed learning, and focus on speech. The authors developed an interactive narrative-based social skills training game for smart-speakers. The game facilitates exploration of the social consequences of making various choices in different social situations and uses natural language inputs. Having tested the game with 10 adults with intellectual disabilities, the authors offer designers insights into participant engagement and the game's audio-only, natural language interface usability. The authors also propose four design considerations to help designers design applications that help people with intellectual disabilities participate in social activities.

KEYWORDS

Accessibility, Design, Electronic Games, Intellectual Disabilities, Interactive Storytelling, Natural Language Interfaces, Smart Home Personal Assistant, Smart Speaker, Social Stories

INTRODUCTION

Intellectual disabilities (ID) are neurodevelopmental disorders beginning in childhood. They involve intellectual, cognitive, and adaptive behavioral functioning problems, including everyday social interaction and practical skills (AAIDD American Association on Intellectual and Developmental & Disabilities, 2019; American Psychiatric Association, 2013). The Australian Bureau of Statistics (2012) identified that 3% of Australians had ID. 85% of whom were classified as having mild impairments and commonly living independently with minimal support or in a group with daily support (Global Burden of Disease Study 2013 Collaborators, 2015). However, people with ID must interact in social situations outside these environments to manage their lives, work, and build a greater sense of community belonging.

Social situations can be challenging for many adults with ID (National Disability Strategy Consultation Report, 2009), and social isolation is an important issue. Limited inclusion, participation,

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and socialization are worldwide concerns (World Health Organization & World Bank, 2011) and Australian Government priorities (National Disability Strategy Consultation Report, 2009). Many Australians with ID find it challenging to participate in community-based activities and social networks. Poor social skills can contribute to social exclusion, loneliness, and low social interaction (Abbott & McConkey, 2006) and may affect health care outcomes (Burke, 2017; Gilmore & Cuskelly, 2014) and successful aging (Stancliffe et al., 2015). Moreover, poor social skills can increase the family and support service burden of care and negatively impact family members (Hotton & Coles, 2016). Social situations are often discussed, role-played, and practiced in group environments to deliver social skills training. However, where paid staff provide this training, it can be time-limited, costly, and hard to access (Walsh et al., 2018). In response to these challenges, researchers are working toward technological solutions that increase access and enable people with ID to engage in self-directed social skills learning.

Social Stories™[1] often provide the basis for contemporary social skills training approaches. Social Stories™ is an empirically validated intervention (Walsh et al., 2018) and is generally viewed as an effective form of training (Hotton & Coles, 2016). The content of Social Stories™ is usually short (primarily written, sometimes with illustrations), linear stories set in typical social environments that describe social cues in a challenging social situation along with appropriate responses and behaviors to address that situation (Gray, 2015).

The fictional setup of these stories lends itself to gamification (Kapp, 2012) via interactive narratives that provide users with the agency to manipulate the direction of a plot (M. C. Green & Jenkins, 2014). While most research focuses on interventions for people with autism spectrum disorders (ASD), some findings suggest that story-based social skills training improves the behavior of children (Gray, 2004) and adults (Gül, 2016; Kim et al., 2014) with ID.

While there is evidence for the effectiveness of interactive, screen-based simulations and games, the technology is often not usable, not disability-friendly, or not accessible (Lussier-Desrochers et al., 2017; Putnam & Chong, 2008). Moreover, technology support, internet accessibility, equipment cost and maintenance issues, and design complexity are significant barriers for people with ID (Chadwick et al., 2013; Lussier-Desrochers et al., 2017; The Centre for Development Disability Health (CDDH) Victoria, 2014; Yuan et al., 2011). Smart speakers are increasingly being used to support people with disability in a range of areas, including speech production (Smith et al., 2021) and increasing self-determination (Smith et al., 2020). However, using smart speakers for social skills training has not been explored with this population and could potentially offer persons with ID several benefits.

Smart speakers are inexpensive and can be installed in multiple locations at work and home; they have lower maintenance requirements; they potentially offer more usability and accessibility via natural language interaction. In 2021, approximately 50% of internet users owned at least one smart speaker (Bratten, 2021). Smart speakers are most commonly used to process simple and predominantly transactional requests, such as weather forecasting, making a shopping list, and playing music (Clark et al., 2019). However, developers can extend the capabilities of a smart speaker through the deployment of apps, also known as skills, thus making smart speakers an exciting platform for audio-only games.

Audio-only games provide a popular form of entertainment and are also increasingly used as a medium for educational purposes. Narrative adventures are a popular format of audio games that requires a user's active involvement to make decisions and complete tasks via textual or verbal input to play (Röber & Masuch, 2004). Moreover, the absence of visual stimuli and the user's concentration on sound perception is believed to enhance learning (Rovithis et al., 2014).

The authors decided to use a smart speaker platform for three reasons. First, smart speakers are a cost-effective alternative to mobile smartphones and, due to the natural language-based interface, provide ease of use, especially for people with physical disabilities and visual impairments and for children without access to tablets or mobile phones. Second, smart speakers offer a non-screen alternative, which reduces screen time, given that too much time in front of screens has been associated with non-communicable diseases, particularly among young adolescents with long term illnesses or

disabilities (Melville et al., 2018; Ng et al., 2018), and reduces usability problems people with ID encounter with graphical user interfaces (Balasuriya et al., 2018). Third, the natural language interface requires users to respond to a given situation with their own words. The authors believe it is more natural than selecting a dialog option displayed on a screen.

This study presents the experimental design of an interactive, narrative social skills training game for people with intellectual disabilities using the Google Home mini smart-speaker. The authors developed five interactive social stories with a continuous storyline and complex story trees with multiple story endings. Users were required to provide natural language inputs at crucial decision points to communicate their reactions to a given situation to progress the story. Figure 1 illustrates the research project idea.

Figure 1. Social environments can be challenging for many adults with ID

Ten adults with ID tested the game at a local disability support service center. The authors' findings provide designers with insights into participant engagement and the usability of the audio-only social skills training game and natural language interface. The authors also propose design considerations to enhance the design of future audio-only interactive social skills training applications. This study contributes a starting point to better understand the design of interactive social skills games on smart speaker platforms for people with ID and contributes to the social participation of people with ID. This work may also benefit caregivers, occupational therapists, teachers, and other professionals who work with people with ID.

BACKGROUND

This research focused on work in three related areas: existing guidelines on the design of social skills training applications; prior work addressing the consequences of social skills training; and smart speaker use to support disabled populations.

Several studies provide guidelines on the design of social skills training applications for people with ID. Researchers working on the development of assistive software for people with cognitive disabilities recommend software to be fully configurable, easy to understand, designed to deal with a particular kind of disability or disorder, and open source to promote its further adaptation (Paniagua Martín et al., 2009). Furthermore, Brown et al. (2011) presented a range of design considerations

by drawing on recommendations from several notable resources, including using text in interactive systems aimed at people with a learning disability (Evett & Brown, 2005) and in the design of serious games (Brown et al., 2010). Based on these recommendations, the authors provided settings to adjust the speed of the narration, repeated user choices to address the limited capacity of participants to concentrate, and trained the speech recognition with synonyms to allow for slurred speech. However, the authors could not find guidelines relating to the design of content and gameplay of social skills games for people with ID.

The authors identified prior work addressing the consequences of actions in response to social situations for social skills training. Bayor's Ph.D. project (2018) outlined the plans for a social media-based, social skills training framework to support the social participation and skills development of young adults with ID. Sani-Bozkurt et al. (2017) introduced a design for a screen-based, interactive social stories game for children with ASD. The games utilized interactive features to provide the user with a small degree of influence over the story. The comprehension of users was subsequently tested via multiple-choice questions. While the authors agree with this approach, the work told us little about the design of interactive story games, and the approach to social skills training has not been tested with adults with ID.

Most research related to smart personal assistants (SPA) in smart speakers and mobile devices investigates assistance-based usage by aging and disabled populations (Marston & Samuels, 2019; Reis et al., 2017). Marston et al., stated that SPAs could positively impact those with chronic health conditions (Marston & Samuels, 2019). Several news reports have touted the benefits of smart speakers for those with disabilities as diverse as blindness (P. Green, 2017), multiple sclerosis (Sweeney, 2018), and quadriplegia (John, 2017). Recent research investigated the use of Voice-Activated Interfaces by people with ID and found that most liked and were successful at using speech interfaces and could produce speech that was intelligible to the natural language processing interface (Balasuriya et al., 2018). The authors were encouraged by these prospects and imagined a widespread application of natural language-based applications for people with disabilities. However, the authors were unable to find guidance on the design of audio-only, natural language-based, interactive social story games to improve the social skills of people with ID.

Therefore, the research discussed in this paper addresses two questions: (i) How should natural language interactive social stories be designed for use on smart speakers? and (ii) What are people with ID's views on the usability of natural language interactive social stories?

PARTICIPANTS

The authors recruited ten participants from a local disability support service to participate in a co-design workshop to assist in the development of stories and the user study. Seven were male, and three were female. All participants were over 19 and under 31 years of age (MEAN=24.6, SD=3.94). All participants had moderate ID with an IQ of 50–70. Table 1 provides an overview of the participant details, including their disabilities and ID. Participants were selected based on: (a) their ability to communicate verbally, (b) their familiarity with technology, and (c) their desire to improve their social skills.

Pre-trial findings revealed a positive attitude toward games. All participants reported that they enjoyed playing games. They also stated that they enjoyed immersing themselves in games. One participant had his own Google Home Mini at home. There was little acknowledgment by participants of limitations in their social skills, but they generally agreed that practicing difficult social skills would be helpful.

SOCIAL ADVENTURE

The prototype game Social Adventure is an interactive narrative designed to expose players to various potentially challenging social situations. The smart speaker's synthetic voice interface describes each situation and requires a player's verbal response. Predefined response options are offered and

Table 1. Participant Details

P	Sex	Age	IQ Range	Disabilities in Addition to ID	Schooling
1	Male	19	50–70	Autism	Special school for students with autism
2	Male	31	50–70	Autism, Anxiety	Special school for students with autism
3	Female	28	50–70	Autism	Special school for students with autism
4	Male	23	50–70	Autism	Special school for students with autism
5	Male	27	50–70	Autism	Special school for students with autism
6	Male	24	50–70	Autism, Anxiety	Special school for students with autism
7	Female	20	50–70	Down syndrome	Special school
8	Female	21	50–70	Down syndrome, Intellectual Disability	Special school
9	Male	28	50–70	Global developmental disability	Special school
10	Male	29	50–70	Global developmental disability	Special school

read out to the player at each interaction point within the interactive narrative. The player's selection results in different progressions along with branching storylines, which, in turn, lead to specific social consequences and customized feedback at the story's end. The authors designed the game to be played on a Google Home Mini as the authors envisioned this technology's deployment in an environment familiar to the user, such as their disability support center or home.

Story Co-Design and Story Development

A co-design workshop (Muller & Kuhn, 1993) provided the topics for three story writing workshops. The authors led the co-design process (Sitbon & Farhin, 2017) with the participants and two co-workers. Two of the three academics have backgrounds in disability and inclusion and experience developing educational materials for people with disabilities. The co-design workshop process comprised three stages. In Stage 1, the authors demonstrated the game's prototype tutorial level. During this stage, each participant demonstrated their ability to understand the narrative and to make verbal story choices. Stage 2 comprised roundtable discussions in which participants contributed prior challenging social situations. In Stage 3 of the co-design workshop, the authors, support staff, and participants discussed the social situations and the participants voted on the scenarios for further development.

The stories were developed based on these scenarios, with the assistance of a professional story writer under the supervision of the two academics with backgrounds in disability and inclusion. The authors developed five interactive stories. The stories were designed in a sequence, taking the player through a day in the life of a fictional character called Lea. The five stories comprise a short tutorial story, set in a park (Story 1—Introduction to the game); social situations at home with other housemates (Story 2—Morning routine); getting to work using a crowded bus (Story 3—Getting to work); at work managing relationships with co-workers (Story 4—At work); and interacting with strangers in a store (Story 5—Going to the store). The stories were developed based on the Social Stories™ guidelines (Gray, 2015) and are narrated from a third-person perspective using consistent introductions. The stories are socially and emotionally safe. The tone of the stories is supportive, consistent in voice, and descriptive in meaning. The feedback provided by the system is designed to be reassuring and to praise appropriate choices that reflect traits such as thoughtfulness, perseverance, resilience, and sharing.

Narration and Character Voices

Google's text-to-speech system reads the stories to players. At the time of development, Google Assistant supported one male and one female voice, each with five pitches and different speeds. The authors selected four voices that sounded sufficiently different and authentic: a narrator (normal-pitched male voice); Simon, who is Lea's male friend and co-worker (low-pitched male voice); Vanessa, who is a female co-worker (high-pitched female voice); and the default female voice (standard pitch) for Lea's support worker in Story 2. The main character, Lea, does not have a voice, and the narrator describes her actions. Using synthetically generated narrator and character voices provided a significant amount of flexibility during the story design as the stories, and character responses could be edited easily without the need for (human) studio dialogue re-recording.

Player Choices and Feedback

The game consisted of short textual descriptions of the situations followed by a story choice point where players are given the opportunity to choose from up to three predefined story choices. The story choice points divided the story into sections. Based on current guidelines for working with people with ID (The Centre for Development Disability Health (CDDH) Victoria, 2014) and considering the limited capacity for participants to concentrate, the authors limited each section to approximately 30 seconds. For example, a three-minute-long story consisted of approximately six choice points. These choices usually involve an appropriate and an inappropriate behavior, and sometimes an "adequate" behavior choice. Players make their choice by either stating it in words or by saying "A," "B," or "C," depending on the number of choices. Multiple-choice options are randomized to ensure that the best option is not the same letter each time, helping players understand that their choice matters. For example, in the last story, "Going to the store," Lea is asked by Simon to purchase his favorite cereal, but Lea discovers that the store shelf is empty. At this stage, a player has to choose between: "A) Ask someone? B) Pick something else? C) Get nothing." If a player chooses to say "A" or "Ask someone" the following dialogue is triggered:

"Lea walks to the end of the aisle and looks for someone to help her. Two aisles over, there is someone putting bottles onto shelves. Lea says hello and that she's looking for cornflakes. 'There's none on the shelves,' she adds. The store worker nods and offers to check if there is any out the back. Lea follows them to the door to the storeroom and waits while the store worker looks. The store worker puts down a box of cornflakes, tears off the cello tape, and takes one of the smaller boxes out. The store worker hands it to Lea and asks if there's anything else she needs help with."

If the player chooses to say "B" or "Pick something else" the following dialogue is triggered:

"Lea decides to get something else. She looks to either side of the blank space. Both alternatives look similar, so she decides to take the cheaper cereal."

If the player chooses to say "C" or "Get nothing", the following dialogue is triggered:

"Lea decides to get nothing. Lea thinks that perhaps someone else will have bought cereal or she and Simon can just have toast in the morning."

Choice A shows thoughtfulness toward Lea's housemate, Simon, and perseverance in a difficult situation, and is the appropriate behavior choice in this situation. Choice B addresses the problem of needing to buy food for breakfast but does not show thoughtfulness toward Lea's housemate. At the end of the game, the user feedback addresses this by saying: "The items were available; it just required a bit of effort and patience on Lea's part." However, this choice is still "adequate," and players are

allowed to finish the game. Choice C does not address the problem and means that there will be no food for breakfast the next day. As this is a critical issue, the player is asked to replay the story in the final feedback. The feedback states: "Unfortunately, you cannot complete the story as Lea needs to get breakfast for the household at the store."

IMPLEMENTATION AND TESTING

Together with an AI developer, the authors developed Social Adventure using a combination of JavaScript and Dialogflow (Google, 2018a). Dialogflow is a natural language processing (NLP) platform that utilizes speech recognition and machine learning to build conversational applications and interfaces. It is the most used tool for creating functionality for Google Assistant devices, such as the Google Home Mini.

For each story, a Dialogflow agent (Google's terminology for a Dialogflow application trained to recognize user intent from natural language input) was developed. User inputs, story scripts, and branching story dialogues were captured via custom intents developed in JavaScript and made accessible via a webhook as cloud functions for the Firebase (Google, 2018b) real-time database. The authors used extensive language samples to train all the software agents to recognize the expected user input at the stories' branching points. On user input, the active agent for the story sends the recognized intent—or lack of such—to the JavaScript component of the project, which in turn is responsible for determining the next course of action according to the intent, the current position in the story, and the history of previous user inputs. The system also captures player data such as the player number and the player's parsed responses.

Before deploying the prototype, the authors tested it extensively over three months. The authors played each story over 50 times to ensure it could be played through without problems and to capture synonyms for custom entities, such as: "pick," "pick something," "pick something else" in response to the question in Section 4.4. The authors also added synonyms for parsing errors related to the letters "A," "B," and "C" such as "Hey" for "A" and "Bee" for "B."

STUDY

The study received University High-Risk Ethics approval, reflecting the involvement of people with ID, and comprised three stages: pre-trial participant interviews, user test, and post-test interviews.

Before user testing with the smart speaker, the authors conducted pre-trial interviews with participants to ascertain their demographic information and their level of previous exposure to electronic games and smart speakers. At the end of each interview, the authors introduced each participant to the Google Home Mini and explained how to interact with it. The authors offered each participant the opportunity to play Story 1—Introduction to the game (containing a tutorial on interacting with the game). All participants completed Story 1, giving the authors confidence that they could use the smart speaker effectively and participate in the study.

The authors deployed a Google Home Mini device in a disability support center multi-purpose room. The participants could interact with the game in a natural, relaxed, and informal environment and in total privacy without staff supervision or interruption by other colleagues, safeguarding their confidentiality and allowing them to make their own decisions. Participants had the freedom to play as often as they wished during their breaks, as long as the room was not needed for other activities. The authors made the game available for three months to allow sufficient time for participation and to measure interest in replaying the stories.

The authors provided each participant with a player number to track their user inputs for later analysis. The participants had access to a sheet with their player numbers on, in case they forgot them. They were provided with the Google Home Mini device and instructions on how to start the different stories. At the beginning of each story, the game asked the participants to input their player

number verbally, and they could then proceed to play the game. The game captured a log of parsed user inputs, which provided insights into participants' usage, progression, response times, etc. At the end of the user test, the support worker destroyed the sheet with all the player numbers to maintain the anonymity of participants.

At the end of the study period, the authors conducted semi-structured post-test interviews with participants following recommendations for interviewing people with intellectual disabilities (Prosser & Bromley, 2012). One researcher independently interviewed each participant. A support worker was present to support the participant and act as an interpreter to avoid misunderstandings.

The post-test interviews consisted of 28 questions about the participants' experiences with the interactive narratives and the natural language interface. Keeping in mind the participants' cognitive ability, all questions were worded in simple terms using language and meanings of words they used regularly. The questions were open-ended to allow the respondents to describe situations in their own words. Follow-up questions employed probing and cross-questioning techniques to obtain the fullest answers possible. Each interview lasted approximately 10 to 15 minutes and was audio-recorded. At the end of the interview, the authors provided each participant with a gift voucher as compensation for their participation. Unfortunately, one participant was unavailable for the post-test interview.

Audio recordings were transcribed by an independent research assistant and loaded into NVIVO Version 12 (QSR International Pty Ltd., 2018). The data was analyzed using Inductive Thematic Analysis (Braun & Clarke, 2006). Two researchers, independent of each other, completed the initial coding of all data. The authors began with an inductive approach, grouping themes under central topics, informed by the interview guide. Once the authors identified a set of initial themes, a data session with additional researchers took place to closely review and refine the coding and initial themes. The initial data coders then further refined these themes. All researchers had experience in conducting qualitative data analyses.

RESULTS

The findings are grouped into six themes:

Playing Interactive Stories on Smart Speakers

Participant engagement with the interactive narratives on the smart speaker platform was marked by their approach to chronology, replays, and exploration of the interactive storylines.

Semi chronological story play. All participants began with story 1 (the tutorial) and continued with Story 2 and, in some cases, Story 3 on the same day, but then took a break from playing the game. Most participant breaks between stories were of significant durations. Five participants (P1, P2, P3, P6, and P9) began by playing stories in chronological order. Rather than continuing from where they had left off, most skipped stories, started again from story 1, or selected a story at random. Six participants played all the stories at least once sequentially (from 1 to 5 inclusive). Most participant breaks between stories were of significant durations. Players completed 88% of all stories they commenced. Figures 2-11 provide an individual story sequence graph for each participant.

Participants replayed the stories. The participants played Social Adventure a total of 109 times, consisting of 47 first plays and 62 story replays. All participants initially showed interest in the games and played the first tutorial story. Several players completed all five stories. Nine participants replayed the stories multiple times. Overall, all stories were played and replayed approximately the same number of times. Participants replayed story 5 the most. Most players (except P8) seemed to have favorite stories that they played more often than others. Only one player, P8, did not replay any of the stories. Table 2 provides a list of story plays and replays for each player.

Participants preferred appropriate interactive story pathways. Almost all participants only selected interactive story pathways with positive social consequences. During the post-test interviews, some participants reflected that they did not need to explore the social consequences of an inappropriate

Figure 2. Visualization of story sequence played by each player. The x-axis represents sequence, and y-axis represents story number

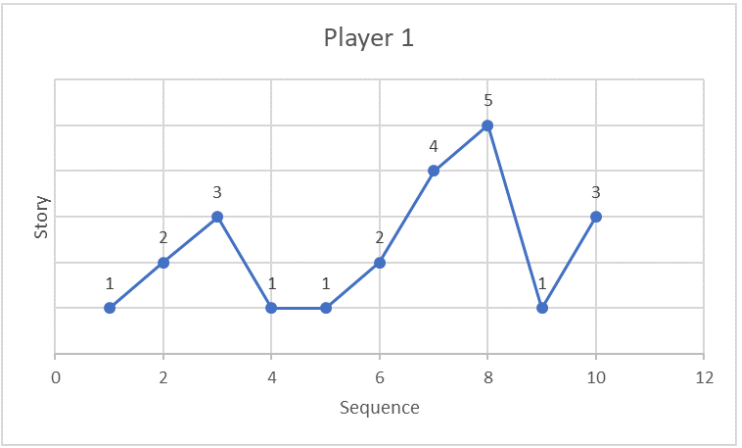

Figure 4. Visualization of story sequence played by each player. The x-axis represents sequence, and y-axis represents story number

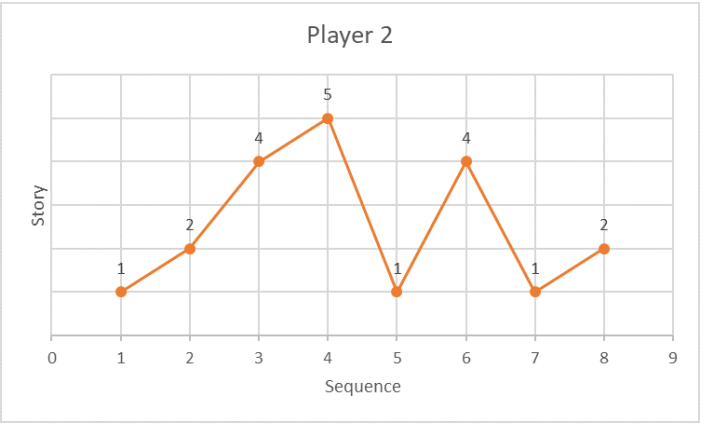

Figure 5. Visualization of story sequence played by each player. The x-axis represents sequence, and y-axis represents story number

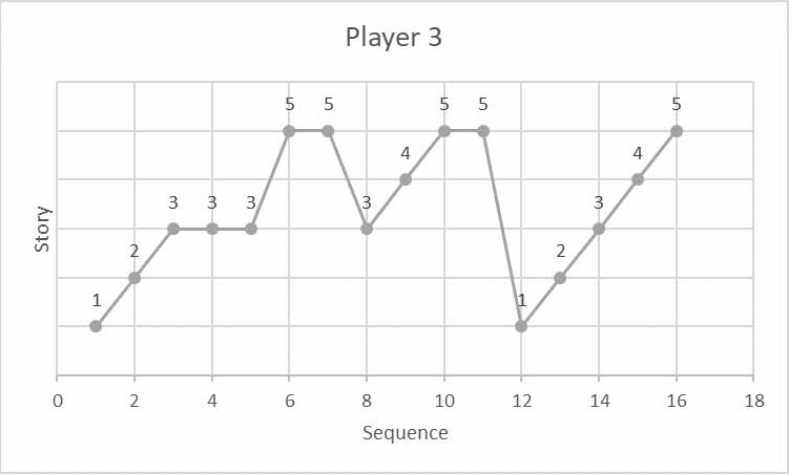

Figure 6. Visualization of story sequence played by each player. The x-axis represents sequence, and y-axis represents story number

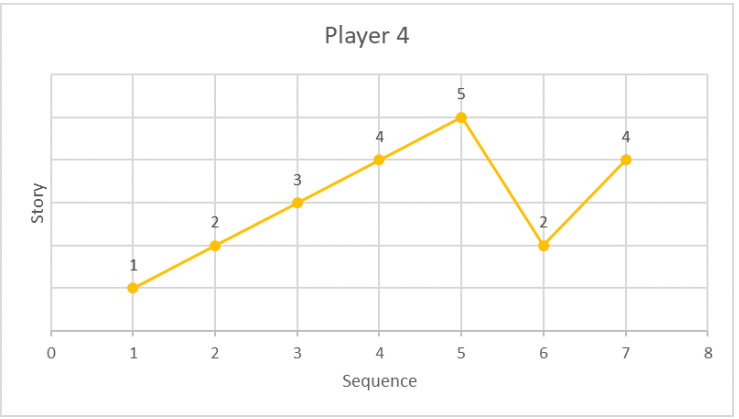

Figure 7. Visualization of story sequence played by each player. The x-axis represents sequence, and y-axis represents story number

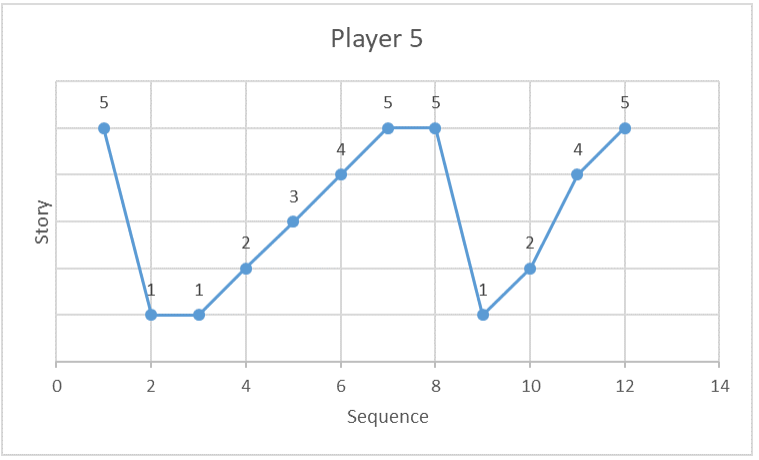

Figure 8. Visualization of story sequence played by each player. The x-axis represents sequence, and y-axis represents story number

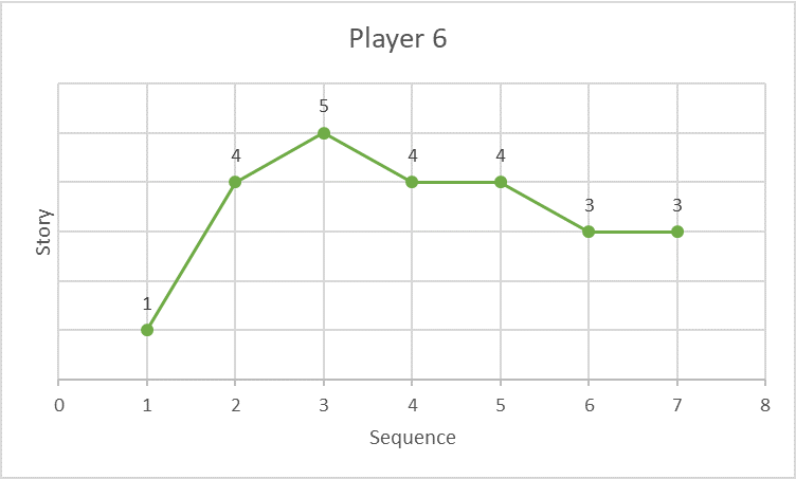

Figure 9. Visualization of story sequence played by each player. The x-axis represents sequence, and y-axis represents story number

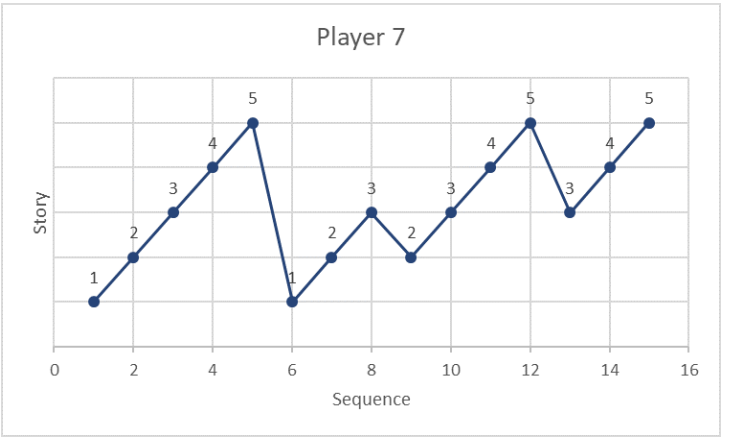

Figure 10. Visualization of story sequence played by each player. The x-axis represents sequence, and y-axis represents story number

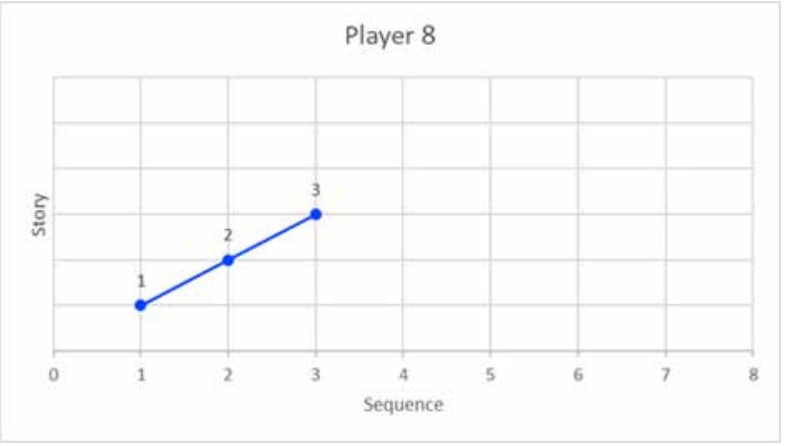

Figure 11. Visualization of story sequence played by each player. The x-axis represents sequence, and y-axis represents story number

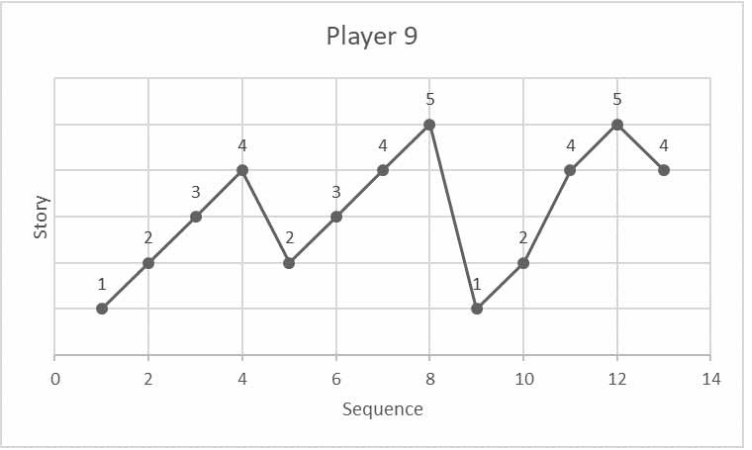

Figure 3. Visualization of story sequence played by each player. The x-axis represents sequence, and y-axis represents story number

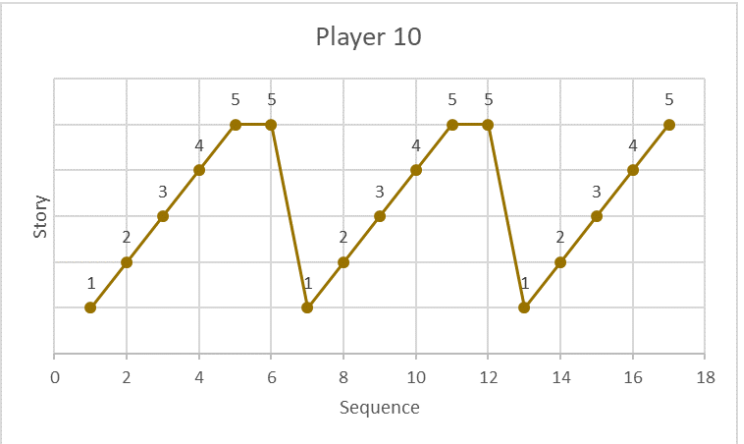

Table 2. Story Plays / Story Replays

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	Total
Story 1	4/3	3/2	2/1	1/0	3/2	1/0	2/1	1/0	2/1	3/2	**22/12**
Story 2	2/1	2/1	2/1	2/1	2/1	0/0	3/2	1/0	3/2	3/2	**20/11**
Story 3	2/1	0/0	5/4	1/0	1/0	2/1	4/3	1/0	2/1	3/2	**21/12**
Story 4	1/0	2/1	2/1	2/1	2/1	3/2	3/2	0/0	4/3	3/2	**22/13**
Story 5	1/0	1/0	5/4	1/0	4/3	1/1	3/2	0/0	2/1	5/4	**24/14**
Total	**10/5**	**8/4**	**16/11**	**7/2**	**12/7**	**7/4**	**15/10**	**3/0**	**13/8**	**17/12**	**109/62**

behavior choice. When players mistakenly selected an inappropriate behavior, they were motivated to rectify the mistake. For example, in five instances, players chose the option to apologize to their story housemates for their behavior later in the story. In four instances, players repeated the stories and made different choices until they reached a result they saw as 'correct' or 'appropriate'. Four participants replayed the same stories for perfection, repeating precisely the same 'appropriate' story choices each time. Only four participants explored an inappropriate behavior option, once each, in only one story.

The game required a high level of concentration from the participants. Four participants found it challenging to listen to the audio-only interactive narrative. "I concentrate very hard, yes. I have to concentrate without interruptions" (P3); "I was a bit focused more, so I needed to be alert" (P1). Remembering questions and options at key decision points was difficult: "I got confused remembering the choices" (P8); "Sometimes I was confused about what the questions were" (P9).

Few participants experienced problems with the natural language interface. One participant suggested clearer audio, similar to the quality of human voices in voice–narrated audiobooks from services, such as Audible (P3). One participant did not remember the configuration options and requested slower audio, particularly for the narration of the game options and making choices: "Saying it slowly and clearly …" (P4).

One player reported difficulties using his own words to convey choices via the natural language interface. "It's too hard" (P2). P2's data shows that out of 24 word-based choice inputs, only 10

(41%) were correctly parsed. Other players had fewer problems. Of 308 word choices, 48 (16%) were incorrectly parsed. However, most participants decided to make choices using option letters rather than fully verbally articulating their instruction. Participants made 560 of 868 (65%) choices by the option letter "A," "B," or "C."

Relatability of Audio-Only Stories

The participants' reflections showed that they could relate to the story characters and situations.

All participants enjoyed playing the games and engaged with story characters. Aspects that participants particularly enjoyed included: the characters, especially Lea: "She's independent ... she learned the bus timetable" (P4); "Lea is a nice woman, goes to work on time and goes shopping and gets milk for Simon" (P3); "she was great" (P6); "I respect Simon as a human being" (P9); "all the characters were fun" (P4).

Some participants experienced empathy toward game characters. For example, when asked how they felt about Lea: "I cared about Lea" (P5); "People will get angry … [if you don't let them sit down inside the bus] and she'd [Lea] be sad, upset" (P7); and "It was good to put yourself in their shoes and understand how they're feeling" (P9).

Participants could relate to the story situations. P7 pictured herself catching the bus because she caught the bus each morning. P9 reported that he felt involved in the story about Lea going to work.

Suitability of Interactive Narratives for Social Skills Training

Participants reflected positively on their gameplay, particularly the game mechanics, the responsibility of controlling the main character, and the interactive stories' positive feedback.

Participants felt they possessed enough agency to influence the story and liked being in control of the character. The participants could relate to the situations and commented that they found the available choices for controlling their characters generally acceptable: "I was very happy with all the choices that they did" (P1); "The choices were good" (P9). The choices also involved the participants in the situations that the game presented: "I was thinking about the situation … yeah, I could picture it" (P9). Participants liked the experience of being in control of Lea's character and deciding what she would do. For instance, P3 enjoyed controlling what happened at the bus stop: "I controlled her ... I said B for stand, I prefer standing" (P3).

Feedback was a significant motivator to play the interactive narratives. The positive feedback provided to players after each game contributed to their enjoyment and encouraged them to continue playing: "It made me feel a little bit good" (P8); "It was good, I really liked that …I did a good job, yeah" (P2); "I did everything, good job with everything" (P1); "I was very, very happy in fact, very happy in fact" (P5); "It said to me I did a sterling job" (P4). Participants accepted feedback on their mistakes philosophically: "Well it's a mistake, so..." (P3); "If you get something wrong it tells you why ... if you don't make mistakes, you don't learn anything" (P9).

The story duration was suitable for the target audience. The time required to play all stories was approximately 17 minutes (M=17:10min, SD=4:24min). However, participants could complete individual stories in under 5 minutes. Table 3 provides a breakdown of completion times for each story. To complete all stories, participants were required to make at least 37 story choices. Participants often played more than just one story in one session but not usually more than three, suggesting an

Table 3. Duration per story

	Story 1	Story 2	Story 3	Story 4	Story 5
Duration Mean	0:01:30	0:03:35	0:04:37	0:01:37	0:06:40
SD	0:00:55	0:00:42	0:00:56	0:00:44	0:01:08

attention span of approximately 10 minutes. Half of the players (P1, P2, P4, P5, and P9) felt that time passed quickly.

Playing the games was a positive experience for participants. "I'm feeling really, really good" (P2); "The game really helps me a lot, it helps me clear my mind, and it helps me inside my head" (P1).

Familiarity With Content

Participant reflections revealed a preference for story content that extended past their day-to-day activities and involved new socially challenging situations.

The participants wanted more than day-to-day routine stories. Some participants suggested the development of stories with different subject matter that focused on activities they enjoyed, including "playing mini golf" (P1), being "fit and strong" (P4), and "working in the classroom" (P5).

Not all participants found the game choices sufficiently challenging. Several players regarded the interactive stories' challenges as too easy: "I'd like it [the game] to be harder" (P4); "It's kind of easy …" (P3); "They were easy, too easy" (P6). Half of the players (P1, P2, P4, P5, and P9) felt that the story's difficulty was in balance with their skill. The prototype data summarized in Table 4 confirm these views, as most participants could complete the game with mostly appropriate choices.

Table 4. Number of appropriate and inappropriate choices in each story.

	Story 1	Story 2	Story 3	Story 4	Story 5
Appropriate Choices	59	120	122	68	217
Inappropriate Choices	0	14	18	8	20

RECOLLECTION AND REFLECTION

For most participants, Social Adventure had a lasting impact and triggered reflections on their prior learning experiences and personal situation.

Participants were able to recollect story details. Participants with the most enthusiasm for Social Adventure could recollect stories in greater detail. For instance, P1 and P3 were able to distinguish between episodes. The activities featuring prominently in participants' memories were getting out of bed in the morning, having a shower, having breakfast, catching a bus to work, getting to work late, and going shopping.

Participants reflected on the situations. Participants mentioned practical skills: "people will get angry if you don't let them sit down in the bus and she'd [Lea] be sad, upset" (P7); "I learnt about catching the bus from home to the shop, and to be ready for work" (P1); "To get to work on time you have to catch the bus before you get late, it's better you get there on time and you'll arrive about 5 minutes earlier" (P3).

Participants reflected on the interactions between characters in the stories. Participants stated that they had learned about appropriate ways to interact with people in public places and at home. They reflected on politeness, patience, and thoughtfulness, and acknowledged their social interaction shortcomings. For instance: "think before speech, not giving in to impulses"; "two wrongs don't make a right" (P9); "I learnt about [being] polite ... I need to be respectful with other people" (P1); "I learnt how to talk to people" (P2).

The stories prompted participants to think about their future. P4 talked about living more independently, like the story characters: "Thinking about our own life—living by ourselves, in the future, with your mates" (P4).

DISCUSSION

This study investigated the design of natural language interactive social stories for use on smart speakers and gathered insights relating to the usage of interactive social stories by people with ID. Overall, the authors' findings indicate that Social Adventure offered a playful, relatable, and immersive experience for people with ID. Participants generally enjoyed the agency provided by the interactive story format, and they related positively to the stories and characters. The duration and interactivity provided by the stories were adequate for most participants, encouraging them to replay their favorites stories. The format required the participants' focused attention, and, as a result, many were able to remember story contents in sufficient detail to recollect details and reflect on them. However, despite the co-development of the stories with the participants, the five provided stories were not sufficient to sustain interest during the entire test period, and users suggested the development of further narratives adjusted to their interests and abilities outside the already familiar day to day activities.

Based on this study's findings, the authors propose the following design considerations for designers of smart speaker based interactive narrative social skills training games for people with ID.

Short, Independent Storylines With the Same Characters

Most participants played two or three games in one session, suggesting an attention span of approximately 10 minutes. Participants provided no comments, positive or negative, on the duration of the stories, and they were satisfied with the interactions that the game provided. The authors, therefore, suggest limiting audio-only interactive narratives to a duration of approximately 5 minutes.

Most participants left long pauses until they continued to play again. Perhaps the multi-purpose meeting room was not always accessible, or the smart speaker was used by someone else. This inaccessibility may have affected participants' ability to remember where they were up to (the social story number), which, in turn, may have led to the random gameplay behavior the authors observed (missing stories in the sequence and long durations of inactivity between sessions). The participants, however, felt empathy for the characters and the player choices of the main character they controlled. Therefore, the authors believe that designers should avoid framing social skills stories within a continuing storyline. Instead, the authors recommend the design of short, self-contained stories with the same characters addressing a specific target behavior.

Two Options per Story Choice Point With Short Descriptions

Social Adventure minimized the interaction in most instances by offering three predefined behavior choices for each social interaction, repeating the choices if asked or if no valid answer was provided. The participants appreciated having agency over the character in the story and were mostly satisfied with the game's choices. However, some participants had difficulties remembering questions and game choices, particularly when the choice descriptions consisted of more than just a few words. Therefore, to decrease confusion, the authors recommend limiting the number of options to just two per choice point and describing each behavior using only a few words.

Shallow Story Trees, Immediate Feedback, and Opportunities to Rectify Mistakes

The authors identified that some participants had favorite stories and replayed them in the same way without exploring alternative behaviors and story pathways. This reluctance to engage with the stories more playfully, such as exploring behaviors with negative social consequences, was surprising. However, this behavior reflects the motivation of people with ID to please and 'do the right thing', as has been found in other contexts (G. H. Gudjonsson & Henry, 2003; G. Gudjonsson & Joyce, 2011).

Positive feedback was a significant motivator for participants to play and replay the interactive stories. Participants reported that receiving positive feedback on their choices made them feel good and motivated them to make appropriate choices and replay stories. A key motivator for players to replay an interactive narrative is to explore the consequences when different choices are made.

Surprisingly, people with ID, however, seem to be more motivated to play for perfection and to hear the positive feedback. The authors, therefore, recommend keeping the story tree shallow and, where possible, offering immediate mistake rectification options. Moreover, the authors believe that giving feedback immediately after each choice could give players confidence to complete the story and increase their enjoyment as they progress.

User Customization of Narration and Stories

The authors expected participants would use the NLP capability of the smart speaker and prefer their own words to the single letters "A," "B," or "C" when making story choices. However, participants made only 35% of all choices using more complex word commands. While responding via complex word commands seems more intuitive, participants with speech impairments could not have played the game without the single-letter option.

Just as visual games provide options to make the game more playable for players with different skills, audio-only interactive story games for social training should also allow users to adapt stories to their specific needs and difficulty similar to suggestions made in other research (Brown et al., 2011; Paniagua Martín et al., 2009). Given the scripted nature of Social Adventure, adapting the game to the specific needs of users and including different difficulty settings is easy to implement to present a suitable challenge for players with different preferences and abilities.

Limitations and Future Work

This work represents a starting point to better understand the design of interactive social skills games for people with ID on smart speaker platforms. While the participants had similar levels of ID, they exhibited widely varied skillsets that were determined by other disabilities often associated with ID and consequently, the data may not apply to all populations of people with ID. Moreover, obtaining views or information from people with ID still holds some complexities, primarily because of their cognitive disability and limited communication skills. Also, people with ID often have a proclivity to acquiesce, that is to agree to whatever is presented to them, especially when they do not understand a question or seek social approval. Furthermore, like many people with ID, the study participants demonstrated difficulties maintaining conversational topics. The authors addressed this challenge by using additional probing and cross-questioning techniques to ensure the authors could obtain the fullest answers possible.

The authors did not use scales in the experiment due to concerns regarding the participants' limited language and literacy skills, which makes using empirical literature questions difficult and less reliable (Hartley & MacLean, 2006). However, future work might be able to utilize System Usability Scales (SUS) as demonstrated by Wu (2020) or modify existing SUS as shown by Holden (2020) to gain further insights into the usability of smart speaker based interventions for people with ID.

Moreover, the authors collected data in a multi-purpose meeting room within a local disability support service center. This location may have limited participants' opportunities to access the smart speaker. Future work should provide participants with a device they can set up at home, which may provide further insights regarding the game's potential vis-a-vis other media (Bentley et al., 2018).

The synthetic voices of the smart speaker further limited the stories of Social Adventure were limited to only four characters. The addition of authentic character voices, as well as ambient sounds (e.g., bus motor noises, office background noises, right and wrong answer sounds), offers exciting opportunities to improve verisimilitude, enhance the user interface, provide feedback to player actions, and to express the game's plot mechanics and meaning. Future research could investigate the impact of sounds and music on both player immersion and concentration.

Lastly, the authors did not compare different smart speaker platforms' usability or design features. However, the authors note that Wallace found differences between Google Home and Amazon Echo (Wallace & Morris, 2018). For example, Wallace found that Google Home understood voice commands

better than Amazon Echo, but Google Home's initial setup was more difficult. Future work should deploy Social Adventure on multiple platforms and compare the results.

Given the imitated number of stories and participants of this pilot project, future work should expand to a larger number of subjects, introduce quantitative methodology and test the game with other populations. Moreover, to address the participants' request for more stories, future work should investigate how the smart speaker interface can be used in conjunction with AI and story structure templates to enable people with ID to design and publish their own interactive stories and games.

CONCLUSION

This work explores the timely topic of facilitating voice-based interactions to develop and enhance social skills for people with ID. Given the proliferation of smart speakers and SPAs, it is timely to investigate whether the authors can use natural language interactive storytelling games to provide people with ID with playful, accessible, and cost-effective training to improve their social interaction skills. The authors' findings indicate that the Social Adventure interactive narrative—delivered through the Google Home Mini platform—engaged the participants and helped them focus and reflect on social skills and holds the potential for future social skills development. Only a few participants experienced problems with the device's natural language processing capability. However, several participants found that following the audio-only narration required sustained concentration, which limited their engagement. Based on participant data collected via the prototype and interview feedback, the authors have articulated an initial set of four design considerations that focus on enhancing participants' engagement and experience with interactive social skills games on smart speakers and SPA platforms. Ultimately, with this work, the authors aim to contribute to the broader vision of helping people with intellectual disability to participate in social activities.

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ENDNOTE

[1] Social Stories™ are trademarks originated and owned by Carol Gray." Please see the https://raisingchildren.net.au/autism/therapies-guide/social-stories for details.

Stefan Greuter is a Professor for Screen and Design and Director of the Deakin Motion Lab in the School of Creative Arts at Deakin University. He specializes in the interaction design and development of innovative interactive experiences using technology including game engines, virtual reality, augmented reality, large screen, and distributed screen systems to develop solutions that result in serious games and playable user experiences. Previously, he was at RMIT University, where he directed the Center for Game Design Research.

Joanne Watson is a Speech Pathologist and researcher with over 30 years' experience in the disability sector as a clinician, trainer, support worker, family member and researcher. Her PhD research explored supported decision-making mechanisms with people with severe-profound intellectual disabilities and those who care for and about them. Jo has a special interest in working with and supporting people with severe to profound intellectual disability and their supporters, augmentative and alternative communication, assistive technology, supported decision-making, and the application of digital technologies in her teaching and practice.

Susan Balandin completed her PhD in the Department of Linguistics at Macquarie University, Sydney. She has published over 110 articles in peer reviewed international journals and 20+ book chapters. Her research interests centre on adults with lifelong disability with a particular focus on participation of those with little or no functional speech who require augmentative and alternative communication (AAC) and those who are ageing. She has conducted research into health interactions for adults who need AAC including several studies on interactions between this group of adults and staff in hospitals. She has studied the impact of dysphagia on those who are ageing with cerebral palsy and has also explored a range of issues around friendships and loneliness for both adults and children who use AAC. She was a lead investigator on an ARC linkage grant that investigated transition to retirement for adults with lifelong disability and also explored how Norwegian seniors viewed the inclusion of adults with intellectual disability in their senior centres. With Norwegian colleagues she conducted the first studies in the affordances of Virtual Worlds for fostering friendships and new leisure experiences for adults with disability and also how such virtual environments can be utilised for teaching students about disability. This study built on her previous research on teaching with people with lifelong disability in tertiary education. She is currently one of the chief investigators on two NHMRC projects, one exploring safety incidents in hospital where the patients has little or no functional speech and one investigating the use of personally controlled electronic health records (PCEHR) by adults with disability. Professor Balandin has supervised more than 20 doctoral students whose topics have included 'The experiences of older parents of adults with autism' 'End of life issues for adults with intellectual disability and those who care for them', 'Participation of students who use AAC in Norwegian secondary schools' and 'Experiences of grief and loss of adults with cerebral palsy and little or no functional speech'.