

Exploring Rulebook Accessibility and Companionship in Board Games via Voiced-based Conversational Agent Alexa

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ABSTRACT

The inaccessibility of rulebooks hinders the rule learning experience of board game players who are blind or have low vision (BLV). We conducted two qualitative studies to explore the design of conversational agents (CAs) that can support BLV players' learning and provide companionship. In Study 1, we recruited 14 BLV participants and identified their rule learning challenges, with emphasis on cognitive load, and co-designed functional and social characteristics in Amazon Alexa that can support rule learning and offer companionship. We then developed a new Alexa skill and had 9 BLV participants evaluate our skill against the Alexa skill for the game Ticket to Ride (Study 2). We generated four design principles for CAs to support board game rule learning for BLV people: conciseness, pausing capacity, customization, and companionship.

CCS CONCEPTS

• **Human-centered computing** → **HCI design and evaluation methods**.

KEYWORDS

accessibility, board games, conversational agents, companionship

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1 INTRODUCTION

Board games are a popular social activity for all, but many of them are not accessible to people who are blind or have low vision (hereafter, BLV) [17, 47]. Inaccessible board games mean individual game elements (e.g., game pieces) and rulebooks cannot be readily identified or read by BLV players [8, 23]. The increasing effort has been dedicated to making accessible board game elements [8, 14], and only a paucity of research exists in advancing new ways (e.g., an interactive system) of making accessible board game rulebooks. Could a conversational agent (hereafter, CA) be an accessible means of communicating board game rules to BLV players?

A CA is an artificial intelligence system that mimics human language through text or voice [25]. Popular commercial CAs are

Alexa, Siri, and Cortana. A voiced-based CA, specifically Alexa, can be an attractive assisting technology in communicating board game rules to BLV players. With its natural language capacity, Alexa can communicate rules clearly and quickly; it is readily available to recite rules with a simple user command of "Alexa, rules." Alexa and its social characteristics can also promote rule learning to BLV players by offering companionship. Prior work suggested a positive relationship between companionship and student learning outcomes [26].

Against this background, we sought out to understand how a CA can support BLV players when they are learning board game rules and designed and evaluated such a CA. We asked these three research questions (RQ). First, what challenges are experienced by BLV players when learning board game rules? Second, what functional characteristics in Alexa can support rule learning for BLV players? Third, what social characteristics in Alexa can offer companionship for BLV players?

We conducted co-design workshops to ideate Alexa's desired characteristics for rule learning and gameplay with 14 BLV participants (Study 1). We developed a new Alexa skill based on the results and recruited 9 BLV players to evaluate our Alexa skill versus an existing Alexa skill for the game called Ticket to Ride (Study 2). We focused on generating Alexa's functional and social characteristics. Functional characteristics refer to what CAs do to support a user in a given activity. Past studies have explored the functionalities of CAs in mental-health counselling [16] and customer service [46]. Social characteristics refer to the social skills of CAs [43], which are crucial in designing human-like CAs that offer social presence and companionship [30, 35].

The main contribution of our work is twofold. First, we offer an in-depth analysis of challenges associated with board game rule learning and identify a list of functional and social characteristics of Alexa that can combat some of these challenges. Second, we evaluate the effectiveness of the identified characteristics and offer refined design guidelines of Alexa that can support board game rule learning for BLV players. UX designers and board game developers can use our design guidelines in creating an Alexa skill for other board games of similar nature.

2 RELATED WORK

2.1 Accessibility of Board Games for Blind or Low Vision Players

Research has shown that many board games are inaccessible to players who are BLV. Bolesnikov et al. [8] and Heron et al. [19] reported visual inaccessibility: some board games use extremely small or decorative text on game elements, and some cards are text-heavy that hinders readability for players who are BLV. Both studies highlighted the use of poor colour contrast on game components that

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complicate BLV players' capacity to differentiate between one another for BLV players. The studies also presented the inaccessibility of games. For example, time-bound actions tend to be inaccessible for BLV players because they add an extra amount of stress [8].

Researchers have explored adaptations in existing board games to address the inaccessibility of game components. Tomé et al. [14] adapted the cards of two commercial board games, *Splendor* and *Coup*, including modifying font size and style and tactile numerical system to indicate various information on the cards and rounding the top edges of each card to guide the right way of reading them. The researchers found that their modified board games increased the feeling of autonomy among BLV participants.

However, these handcrafted techniques might not be sufficient to convey all information related to game mechanics, which motivated some researchers to include interactivity. For example, *Game Changer* [23] is a system that combines tactile markers on game elements and audio feedback to make games accessible for BLV players. The system consisted of an overhead camera to track the game pieces and an attached keypad that could be used to query the game state, which is conveyed through audio via headphones to the BLV player.

Augmented reality (AR) has also been explored to adapt games to foster inclusivity and accessible gameplay. For instance, Thevin et al. [41] introduced *JamaicAR*, an adapted version of the *Jamaica* board game using AR. They modified the game components using a mix of handcrafted techniques as well as AR.

Researchers have also geared their efforts toward making board game rulebooks accessible to people who are BLV, and most of them have focused on identifying what constitutes as inaccessible rulebooks and offering guidelines. For instance, Heron [18] identified 14 characteristics of inaccessible rulebooks, including font usage, background and contrast, and text complexity. The digital versions of a rulebook are similar in terms of inaccessibility. Many of them are incompatible with the screen readers [8, 14, 15, 36] and they rely on visual information to explain game rules [14], for instance, using images of monsters and swords to show its ability statistics. Even when rulebooks are accessible, players who are BLV find it hard to search or reread a particular paragraph in the rulebook as the screen reader starts reading everything from the beginning [36].

The findings from Tomé et al.'s study [14] highlighted the importance of an assistive technology that can teach game rules to players. Most participants who are BLV voiced such an application can communicate game information through sound and should help them independently learn rules. Similarly, Bolesnikov et al. [8] provided suggestions on improving the accessibility of rulebooks, including using assistive technology to communicate game rules such as video tutorials, OCR, and using multimodal interaction (texture and audio). The topic of designing an interactive system that can support inaccessible board game rulebooks has not yet been explored in depth.

2.2 Conversational Agents for Tabletop Games

CAs have been explored in the context of digital and tabletop role-playing games. Allameh et al. [4] introduced *Jessy*, which is a CA for the digital board game *The Royal Game of Ur*. *Jessy* helps players with game-related queries, suggests best moves, and informs them about the game's current state through an interactive chatbox. *Jessy* has shown promising results regarding facilitating player

engagement and understanding of the game rules. Rogerson et al. [22] surveyed board game players and interviewed board game designers and publishers about their thoughts on hybrid digital board games (traditional board games that work with digital apps). The researchers outlined eight categories of functions that digital apps (e.g., CAs, mobile applications) can perform in a board game play, including teaching rules, calculating scores, storytelling, and informing. These studies suggest that incorporating a CA or other digital technologies is valuable in supporting board game rule learning and gameplay.

To the best of our knowledge, CAs have yet to be explored in guiding BLV players, and this is the knowledge gap that our current research aims to address. Using CAs to communicate board game rules can be a promising solution to break accessibility barriers. Learning and remembering game rules can be challenging, especially for BLV players. One has to understand rules around managing a hand of cards, remembering the map, remembering win conditions, and constantly keeping track of the score [34]. Heron et al. [19] referred to this as table knowledge and explained that players must memorize a large amount of knowledge about the parts of the game that are relevant to them to plan their moves strategically. Remembering the rules is a cognitively heavy task that can burden the players, especially for games with complex rules. CAs might remove two types of burdens from BLV players: 1) CAs can relieve the players from scanning hastily for specific information through the document, especially using a screen reader that comes with its own challenges and 2) CAs can relieve the players from intensive cognitive labours that involve memorizing and recalling game rules and tracking the game state.

Also, CAs can provide flexible options for communication based on user preferences, such as speech or text, making the system more inclusive. Speech-based interaction has been traditionally adopted as one of the most commonly accessible forms of interaction, especially for people who are BLV. Technologies like screen readers and voice-overs have existed for decades and transform text to speech for users, bypassing the need for typing through the keyboard. Research on the usefulness of CAs for users with disabilities has accelerated in the past couple of years, and it suggests that CAs can support these users to be independent. For instance, Abdolrahmani et al. [3] found individuals who are legally blind use CAs to perform a wide range of tasks that require a timely response, such as asking for directions while navigating, and participants referred to the CA as a "time saver".

2.3 Conversational Agents for Companionship

We believe that CAs can also support BLV players' learning of board game rules by offering companionship, defined as having a system with whom a user has a high emotional connection and bond [39]. Extensive work has demonstrated that CA-based technology can become a user's companion by embodying several social characteristics. Ta et al. [40] found that CAs can provide companionship by paying attention, communicating in a human-like manner, and engaging in various types of conversations with the users. Ramadan et al. [33] studied the relationship between Alexa and people with disabilities by analyzing online reviews and interviewing industry experts and Alexa users with disabilities. Their findings suggest that users perceive Alexa as a companion who can offer emotional support and make them feel less lonely, presumably due to Alexa's

many human-like features. CAs can become a companion by expressing enthusiasm [28] and positive facial expressions [44], empathy [24], and encouragement [13].

Other researchers have explored the design of social chatbots for companionship in various contexts, including difficult life situations [38], depression and anxiety [16], and online learning [43]. One novel application of AI agents as a companion was done by Weber et al. [45] in the area of Human-Food Interaction who developed FoodChattAR that employed augmented reality and chatbots with anthropomorphic elements to make some users perceive their physical food as a friend or an entertainer.

One reason CAs can offer companionship is their human-like characteristics that make a user to subjectively experience as if they are with “another human being,” a concept called social presence [6]. The social presence of CAs has been widely studied and linked with companionship. In a recent survey, Shao and Kwon [35] found that companionship is one of the four key motivations for using CAs in users. They showed CA’s ability to provide companionship in terms of social and emotional support and accompany users so they do not feel alone.

It is important to offer companionship to BLV players to facilitate rule learning. Prior work has suggested companionship can mitigate learning-related negative emotions (e.g., anxiety) [12, 37] and is associated with better learning outcomes [26] and motivation [21]. One explanation for such a positive impact of companionship is that companionship can make a learner feel related to others who are embedded in the same learning environment. This relatedness needs fulfilment is the critical antecedent that evokes a host of positive learning and emotional outcomes [31]. A BLV or general player can encounter difficult situations when learning board game rules. For instance, the player may become frustrated with learning complex rules or losing a game round. A CA that gives immediate emotional support may motivate the player to continue to learn the rules and play the game. The potential of CAs in providing companionship in the context of board game play to BLV players has yet to be explored.

In sum, HCI researchers have begun to highlight barriers to accessibility associated with tabletop games, specifically for the BLV community. However, the area of inaccessible rulebooks largely remains unexplored. Hence, our research explored the role of CAs (specifically Amazon Alexa) in the context of rule learning and asked the following research questions:

- RQ1: What challenges are experienced by BLV players when learning board game rules?
- RQ2: What functional characteristics in Alexa can support rule learning for BLV players?
- RQ3: What social characteristics in Alexa can offer companionship for BLV players?

3 STUDY ONE: METHOD

3.1 Participants

We recruited 14 BLV participants using convenient and snow sampling techniques. Eight participants identified as men, five as women, and one indicated they preferred not to say. The age range for participants was 20 to 76 years old ($M=42.2$, $SD=16.7$). Eight participants were from the United States, four were from Canada, one

was from Europe, and one was from Australia. Eight participants were completely blind, three were legally blind with the ability to see lights and shapes, and three had low vision. Five participants were visually impaired by birth. Table 1 summarizes our participants’ demographics. Experience with board games or Alexa was not a requirement.

3.2 Procedure

Our co-design activities centred on eliciting verbal feedback to make the session accessible for BLV participants. We conducted nine co-design sessions over the period of three weeks. Each session lasted two hours. We held separate sessions to account for participants’ scheduling conflicts. We had five sessions with two participants and four individual sessions (Table 1). To facilitate brainstorming of Alexa’s desired features among participants, we recorded the demonstration videos to show how Alexa skills can be used for two board games Ticket to Ride and No Thanks, respectively. The first video showed the first and second authors playing the game, from setting up the physical elements of the game to learning about the rules from the Alexa skill and playing one round of the game. The second video showed the first and second authors and an undergraduate research assistant playing the game for five rounds. We asked Alexa important questions that it could answer for each stage of the gameplay and recorded Alexa’s social characteristics. The first author added their voice-overs in between to explain any visual activity and added closed captioning to ensure accessibility. The collective duration of videos was around 16 minutes.

The session was structured into three components. First, participants responded to questions about their process of learning and teaching new board games and challenges associated with rule learning. During the co-design sessions, the first author played two demonstration videos in the order of the first and second videos. Participants shared their feedback on Alexa’s current capabilities that stood out to them while watching the demonstration videos. Second, participants were asked to imagine a board game with a slightly complex set of rules. They collectively brainstormed (with one another or the first author) functional characteristics of Alexa to support them during the gameplay. Third, participants discussed the social skills of Alexa that would assist a BLV player and whether and how Alexa can offer companionship in rule learning or gameplay. Finally, we concluded with a discussion and debriefing.

3.3 Data Analysis

We conducted reflexive thematic analysis on transcribed audio recordings [11]. The first and second authors independently coded the first 10% co-design session transcripts using Excel. Next, we discussed and agreed upon a list of codes along with their definitions. We independently coded the rest of the transcripts using software called MAXQDA [2], applied the agreed-upon codes, developed new codes, and met to discuss the newly identified codes. Then, we discussed grouping the codes based on their similarities and organized them into themes. Regardless of the programs, we applied the same analytical procedure and leveraged each program’s functionalities. We adopted the interpretative view of reliability in coding (vs. a positivist view of reliability). Within this qualitative framework, coding is an evolving and organic process where there

Table 1: Study 1 participant information

Participant ID	Age	Gender	Visual Ability	Country	Co-design Session
P1	76	M	Blind (at age 15)	Canada	Session 1
P2	29	W	Blind (by birth)	USA	
P3	40	M	LV (at age 15)	Canada	Session 2
P4	26	M	Blind (at age 4)	USA	
P5	54	M	LB (at age 53)	USA	Session 3
P6	54	M	Blind (at age 25)	USA	Session 4
P7	67	W	LB (later in life)	Canada	
P8	34	W	LV (at age 28)	USA	Session 5
P9	37	W	LV (since birth)	Australia	
P10	20	Prefer not to say	LB (since birth)	North Macedonia	Session 6
P11	40	M	Blind (at age 1)	Canada	Session 7
P12	23	M	Blind (since birth)	USA	Session 8
P13	55	W	Blind (since birth)	USA	Session 9
P14	37	M	Blind (at age 29)	USA	

*LV = Low Vision, LB = Legally Blind (can see lights and shapes), M = Man, W = Woman

is no single objective truth in data [11] and we did not calculate inter-rater reliability. We defined reliability in terms of the rich description of the analytic procedure and plentiful descriptions of raw data obtained from study participants.

4 RESULTS

4.1 Theme 1: Challenges with board game rule learning for BLV players

4.1.1 Sub-theme 1: BLV players cannot read rulebooks due to poor format. Participants indicated the inaccessibility of rulebooks was the most common reason that hindered the book's usability. They shared the aspects of rulebooks (digital and physical) that made them inaccessible. First, game designers created inaccessible PDFs by scanning the rulebook documents as image-only PDFs ($n=6$). These PDFs would not allow the user to select or copy a text and they are unreadable by screen readers. P6 indicated, "They [designers] basically put PDFs and they just scan them as images. So a 30-page rulebook is 30 pages of images and nothing else...you can't access it at all. And that's very frustrating."

Several participants ($n=5$) specified the layout of multiple columns and tables was not recognized by screen readers if designers did not tag the columns and tables. Consequently, they read the information from left to right, as if it was linear, causing the flow of information to be incoherent. P13 explained, "That's because for PDFs to really read properly, they need to be tagged. And if you don't tag your PDFs, it can just become a jumble of text and things won't be presented in the right order." The poor layout of PDFs also makes numbers and text elements "smashed together" (P4) or causes certain words to get cut off, making the reading of rulebooks difficult. When it comes to physical rulebooks, it was the use of small fonts that made the books inaccessible.

4.1.2 Sub-theme 2: BLV players have a lot of information to process. As a consequence of the absence of accessible rulebooks, the participants must make the effort to memorize the rules. Eight participants said they had to memorize the rules. P9 said, "I can't read them [rulebooks], but I've just had to memorize. I think that's something a lot of vision impaired people do is just teach ourselves

to memorize stuff." Participants explained that there was a lot of game information that they needed to remember at once. This can increase their cognitive load, especially when there were complex rules, information specific to certain characters, and rules that did not come into play until certain situations arise. For instance, P4 said, "I know that there's a lot of rules that never come into play unless there are specific situations that happen...So it's going to be really hard to memorize stuff that I don't consistently use because I don't have a very good memory anyway."

P9 felt pressured to react quickly in the game like her sighted co-players; she cannot possibly memorize all the information and she felt that she was not able to equally compete in the game: "I can struggle at times because my friends can react quickly because they can quickly read a card and play that. There is lots of different cards, you can't possibly memorize it."

The content of rulebooks can also cause information overload. P8 and P9 collectively gave examples of such rulebooks: "one that has so much information right at the start" and "really lots of detail and not really logical following." The struggle can intensify for novice players or player groups with only players who are BLV and result in abandoning certain games or choosing the games they know to avoid "going to go through all the hassle" (P3).

4.2 Theme 2: Desired functional characteristics in Alexa for rule learning

Participants engaged in outlining several functional characteristics that are desired in Alexa for rule learning, some of which were inspired by Ticket to Ride. We summarized these characteristics in the Table 2. Some characteristics already exist in the Alexa skill for the game and other characteristics were not present in the skill at the time of the study.

4.2.1 Sub-theme 1: Alexa's speech should reduce cognitive load. Participants reported Alexa's speech can be modified to reduce the cognitive load in BLV players. Firstly, four participants noted that they did not enjoy Alexa's voice, which is monotonous and lacks expression. P2 said, "Sometimes the responses are more robotic in Alexa. I think it'd be cool to have a little more expression and

Table 2: Functional characteristics for rule learning

Characteristics for Rule Learning	Strategies Alexa Uses or Should Use	Existing (E) vs. New (N) Characteristic
C1. Alexa’s speech should reduce cognitive load	Alexa should emphasize certain things	E
	Use breaks and stops	E
C2. Players need time to digest information	Be concise by avoiding extra information	N
	Repeat rules when asked	E
C3. Use Alexa as a quick reference guide	Reference to the commands it understands	E
	Quick setup and rule summaries	N

less monotone." This can alienate the players during rule learning because "it’s a little droning because it’s monotone" (P6).

Three participants suggested that Alexa can emphasize certain things in its speech, which could be achieved by adding breaks and stops. This will help players absorb the information gradually, without losing attention. P14 said, "...when you get to an instruction set where I was expecting it [Alexa] to be a little more broken up like you have this is the first rule or second rule...But she just kind of went straight through everything and I found myself zoning out."

4.2.2 Sub-theme 2: Players need time to digest Alexa’s information. Participants repeatedly emphasized that they need time to absorb all the game-related information that Alexa is teaching; otherwise, they might feel overwhelmed. For example, P6 explained the importance of Alexa’s ability to repeat a rule. Hence, an option to make Alexa repeat information helped him slowly understand the information. P6 said, "It took me an hour to go through the rules because Alexa would say a rule, and I would tell it to go back because it wasn’t registering in my head since I had never played that game before. And it took me a long time to get through all those rules, and it was frustrating."

Participants noticed an instance from the demonstration video, where Alexa explained a rule that applied to four or five players when only two players were playing the game. Alexa was giving away extra information that was not applicable. Participants explained how some game rules do not come into play until certain situations arise. Alexa should not tell those rules to avoid bombarding players with excess information but give brief audio cues to specify that this rule will come up later in the game. P4 mentioned, "I did notice that Alexa...was saying, 'Oh, when it’s two players, it’s like this, but when it’s four or five, it’s like that.' I’m probably not going to remember that. I’d rather have it brought up when there’s four or five players.". P9 described, "That’s where you get really overwhelmed. If Alexa went through every detail, I would be at my eyes glaze over and I can’t keep that much information in my head, but Alexa [can give] high level [rules]."

Finally, participants mentioned that Alexa should provide information concisely; novice BLV players might find it hard to digest all the information at once. P6 said that BLV players need to exercise patience when learning rules through Alexa because Alexa’s instructions are verbose: "I think those things are wordy. Also, I knew what they were talking about because I’ve played both of those games dozens of times. But, to someone who may not have played them before, they may have trouble visualizing what’s going on in the game."

4.2.3 Sub-theme 3: Alexa can be a quick reference guide. P2 and P4 shared that Alexa should inform players in the beginning about the commands it understands. It helps them navigate the skill in an efficient way without having to remember all the commands. P4 further insisted that it is challenging for him to memorize information in general and having to remember Alexa’s commands could aggravate the challenge. Participants exercised their creativity to suggest solutions to make their navigation while using the skill efficient; they emphasized on the importance of having a quick reference guide for rules and setup that similar to a "searchable help system" (P4).

P13 and P14 collectively produced examples to imagine how a quick reference guide could look, similar to what they have been using with other smartphone applications. P13 described, "[You could say] 'Alexa, Table of contents.' And it could give us all the headings that we could look for. And then you could say 'Alexa, in-game scoring' and it would tell me the rules about that." P4 added a reference guide would help him go at his own pace without having to hear redundant details, "I prefer having references that anybody can use at any time. I know that you can repeat the rules, but I like being able to choose my own pace and highlight certain things that I need to go over again...instead of having to hear the whole thing again."

4.3 Theme 3: Desired functional characteristics in Alexa for gameplay

Participants also offered functional characteristics of Alexa that can enhance gameplay.

4.3.1 Sub-theme 1: Alexa’s encouragement, music, and reminders can be customized. The demonstration videos showed Alexa encouraging players by saying phrases such as "Barabing bara boom!", "Bingo!" or "Way to go". Nine participants found the phrases funny and entertaining, but five of them thought the phrases might get annoying after a while. Three participants thought Alexa was "trying too hard" to be human-like and did not encourage this feature. Five participants suggested Alexa’s encouragement should be customizable; children might enjoy frequent affirmations from Alexa more than adults.

Similarly, the Ticket to Ride demonstration video showed Alexa playing train-themed music in the background during the gameplay. Seven participants found the music to be distracting. For example, P7 did not enjoy the music because it interfered with her hearing aid and ability to concentrate on the game rules. Three other

participants perceived the music to slow down the gameplay altogether. P13 mentioned that her playgroup would prefer to play their choice of music during the gameplay. Hence, participants suggested there should be an option to turn it off.

Participants liked Alexa's ability to announce rule reminders in the demonstration video for Ticket to Ride. For instance, Alexa notified the players about the rule that a player with the longest continuous route will score additional ten points. Two participants said that this might be helpful for games for which they need a quick refresher of certain rules. However, they might not need rule reminders for games they have played extensively. Rule reminders are another domain that could benefit from customization.

4.3.2 Sub-theme 2: Alexa as a game moderator. Participants perceived Alexa's role as a moderator and suggested certain features that could have Alexa to fulfill the role. For instance, P11 has experienced quarterbacking in cooperative games: one player in the team dominates over other players and tells them what to do. He suggested Alexa could overcome this challenge by telling players how to play and providing unbiased answers to their questions.

Three participants noticed how the current Alexa skill had no option to pause the game and shared scenarios where having a pause feature can be crucial. Participants mentioned that it is a common practice to pause the game to have random conversations or use other applications on their smartphones. P11 also added that BLV players might need to pause the skill during setup to add braille to their cards: "For a player who adds braille to their cards to make them readable as a closed hand, they would need the opportunity to stop and be told in what order the cards are in the pack so that they can put the braille on them as they're going through and then continue with the decks being shuffled."

4.3.3 Sub-theme 3: "I see Alexa as a tool, not as a companion". Participants were adamant that they did not see Alexa as a companion when they played board games, especially in the context of social play. Their social needs are met through human interactions, and they saw other co-players as companions. P6 said, "This is a personal view because I had my social needs met by all of my friends, whether we're playing virtually through tabletop simulator or preferably in real life, that's where I have the fun is the interaction, but I'm not likely to have anywhere near as fun of as an interaction with Alexa."

Even though they liked Alexa's guidance and ability to answer questions, participants felt that Alexa was taking away the primary focus of board gameplay i.e., social interaction. P4 and P5 would prefer to ask questions about the game to other co-players instead of Alexa in order to get a prompt and relevant answer that applies to the game state.

Moreover, participants saw Alexa as "a tool" or "chatbot" to seek information, rather than "a companion," and they did not expect a human interaction from it knowing that "it is artificial and programmed" (P13). P6 described the efforts of AI-based technologies to be "trying too hard to sound like" human beings, which can elicit feelings of discomfort. P14 reported, "I would be primarily just using it as an information source. I wouldn't be expecting a human interaction from Alexa. So I'm not really sure." P13 said, "I know all of that stuff is programmed...It's not real, so it all just feels artificial and sort of pointless."

Participants brainstormed for social characteristics: empathy ($n=3$), sense of humor ($n=3$), responsive and conversational ($n=3$), flexible to accommodate players' choices ($n=3$), and being affirmative and encouraging ($n=2$).

4.4 Summary

We ideated with BLV participants about Alexa's characteristics that can support rule learning and gameplay. For desired characteristics for rule learning (Table 2), all but "Be concise by avoiding extra information" and "Quick summary of setup and rules" were inspired by and are not present in the Ticket to Ride Alexa skill.

For desired functional characteristics for gameplay, none of them is present in the Ticket to Ride Alexa skill. A key finding was cognitive load being the primary challenge for BLV participants and we took on the next step in conducting Study 2. We focused on new characteristics that are presently not in the Ticket to Ride Alexa skill that could reduce cognitive load in BLV players when learning rules, designed an Alexa skill with new characteristics, and examined the effectiveness of such characteristics.

When it comes to companionship and social characteristics in Alexa, our findings suggest most participants do not perceive Alexa as a companion, especially in a social context where there are multiple players as opposed to an individual context. As such, our Study 2 focused on evaluating the relationship between Alexa's new characteristics and cognitive load.

5 STUDY TWO: METHODOLOGY

5.1 Participant Demographics

We recruited nine English-speaking adults who had some level of experience in board gaming and had access to Amazon Alexa (either the Amazon Echo or Alexa application on a smartphone). We invited five participants from Study 1 and recruited four new participants. Table 3 outlines participant information. Each interview lasted an hour and participants received a \$30 CAD e-gift card.

5.2 Alexa Skill Development

We created our own Alexa skill for Ticket to Ride so that participants can compare our skill against the existing skill for the game. We chose this particular game as a reference point since our Study 1 participants found many of its characteristics to be beneficial for BLV players. We developed our skill using Amazon Alexa's framework called Alexa Skills Kit (ASK) and we refer to our skill as Board Game Assistant.

For functional characteristics of rule learning, we focused on two characteristics and their specific strategies as outlined in Table 2: C2. Players need time to digest information and Alexa be concise by avoiding extra information. We further broke down this characteristic: C2-A) Alexa should only tell a rule when needed and C2-B) Alexa should concisely describe rule examples; and C3. Use Alexa as a quick reference guide and provide quick setup and rule summaries. We further operationalized this characteristic by providing a quick reference guide available on a mobile phone. We judged these two characteristics and strategies had the potential to reduce cognitive load based on prior work suggesting cognitive load can be reduced when information is broken down into bite-sized

Table 3: Study 2 participant information

Participant ID	Age	Gender	Visual Ability	Country
PI1*	40	Man	Blind	Canada
PI2*	54	Man	Blind	USA
PI3*	29	Woman	Blind	USA
PI4*	26	Man	Blind	USA
PI5	47	Man	Blind	USA
PI6	28	Woman	Legally Blind	USA
PI7	67	Man	Blind	USA
PI8*	38	Woman	Low Vision	Australia
PI9	40	Did not identify with any gender	Legally Blind	USA

*Note: The asterisk on participant ID means that they also participated in Study 1.

segments (C2) and when information presentation is outsourced to a different medium (C3) [29].

We also developed characteristics that we had originally identified to support gameplay: Alexa’s encouragement, music, and reminders can be customized. Some participants found Alexa’s background music to be distracting and interfering with their hearing aids. Alexa that is not delivering rules for the first time may be bombarding BLV players with too much information and interfering with the overall learning process. In the end, our Alexa skill had seven new characteristics.

5.3 Procedure

We had participants to evaluate each characteristic individually. For six characteristics out of seven, we used audio recordings that showed the first author’s interaction with the existing Alexa skill (Recording 1) and with the Board Game Assistant (Recording 2) to facilitate the comparison of two skills for participants. We used recordings so that participants can engage in one-to-one comparison between our prototyped feature in the Board Game Assistant and the feature’s counterpart in the existing Alexa skill without having to close and open different skills on their mobile phone. Below, we describe the recordings for seven characteristics that were played to participants. We did not ask participants to interact with the Alexa skill because navigating between two Alexa skills (i.e., the existing Alexa skill and the Board Game Assistant) would have been a complex task.

Characteristic 1. Alexa should only tell a rule when needed: Participants heard Recording 1 in which Alexa described rules for wildcards and claiming a train route for 4-5 players. Understanding these rules is not necessary until players find themselves in a situation needing the rules. Then, participants heard Recording 2 in which Board Game Assistant did not offer the rules and let players know they can ask about the rules later. For example,

Existing Alexa Skill–Wildcards

Alexa: ‘Quick question. The deck of train cards contains some wildcards. These are multicolored, showing a rainbow of all colors. Have you seen a wildcard in the row of five face-up cards yet?’

Player: ‘No.’

Alexa: ‘Don’t worry. You’ll see them soon enough. Multicolored cards are wild and can be used in place of any other

card to claim a route ... [Alexa continues to explain game rules for ‘Wild cards’].’

Board Game Assistant–Wildcards

Alexa: ‘...wildcards have different rules. To know more about them, say ‘Alexa, wildcards’ at any point.’

Characteristic 2. Alexa should be concise: We made Alexa’s speech concise in giving examples of a rule. For instance, Board Game Assistant offered 3-line explanation of how a player can claim a train route (vs. 6-line). The existing Alexa skill also guided a player on how to claim a route by giving a specific example (i.e., Phenix to Denver), whereas our version did not. Our findings from Study 1 indicated Alexa’s speech assumed players can ‘see’ the board and we removed this characteristic to make Alexa’s speech inclusive.

Existing Alexa Skill–Train route explanation

Alexa: ‘So what is the train route? Great question. Take a moment to find Pheonix on the bottom left-hand side of the board. [Pause] Did you find it?’

Player: ‘Yes.’

Alexa: ‘Now find the white rectangle connecting Pheonix to Denver. [Pause] See them?’

Player: ‘Yes.’

Alexa: ‘This is called a route. And these spaces are where you will lay down your plastic trains in order to score points. This is also how you’ll connect the cities on your ticket cards. Each rectangle of a route requires one card, and the cards must match the color of the rectangles on the round. It’s important to note that the color of the spaces have nothing to do with the color of your plastic trains. Only the cards required to claim the round. So the route between Pheonix and Denver can be claimed by any player. Got it?’

Alexa: ‘So if you want to claim the route between Pheonix and Denver, what do you think? How many white train cards will you need to play?’

Board Game Assistant–Train route explanation

Alexa: ‘The second action you can take to score points is claiming a route by playing a sequence of train cars that match the color and length of the route and then placing one of your colored trains on each face of this route.’

Characteristic 3. Alexa can offer summaries through reference cards: We did not have any recordings for this characteristic

and we asked participants to interact with the app on their smartphones prior to the interview and provided step-by-step instructions on how to access both skills on their smartphones.

Characteristic 4. Alexa should pause: Recording 1 demonstrated the existing Alexa skill describing the game's object without the ability of a player to pause. Then, Recording 2 demonstrated our Board Game Assistant describing the same rule with the ability of a player to pause.

Board Game Assistant–Pause

Alexa: 'Object of the game is to score the highest number of total points. Points can be scored by...'

Player: 'Alexa, wait.' [Alexa pauses.]

Player: 'Alexa, next.'

Alexa: [continues to explain the rule.]

Characteristic 5. Alexa's music can be customized: Recording 1 demonstrated the existing Alexa skill playing music in the background while a player is drawing board game cards. Then, Recording 2 demonstrated how the first author can turn off the music with Board Game Assistant by saying, 'Alexa, music off'.

Characteristic 6. Alexa's encouragement can be customized: Recording 1 demonstrated the existing Alexa skill saying 'Woohoo!' versus Recording 2 demonstrated how a player can set Alexa's encouragement on a low mode.

Existing Alexa Skill–High encouragement

Alexa: '...The route between Kansas City and Saint-Louis is two spaces long, so the yellow player gets two points. Woohoo!'

Board Game Assistant–Low encouragement

Player: 'Alexa, set encouragement to low.'

Alexa: 'Okay. Encouragement is set to low.'

Alexa: 'That's two points for yellow.'

Characteristic 7. Alexa's rule reminders can be customized: Recording 1 demonstrated the existing Alexa skill reminding rules without a player prompting versus Recording 2 demonstrated a player turning off Alexa's reminder.

Existing Alexa Skill–Rule reminders without a turn off feature

Alexa: 'Way to go. [Plays train sounds] Sorry, this is a little embarrassing, but I just realized I forgot to tell you one last thing.'

Player: 'Oh, what?'

Alexa: 'At the end of the game, whoever has the longest continuous pack of trains gets an additional ten points.'

Board Game Assistant–Rule reminders with a turn off feature

Player: 'Alexa, set rule reminders off.'

Alexa: 'Okay. Rule reminders are turned off.'

The first author conducted all interviews through Zoom and audio-recorded the sessions. For each feature outlined in the above order, she asked participants questions that probed for their feedback on each feature, preference between the two, and impact of the modified feature on their cognitive load.

5.4 Data Analysis

The first author coded the first 5 transcripts to develop an initial list of codes. The second author reviewed the codes to arrive at a consensus on this initial list of codes. The first author then applied an agreed-upon list of codes to the rest of the transcripts, grouped similar codes, and identified four themes from the data. She used the MAXQDA software for analysis [2].

6 RESULTS

6.1 Theme 1: Alexa that is concise can reduce cognitive load

With reference to the wildcard and player count examples in Ticket to Ride, seven participants said the existing Alexa skill's explanation was unnecessary. In addition to causing confusion, Alexa's lengthy explanation made participants hard to focus on the important information. All participants said the modified version in Board Game Assistant was better. First, it gave players the flexibility to ask for information when they actually needed, even multiple times. Second, as the four participants explicitly mentioned, it would be more effective in reducing BLV players' cognitive load. Third, it was better suited for novice BLV players as it would not overwhelm them with information.

Surprisingly, after listening to the modified version in Board Game Assistant without any examples, five participants insisted that the examples should only be provided when asked. For instance, Alexa can ask users if they would like an example. It will save time and ensure that Alexa is concise. Moreover, as three participants noted, the existing Alexa skill that gave examples would be helpful for novice players, while our Board Game Assistant without examples would save time for returning players.

6.2 Theme 2: Alexa that pauses can reduce cognitive load and supports individual learning

Participants found Alexa's pausing capacity in Board Game Assistant extremely crucial as it would give them the autonomy to move at their own pace. As highlighted by five participants, this feature could help reduce cognitive load when learning rules. P16 explained, "Because then you can pause, and you're not stuck trying to remember all the steps and whatever card you're supposed to find. You can pause, find your card, get the setup going and say next to that, that would be helpful."

Participants added that Alexa should resume from where it was paused so that no information is lost. Moreover, they mentioned that this pausing feature would be helpful not only for BLV players but also children and adults of all ages and abilities. Finally, P11 and P12 emphasized that Alexa's reference card should contain breaks and pauses so that it does not overwhelm the users when their screen reader reads the card. P12 said, "I knew how to play it [the game], and I had a hard time keeping up with that reference card in the revised app [Board Game Assistant]. Just listening to it. And it frustrated me because I wanted it to slow down and give at least one pause, maybe read one or two of the reference card rules."

Another thing that stood out to our participants was Board Game Assistant's ability to be intuitive by stating what commands Alexa

understands at the beginning of the skill. Participants repeatedly said that having to remember all commands can increase their cognitive load; instead, they appreciated Alexa being proactive in stating these commands.

6.3 Theme 2: Reference cards can reduce cognitive load but pose accessibility challenges

Our participants had difficulties accessing the reference cards for both Ticket to Ride and Board Game Assistant on their smartphones. Five participants were unable to find the reference cards on their Alexa app. For three participants, the sound produced by the Alexa app conflicted with the sound of their screen readers. This audio overlap made it impossible for participants to understand the audio output. Hence, the first author accessed the reference cards using her mobile phone and she turned on a voice-over technology and shared the audio output with participants.

Despite these difficulties, participants liked the reference cards. Three participants said the cards would significantly lower their cognitive load and support their various learning needs. PI4 explained that people have different learning styles. For some, a summary that a person can access and read on their smartphone should suffice; others might find audio-based interaction more convenient. In support of this participant's perspective, other participants showed differences in their preference for the mode of reference cards. Four participants preferred Alexa to verbally share the summary while having control over its speaking pace, similar to how they listened to recipe instructions.

Participants suggested how the design and content of reference cards can improve to reduce cognitive load in BLV players and improving the cards' accessibility. First, seven participants said the text on the reference cards in both skills were read as one large block by their screen reader application and not as separate items on the list. Consequently, the poor design of the reference cards hindered seamless navigation between items in the list; if participants wanted to hear the fifth item, they would have to wait and listen to the first four items every time. Moreover, Alexa did not pause and read the whole list in one go.

Second, in terms of content, five participants liked the information mentioned on the existing Ticket to Ride skill, that is, commands players can say to navigate the skill (e.g., repeat, next). Participants found this information to be as useful as the rules or setup summary on Board Game Assistant. PI1 said, "But if it's showing it as a visual reference in the app, it would be good to have one that is the commands and another that is in the actual rules reference."

Being a novice to Alexa's interface, PI9 found these commands would be a good reminder to help with navigation. PI3, PI4, and PI6 saw value in a verbal help or FAQ section where they could find answers to game-specific questions. Moreover, P8 added that BLV players should not have to remember keywords to ask questions to Alexa. Instead, the interaction should be intuitive, where the player can use various commands and still receive an answer from Alexa. She gave an example that if a player forgets the keyword "wildcard," they should still be able to ask, "Alexa, what is a rainbow-colored card?"

6.4 Theme 3: Customizing Alexa's music and reminders can reduce cognitive load, but not encouragement

All participants agreed that having an option to customize Alexa's background music could help manage their cognitive load for various reasons. Alexa's music was annoying and distracting during rule learning and it could disrupt the conversations happening during social plays. PI4 described, "So if you have the option to turn that [background music] off, well, then they can actually hear the people around them better and focus on what they're saying, and they can be in the moment more. Whereas if you've got the music, it's always there in the back of their head, and it makes it harder for them to pay attention."

PI8 and PI3 added there should be an option to keep Alexa's music turned on but lower the music's volume so that it does not affect the volume of Alexa's speech. Alternatively, PI8 suggested that Alexa should be proactive and ask BLV players initially about their preference for music and customize the setting accordingly.

Participants liked an option to customize Alexa's rule reminders. Three participants (PI7-PI9) stated that it would help reduce their cognitive load because they can decide how much information they are willing to accept. In addition, Alexa's excessive reminders can cause distraction and interrupt participants' train of thought.

Participants also suggested that Alexa should provide reminders on-demand or depending on players' experience level. For instance, there can be more reminders for the beginner level but less for the advanced level. This will ensure that BLV players' individual needs are catered to. PI2 said, "that is a very individualistic need for that, for cognitive load versus cognitive processing and keeping in mind the important rules that is variable depending on the person you know, someone might need more reminders."

On the contrary, all participants indicated that customizing Alexa's encouragement can make their playing experience entertaining, but it would not necessarily reduce their cognitive load. They agreed there should be an option to customize Alexa's encouragement; they liked the multiple modes that acknowledged and support entertainment for various users.

7 DISCUSSION

We explored functional and social characteristics in Alexa that can assist board game rule learning and offer companionship for BLV players. We now offer four design guidelines and situate our guidelines in prior work.

7.1 Guideline 1: Alexa's speech should be concise

Our participants found Alexa's responses verbose, causing cognitive overload during rule learning. This finding aligns with the industry standard of making CAs' conversations efficient and concise. For example, Amazon suggests developers keep utterances short enough to pass the one-breath test (i.e., be short enough to be stated in a single breath or break them down into sentences that comply with the same rule [7]). Amazon's guideline for developing board game companion skills specifically advised keeping

the instructions to be ‘bite-sized’ (no more than 2-3 sentences) and saving the rules that do not apply in the earlier stages for later. The guide acknowledged that Alexa’s lengthy statements might cause cognitive overload in players and advised against it [1].

Our work echoes similar findings to incorporate conciseness in Alexa’s speech. We demonstrated how Alexa could be concise in two ways: only tell a rule when needed and only tell examples when needed. Alexa’s statements should allow for the gradual flow of information to improve learnability and ensure that less relevant details are not omitted but flagged so that BLV players are aware while remaining focused on the crucial rules first. We showed in practice how this could be achieved through the wildcard example, whereby prompts indicated that players could request additional information about wildcards when needed.

We suggest a similar design suggestion regarding Alexa providing examples in explaining a rule. Our participants found examples beneficial to visualize the board and components, especially novice players. Hence, prompting a user by asking, ‘Would you like an example?’ avoids assuming players’ needs and reduces time and effort for experienced players while also catering to the needs of new players by equipping them with additional resources to expedite the learning. However, as noted by our participants, Alexa’s language includes visual instructions and examples, showing that the developer assumes that players are sighted. Our findings suggest that Alexa skill developers should provide a more detailed description of components to make them more inclusive.

Relatedly, we created reference cards with rule summaries to combat the possibility of Alexa giving too little information in its attempt to be concise. We noted that reference cards and their summaries are fruitful, whether they include a list of commands to navigate Alexa (in the existing Alexa skill) or refer to short versions of rules or setup instructions (in our Board Game Assistant). This contradicts what Branham et al. [10] found in their guideline analysis of commercial voice assistants. Their findings suggested that providing users with a list of commands discourages experimentation and removes their illusion of control (i.e., their perception of being in control of the system). In the context of board game playing, our participants strongly affirmed that having access to commands to the skill, especially when they are novices, can shift the burden of remembering these commands from the user to the system, reducing the cognitive load.

However, given the inaccessibility of reference cards, we recommend against having these as the primary means of providing summaries in the system. Moreover, as found effective by our participants, verbal FAQ could offer a one-stop shop to answer game-related queries so they would avoid having to navigate away from the skill and find them elsewhere.

7.2 Guideline 2: Alexa should pause

We also found that the pausing functionality in Alexa can increase autonomy in BLV participants and empower them to learn at their own pace. Presently, Amazon does not support longer pauses in Alexa. In Ticket to Ride, if players do not respond to Alexa for over a few seconds, it drops out of the game and exits itself. Players are only allowed to pause for a short time when taking turns, and music is playing in the background. We anticipate it to be an outcome of Amazon’s restrictions which do not allow for a pause or response

to be longer than 240 seconds in total due to security reasons [5]. Despite the restriction, our implementation of the pause feature demonstrated it to be an integral part of the rule learning process. Hence, we suggest that Alexa support the pause functionality, even for the said restrictive period (240 seconds), and then prompt the user to ask if they need more time.

7.3 Guideline 3: Alexa should allow for customization

Within the concept of social plays, our participants pointed out various areas that could benefit from customization, catering to their preferences as BLV players. Regarding music, Amazon [1] guides developers to choose music appropriate for the game theme and the player’s context. However, the instances where Alexa played background music to bridge the time players needed to make a move were concerning for our participants for reasons including the sound being annoying, imposing a distraction, interfering with assistive devices (hearing aid), and disrupting the social interaction. Our analysis highlights the importance of customizing the music to adhere to participants’ choices and streamlining the gameplay. All participants were excited about the option to customize the music. In addition to the option to turn it on or off, they were keen to explore the opportunity to control the volume of the music without altering the volume of Alexa itself. This feature is unsupported by Alexa at present.

While past literature has situated CAs to encourage people by providing social or emotional support [40], we found that our participants were ambivalent about committing to receiving constant high encouragement from Alexa as it might get uninteresting over time. Our data suggest that while some players react negatively to high encouragement, some consider it a crucial feature for making the game fun, especially if it is not repetitive. This aligns with Borges et al.’s [9] guidelines for audio games, where the use of interactive sounds is encouraged to create the fun factor. Hence, deploying multiple modes of encouragement (i.e., low and high) allows for adjustments to support players’ varying needs.

BLV participants’ need for rule reminders varied per individual preferences and game experience. Given our findings, the best approach would be to allow for personalization and customization. Prior research has highlighted the importance of personalization for individual needs when designing pedagogical agents. Tian et al. [42] studied students’ learning needs and created a chatbot to address those needs. They suggested that CA should periodically send motivational tips, encouraging prompts or frequent reminders depending upon the student’s needs. Even though our context was more social than individuals, our participants expected personalization and customization for rule reminders. New players might prefer to seek more reminders initially but benefit from turning them off later.

It would be important for researchers to empower BLV players with tools and techniques so that the players personalize and customize Alexa catered to their unique needs. For instance, some BLV players might not find our customization options for Alexa’s encouragement fulfilling their situation. The paradigm end-user development (EUD) proposes a truly usable interactive system is one that is easy to use and easy to be modified by the users to a certain degree [27]. The Do-It-Yourself (DIY) culture embodies the

ethos of the paradigm; people with disabilities adapt low- and high-level assistive technologies because the technologies only address generic use cases [20]. When Alexa or assistive technologies fall short of meeting the needs of BLV players, one immediate outcome is the abandonment of the device [32]. Supporting BLV players with toolkits to modify the Alexa skill for board games to a certain degree or instilling confidence in the players to reach out to the DIY communities to ask for support can mitigate user abandonment by making the skill highly customized and affordable.

7.4 Guideline 4: Alexa does not have to offer companionship

We found that Alexa should not pretend to be too humanlike or provide companionship to players. Our participants' lack of enthusiasm towards companionship in Alexa could be highly contextual. Playing board games is a social play involving their friends and colleagues, and BLV players may not need an AI agent to be their companion. However, when BLV players practice a board game independently or with friends remotely, Alexa's immediate companionship may be desirable. Although a very small number of participants enjoyed Alexa's expressions and generated ideas for it to be empathetic, have a persona, and be humorous, we believe these are not essential for rule learning. Moreover, adding customizations for these options might increase the system's complexity. Nevertheless, relating to the DIY culture, if BLV players prefer, they can exercise these characteristics within the encouragement customization module and enjoy Alexa's jokes, emotions, and expressions.

8 LIMITATIONS AND FUTURE WORK

Our study has several limitations. First, our study did not require participants to interact with the Alexa skills themselves. Instead, we used audio demonstrations to show the use of the individual characteristics. We studied the characteristics of Alexa as individual features. We did not consider the relationship between them and their collective impact on the user experience, let alone explore the impact of those characteristics in participants' natural home environment while playing a board game. Researchers who replicate our work should test our prototype by inviting BLV and sighted players and identify how our Alexa prototype can be modified to create buoyant playing and learning experiences for people of all abilities. Relatedly, our study developed the Alexa prototype tailored to one game with a medium difficulty level. It would also be essential to validate our prototype with board games of different difficulty levels and genres and pinpoint how it should be modified depending on the situation.

Second, we recruited some participants who participated in both studies—having the same participants could have influenced their thoughts and evaluation of the skill since they co-designed those characteristics from the start. For instance, even though we used a disclaimer at the beginning in Study 1 to encourage honest feedback, these participants could have felt obligated to offer only positive feedback on the modified skill (i.e., the presence of social desirability bias). However, we did not observe noticeable differences between participants who participated in the study twice versus those who participated in the study once, with both groups sharing constructive and similar feedback on the modified Alexa skill. In

the future, having a higher number of new participants for the evaluation phase (Study 2) would have avoided the possibility of biased opinions of participants.

9 CONCLUSION

We explore how Alexa can support BLV players' rule learning and how it can offer companionship to the players. We identified important characteristics in Alexa and demonstrated working examples of these characteristics in practice, evaluating them through interviews and putting forward design guidelines for future designers. Our tentative guiding principles for the design and development of Alexa for supporting BLV players in rule learning for traditional board games. These address conciseness, pausing capacity, customization, and companionship.

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