Color Game: A Collaborative Social Robotic Game for Icebreaking

Towards the Design of Robotic Ambiences as Part of Smart Building Services

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ABSTRACT

Social robots are entering our workplaces, homes, medical and educational systems in assistive and collaborative roles. In our research, we have investigated the use of a social robot *Pepper* as an interactive icebreaker host to create a positive atmosphere at events. This paper presents two user studies (total n=43) in which we evaluated two interactive prototypes of playful applications on Pepper, with the overall aim of providing a personal and entertaining service for event attendees. Data about users' experiences and attitudes were collected with semi-structured interviews, surveys, and observations. The results of the studies suggest that the majority of the participants had pleasurable and positive experiences with the robot and its applications. Moreover, their positive encounters led them to accept social robots as icebreaker hosts to connect with strangers. Based on our findings, we present a list of design implications to help the future design of social robots used to facilitate social connectedness, and to aid in the development of social robots as intelligent agents performing tasks as integrated parts of smart spaces.

CCS CONCEPTS

• **Human-centered computing** ~ User Studies • **Human centered computing** ~ Empirical studies in collaborative and social computing

KEYWORDS

Human robot interaction, social robots, smart building, user experience, social connectedness, ice breaking

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1 INTRODUCTION

Social robots are capable of following social norms with specific roles they have been assigned [1]. In customer service roles, social robots are capable of improving the service effectiveness and customer experience by providing complementary services to humans. For a robot in a customer service role, social interaction modalities including speech, gaze, gestures, and posture are important to be designed so that they can create socially interactive experiences for users [2]. With their multimodal and interactive embodiment (compared to e.g. public screens), social robots can also act as service agents that are tasked to create a specific ambience in buildings and affect the experience of the space. Social robots may be capable of enhancing the visitors' experience of a space to be more relaxing, social and personal.

In this paper, we report our research that explores social robots' potential in enriching the user experience in smart built environment. A smart building is capable of recognizing and reacting to occupants' needs such as their health, comfort, indoor air quality, and operational requirements [3]. New forms of digital technologies such as sensors and AI in the form of robotic applications can be used to provide more personalized and interactive experience of smart buildings to the occupants [4]. As stated by Norberg-Schulz [4], the atmosphere of a space is an essential element in forming people's experience of the space. Even similar spaces can be diverse based on the elements (e.g. materials, forms, lights, and structure) that define them. Hence, using new elements can have an impact on the experience of the space. According to Ahtinen et.al [5], an atmosphere created by ambient technologies and real-world objects can evoke particular user experiences.

The overall aim of this study was to investigate a novel way of promoting social connectedness among visitors in events. We assigned a social robot "Pepper" a role of an icebreaker to interact with people to create joyful user experiences for them. Research has shown that icebreaking activities can create positive

environments, relieve tension and stiffness between people and improve social collaboration and participation, which ultimately results in enhanced user experience [6]. Most icebreaking activities are pre-organized and human-facilitated to encourage people to exchange information and generate more communication between unfamiliar people [7]. Additionally, icebreaker activities mostly provide opportunities for people to take part in common activities and create an activity-based social interaction [6]. However, not everyone is comfortable with ice-breaking activities facilitated by humans. Some people are uncomfortable talking to strangers at social spaces, they might have low self-esteem, or they cannot find the right person to talk to [8]. Therefore, we hypothesized that using a new form of interactive technology in the form of a humanoid social robot might ease the process for some people. Based on our knowledge, there are no prior studies specifically focused on the topic of social robots as facilitators of connectedness between strangers. One study found that interaction with a social robot in a public place sometimes led people to have friendly encounters with others [9]. Additionally, another study used a virtual social robot to connect people together at a conference [10]. However, using a physically embodied social robot in the context of human connectedness has not been explored before.

This paper aims to answer the following research questions:

1. How can social robots facilitate social connectedness between event participants?

2. How can social robots create positive and pleasurable event experiences for event participants?

3. What are design implications concerning robots as facilitators of social connectedness at events?

2. RELATED WORK

2.1 Social robots, icebreakers and user experience

Development of *social robots* has entered an era where the goal is for people to interact with robots in their daily lives [14]. Social robots are holding roles and responsibilities in education, healthcare and retail industries mainly because of their capability to perform repetitive and easy tasks very well [15]. Recently, research has explored new fields of social robotics in which robots are given new roles and responsibilities. For instance, social robots have been utilized as social mediators for children with autism [16]. In another study, social robots were employed to connect young children who lived alone with one another [17]. Social robots have also been witnessed to have potential as facilitators of connectedness among unfamiliar people at a service point [9]. To follow this pattern, we have used a social robot with a new role of icebreaker to help people to get to know each other at events, and form positive and pleasurable user experiences for them.

Research has shown that *icebreakers* has helped people to overcome tension, social distress, and has led them to perform social skills in places where people gather to connect and socialize [18]. Icebreakers can appear in different forms. One example is a mobile game called *Who's Next*, which aims to break the ice among strangers at social events [6]. Wearable solutions are another form of icebreakers that can reveal mutual interests among strangers in close proximity and create friendly encounters among them [19]. Moreover, icebreaker can be in the form of an interactive tabletop that enables multiple unfamiliar people to interact at a conference and become familiar with each other [20]. Icebreakers can also create opportunities for people to contribute and cooperate in certain tasks such as games [6]. Socializing during games can lead to social interaction among people who do not know each other [21, 22, 23]. Thereby, we created a concept of an interactive game application on a social robot to help people to get to know each other easier.

Interaction with social robots can evoke users' emotions and feelings that can influence their entire experience [24]. In a previous study [9], researchers were able to explore the experiences which were elicited by Pepper. Pepper was used for guidance and edutainment of the visitors inside a city service point. The researchers were able to find experiences connected to basic human needs such as relatedness, stimulation, security, and autonomy. The relatedness experiences included fellowship and collaboration for the participants who engaged with the robot's quiz application together. Moreover, in some occasions the robot was capable of connecting unfamiliar people together and led them to socialize.

In another study, a customer service robot called SPENCER was used to guide transfer passengers in an airport [25]. The study aimed at evaluating the passengers' experiences related to the guidance by the robot. The results of the study showed participants were excited and happy to interact with the robot and its services, and they found it useful to guide them towards their destination. Another study conducted at a shopping mall with a Pepper robot found that social robots are capable of evoking positive experiences for both customers and retailers. The novelty of Pepper attracted many visitors to the shopping mall and this led to more sales for the retailers. The study also found that social robots are capable of developing curiosity and discovery experiences in humans because the novelty factor draws the attention of people to approach the robot. Pepper was also able to generate joyful, fun, and pleasant experiences for customers [26].

2.2 Social robots and smart buildings

Smart buildings in the context of public settings can be an area of research where social robots may be utilized as autonomous solutions. Implementing these robots for public places can be challenging since it is important to consider factors such as mood, age, personality and situations of the users in order to create a successful human-robot interaction (HRI) [2]. As a result, a list of five design goals were formulated in prior research [27], which can be used in designing humanoid robots for smart environments. The first goal is for the robot to *engage* and *stimulate user's sense of connection with the environment* e.g. by using tangible user interfaces. The second goal is *unobtrusive*, i.e. minimizing the disruptions to users' other activities. The third goal is when the robots are used to create an interface to intelligent environment; they should be *device-like*, so that the robot would appear to be more than a social agent. Fourth, robots should *respect* users who interact with them, and be sensitive to the social occasions. Finally, the authors mention that it is important for the robot to be

reassuring, trustworthy, and reliable for people so they can trust it and connect with it.

Similarly, there are certain guidelines to follow when using social robots in public areas [28]. Since some people are reluctant in their interaction with social robots, the robot should have a proactive approach and start the interaction with even short phrases such as "hello" first. Moreover, since people move a lot in public areas, the robot needs to know the *position of the human* that it wants to start the conversation with. Furthermore, the robot *needs to face* the person it communicates with and differentiate that person from others. Finally, it is important for the robot to display friendly interactions, so users feel safe while interacting with the robot.

Furthermore, social robots with roles in public settings need to be *adaptable* and *flexible* in order to have natural communication with humans. These robot needs to perform socially to provide information more effectively [9]. It is important to develop the robots' social skills, so they can bond with people easier by showing empathy and understanding towards them. With the aim of social robots as acceptable interaction partners in various roles, they need to have refined social skills. For instance, an ability to identify social context, so they can behave accordingly. In addition, they need to support a broad range of users with diverse genders, cultures, age groups, and social backgrounds [9].

3. OVERVIEW OF THE RESEARCH PROCESS

Our studies followed the human centered design (HCD) [11], and Constructive Design Research approach [12]. We applied these approaches to develop robotic concepts to address users' needs and requirements, and to form a set of design implications for using social robots as facilitators of connectedness between event visitors. By applying HCD we observed the users in the actual context and asked about their feedback on the topic of our study. Additionally, we used Constructive Design Research methodology that involves processes that lead to creating concepts such as a prototype, scenario and mockup that can be built in the future [13]. Our constructive design research involved three phases where we applied the principles of contextual inquiry [41] in the user studies.

The first phase was the User Needs Study in the context of an event. The second phase was the interaction concept development, which included the processes involved in developing a concept based on the findings of the User Needs Study. The third phase was the Interaction Concept Evaluation, in which we conducted the second user study to evaluate a prototype of the concept in an event context.

Research Platform. The robot we used in our study is a humanoid robot named Pepper developed by Softbank robotics [40]. It is the first robot capable of recognizing human emotions and faces. It is 1.2m tall, equipped with cameras, wheels, microphone and touch sensors on its arms and head. It has a tablet mounted on its chest for people to interact with it by touch in addition to displaying images and text. The reason Pepper was selected was its human-likeness, attractiveness in its appearance, and its appropriate size for interaction, its capabilities in having a conversation with people and the use of tablet that makes it possible to interact with people through other modalities [9].

4. STUDY PHASES

4.1 Phase 1: User Needs Study

4.1.1 Study design. The main goal of conducting this user study was to find out how a social robot can serve as a social facilitator, and how it can contribute to human connectedness. We implemented a simple application called "Welcoming" on Pepper to create a new way for people to interact during a two-day Transdisciplinary Workplace Research (TWR) seminar held on Tampere University campus in September 2018. The application contained the schedule of the seminar, workshops' locations and information about the keynote speakers. Figure 1 shows a seminar attendee listening to the information about the seminar provided by Pepper.

Figure 1: Pepper giving information about the seminar

Pepper was located near the registration desk to welcome the attendees to the seminar and guide them in the beginning of the event. The welcoming application was available to the users through both speech and on the tablet in auditory and visual forms, and the user input modality was through speech. The attendees could also interact with entertainment features that were pre-implemented on Pepper by Softbank Robotics such as dancing, giving hugs, high fives, and fist bumps during the break sessions.

4.1.2. Data collection and analysis. The evaluations tools utilized in this user study were questionnaire, semi-structured interviews, and observation. Before the interaction with Pepper started, the participants were asked to give their consent for the user study, and give their background information. The participants were asked to rate their overall interest by using a 7-point scale (1=totally uninterested, 7=totally interested). There were also four multiple choice questions about previous experiences of interacting with a social robot, prior experience of attending seminars, interest in meeting new people and approach of meeting people at events. The researchers observed the verbal and nonverbal interaction of attendees with Pepper and recorded their notes on free format observation forms for later analysis.

After the interaction, following previous research [32], the Robot Attitude Scale Survey (RAS) [31] was used to rate the attitude towards Pepper on an 8-point scale. To use the relevant

attitudes towards social robot, we used a modified version of RAS with 10 items including (unfriendly - friendly; useless - useful; untrustworthy - trustworthy; hard to use - easy to use; unreliable - reliable; dangerous - safe; unhelpful - helpful; boring - interesting; basic - advanced; complicated - simple). Semi-structured interviews were conducted after the interaction to learn more about the users' behavior and expectations from social robots in seminars.

To analyze the data, the content analysis method [33] was used to examine the data from the interview and observations. The notes were all transcribed and transferred to Excel sheets. After going through the notes, the main themes were formed based on the experiences and feelings of the attendees evoked by interacting with the Welcoming application and entertainment packages. Moreover, themes were created for the experience of attendees in meeting new people at events and socializing with them, and possible roles and tasks of social robots in events to break the ice and connect people.

We transcribed the observation notes and transferred them to Excel spreadsheets for further analysis. Themes were formed based on the observed experiences. Basic statistical analysis was performed to calculate the means and standard deviation for RAS and the survey questions.

4.1.3 Participants. Overall, 42 international people were observed interacting with Pepper, and 31 took part in the study. Some people refused to take part in the study, because they wanted to socialize with others without the robot, or attend the workshops. Most of the participants were female (74%) and above 36 years old (45%). The majority were doctoral researchers (41%) and senior researchers (35%) who had previous experience in attending seminars. Most of the participants (84%) did not have prior interaction experience with social robots, and the rest mentioned they had seen social robots in other conferences around the world.

4.1.4 User Needs Study Findings. The majority of the participants (70%) found social robots to be **entertaining** and **interesting** to interact with. They showed interest by approaching Pepper mostly voluntarily and started communicating with it. Those who refused to take part in the study mentioned they were either shy, or they were not certain on how to communicate with Pepper *"I am scared if I do something to break Pepper."* (F, 30-35 years).

We observed that participants were excited to see Pepper and they were happy to interact with it *"It was nice to be greeted in a totally new and unexpected way, and I was happy to talk to a robot."* (F, 30-35 years); *"I wish every seminar or any event I attended I was greeted by a robot, this was really nice."* (M, 25-30 years). This could indicate that social robots can have the potential of becoming interesting means of interaction for people, if they are used in roles as entertainer, icebreaker, or guide. We observed that in many cases people interacted with Pepper in **groups**. We could observe the honeypot effect [20] when people became curious when others were interacting with Pepper and they became interested and joined the interaction or just observed others. Pepper was the center of attention during the seminar breaks and people enjoyed interacting with it, for instance, three people started dancing while Pepper was dancing.

Many participants expressed feeling of **joy** and **curiosity** while they were listening to Pepper welcoming them to the event, or when it was entertaining people. Most of the attendees commented positively about their experiences of meeting Pepper during the two days of the seminar, *"Pepper made it [the seminar] not boring."* (F, 36+ years); "*Interacting with Pepper was the best part of the day."* (F, 36+ years); *"Seeing Pepper dance was so much fun."* (F, 36+ years). Based on the findings of the RAS survey, the overall **attitude towards Pepper was positive**. The highest rated attributes were on Dangerous-Safe (M=6.48; SD=1.36) and Unfriendly-Friendly (M=6.42; SD=1.67). The lowest ratings it got on Useless-Useful (M=5.19; SD=1.83), Complicated-Simple (M=5.19; SD=1.73) and Unreliable-Reliable (M=5.06; SD=1.76). This signified that people were mostly positive towards friendliness and safety of Pepper. These findings may suggest that people expect the future interaction with social robots to be more **friendly, safe, easy to use,** and **reliable**.

The study revealed that many people were interested to see Pepper as an **icebreaker** and guide in the beginning of the event, and this led them to be more relaxed to start the seminar or continue after the breaks, "*I enjoyed seeing Pepper first thing in the morning."* (F, 36+ years). "*I got to laugh and have small talks with couple of people about the robot [Pepper].*" (F, 36+ years). "*I asked some stranger to take a selfie of me and Pepper, and she asked the same thing from me, and we started talking after that."* (F, 25-30 years)The participants were interested in the idea of Pepper as icebreaker and entertainer at events, and they were most interested to have **joyful, fun** and **entertaining experiences** with Pepper "*The Pepper dance is so fun to watch."* (F, 36+ years), "*Pepper hugs are very cool."* (M, 30-35 years).

Additionally, it was found that **entertainment** and **fun factors** were the main reasons people approached Pepper; some participants stated that the entertainments were short and lacked variety. Some participants suggested to implement games, group dance games, joke telling applications, and challenges on Pepper to make the experience more fun and enjoyable.

Most participants did not have clear viewpoints regarding the use of social robots for connecting people at events, but they suggested that the best way was for Pepper to share their information with other people with similar interests. Some of them suggested Pepper could introduce them to other people who were at the event. Although not many participants had clear mindsets about social facilitation of Pepper, they were keen on seeing such development and they said it would help many people, as it could be a fun way to get to know others at events. Some people even gave suggestions "*The implementation should not be childish, it should be implemented in a way that adults get interested in it"* (M, 36+ years), *"The interaction has to be fast, and not slow at all"* (F, 25-30 years). *"It would have been better for Pepper to be able to talk in multiple languages, then people could connect with it easier.*" (F, 36+ years). Some people suggested that the robot needs to be intuitive to interact with and easy to use. *"The robot has to be useful in a way that if it is serving as a guide it gives you the exact response, and if it is serving as a facilitator it needs to be useful enough to connect you to the exact people you are looking for" (F, 36+ years).* This indicates that the participants were interested for the robotic applications to be accurate, useful, fast and smooth.

In terms of participants socializing and connecting with others, many participants stated they were interested to meet others at the events. However, they mostly found the process challenging which led them to communicate with familiar people only, "*it can get really crowded, and it is really hard to meet the right person."* (F, 36+ years), *"I really feel shy to approach others."* (M, 36+ years), *"I find it hard to find an interesting person to talk to."* (F, 36+ years), *"I always find myself talking to the wrong people, those who I don't have anything in common."* (F, 30-35 years). This implied

that social robots have to be designed in ways that they **reduce the awkward encounters** for strangers at events and make it possible for them to connect with those who they share similar interests with.

4.2 Phase 2: Interaction Concept Design

In this phase, we designed and implemented an interaction concept called "Color Game" for the second user study (Phase 3). The concept was based on the findings from the first user study.

4.2.1 The Color Game concept. Color Game is a two-player quiz based game facilitated by Pepper to encourage people to get to know each other and break the ice between unfamiliar people. The main social context of use is the encounter between unfamiliar people in which it can offer an alternative key for **connection** and **socialization** in an event. In practice, Color Game is a game application that players can interact with through Pepper's tablet and speech. First, players select five colors of their choice; the colors are associated with basic fun and interesting information about the players that they get to share with each other (e.g., favorite food, worst fear in life, hobbies, etc. see table 1 for the complete list). After going through the statements, players take part in a quiz, which encourages them to get to know each other and provides them an opportunity to connect. The aim is for players to connect based on mutual interests, or feeling of curiosity that was stimulated by the other person's interesting information which can lead them to talk more and get to know each other better after the game.

4.2.2 Design rationale. The main concept of Color Game is a joint activity that aims to **break the ice** between unfamiliar people. The game also aims to decrease the stress level for those who find socializing with others uncomfortable. We hoped that sharing simple fun information about oneself in a new way could attract even shy people to participate in playing the game. The game is based on the content information provided by the players instead of pre-built game story. The information is unknown to the other player and this can encourage the interest between players. The game is turn based and each player interacts with the game separately and has an active role to answer the personal information in the beginning, and later to collaborate together to answer the quiz questions and move on to the end of the game.

Color game has a short game-play which makes it easier for people at busy events to interact with it in a short amount of time and get to know others fast. Moreover, we added few elements of gamification [34] to make the experience fun and pleasant. For instance, a countdown timer was added where players are given time to state fun information about themselves, or when they have to answer the questions in the quiz. The timer was implemented to add enthusiasm and pressure to perform quicker.

We applied the concept of competition and challenge in the form of a quiz where participants are asked about each other's basic information. Players can receive points or lose points depending on the answers they give in the quiz. Additionally, their score is calculated individually so there can be a winner at the end of the quiz. Different sound effects were also implemented such as Pepper's ability to instruct the game, ask the questions, and announce the winner with music at the end of the game. Similarly, we added the element of color to the game because according to Brooks [30], colors can make the interfaces aesthetically appealing and they can elicit emotions and guide user's behavior. The color of Pepper's eyes change similar to the colors players choose for their favorite colors part of the game.

4.2.3 Detailed game procedure. The game instructions are presented to the players both by Pepper and by text on the screen (Figure 2).

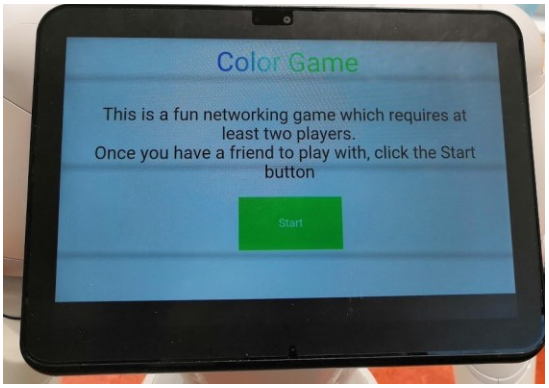

Figure 2: Color Game instructions.

Next, Pepper asks each player to input his/her name on the tablet mounted on its chest. Next, a list of ten basic personal information appears on the screen (Table 1), and Pepper instructs the first player by his or her name to complete the statements while they have only two minutes to do so and the timer starts running. In the meantime, the second player has to listen to the information stated by the first player. The idea of some of the statements are derived from earlier study [6].

Table 1: Personal Statements

Personal Statements
1. My occupation is…
2. I work at…
3. I am from…
4. My favorite food is…
5. What I enjoy most about my job is…
6. My hobby is…
7. If I win a lottery, the first thing I do is…
8. My educational background is…
9. My worst fear in life is…
10. I like to travel to…

After each person completes the list of information, ten different colors appears on the screen. Pepper instructs the players that they each need to select five colors of their choice one at a time and drag the color to the box with their name on it (Figure 3). Each color is associated with one fact initially stated by the players (Table 2).

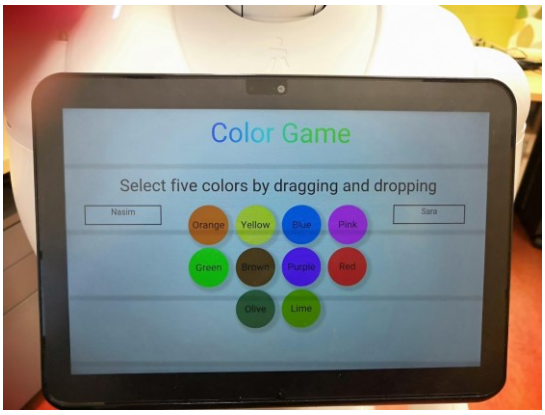

Figure 3: Dragging colors in to name boxes.

Table 2. Colors and the associated questions

Colors	Questions
Red	What was the other player's occupation?
Green	Which place the other player like to travel?
Blue	What is the other player's educational background?
White	What is the hobby of the other player?
Yellow	Where does the other player work?
Black	Where is the other player from?
Grey	What will the other player do first, it they win a lottery?
Pink	What was the favorite food of the other player?
Orange	What does the other player enjoy the most in his/her job?
Purple	What does the other player's worst fear in life?

After selecting the colors, the next level is for players to take part in a quiz where they need to answer questions about the other person's basic information. The questions are revealed one at a time on the screen for each player to answer (Figure 4). If the player answers correctly, the other player selects the correct button, and vice versa. In the final phase of the game, Pepper announces the winner and the number of points they received by each player.

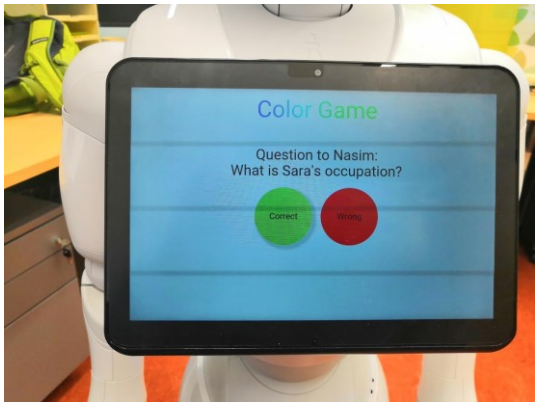

Figure 4: Color Game Quiz.

4.3 Phase 3: Interaction Concept Evaluation

A user study was conducted to test the concept of the Color Game with real users in an event context, using the prototype application implemented on Pepper.

4.3.1 Study design. The user study was conducted at an event for the duration of five hours. The event participants could interact with Pepper and the Color Game in the beginning of the event, during breaks, and at the end of the event. The participants were invited to interact with the game with a person they were not familiar with, or they had very little knowledge. The goal of the study, and the basic introduction about the game was explained to them and then they were greeted by Pepper to give them the instructions of the game.

4.3.2 Data collection and analysis. We used similar data collection methods as in the User Needs Study. The only difference was that we used the User Experience Questionnaire Short version (UEQ-S) [29] with a 7-point scale to measure the hedonic and pragmatic experiences of the participants from the ice-breaking game. UEQ-S has eight attributes: (obstructive-supportive), (complicated-easy), (inefficient-efficient), (confusing-clear), (boring-exciting), (not interesting-interesting), (conventional-inventive), (usual-leading edge).

The participants were observed through their whole interaction with Pepper and the Color Game. The observations were focused on curiosity of people in approaching Pepper and interacting with it, the honey pot effect around Pepper, participants' feelings and experiences throughout the interaction and the connections that happened after the interaction was over.

The data was analyzed similar to the previous user study using Content analysis method. Through the content analysis, we identified 18 themes for the observation notes and interview data, the information about the themes are reported in the results section. Basic statistical analysis was performed for analyzing the data from UEQ-S, RAS and the surveys.

4.3.3 Participants. Overall, 12 participants took part in the user study. The participants were "*familiar strangers*" [39] meaning that they were familiar by being part of the same place, and they knew some of the faces, but some of them were not all familiar with each other. Most of the participants (9) were males. Eight participants were above the age of 36 years old and they were mostly senior researchers. Most participants (7) did not have initial experience in interaction with social robots. More than half of the participants (11) had prior seminar attendance experience, and they were keen on meeting new people at events. However, seven participants mentioned they only talk to familiar people, and do not connect with unfamiliar people.

4.3.4 Evaluation Findings. This section presents the results of the Color Game user study conducted in an event in built environment.

Feeling about the Color Game as an icebreaker game. Nine participants stated they enjoyed their interaction with the game and found it to be **fun** and **entertaining**. Moreover, they mentioned the game was fast, pleasant and made them curious about its purpose so they continued to play it until the end. "*I kept thinking about what is coming next after the statements"* (M, 36+ years), "*I played because I got interested to see why everyone was introducing themselves in front of a robot.*" (M, 36+ years). The remaining participants stated the game was a nice way to interact with a robot, and did not mention any specific details on how to make their

experiences to be more positive. In few occasions, we observed people avoiding interaction with Pepper because they mentioned they were either shy, or petered to interact in their own language.

Social robots connecting people at events. The majority of the participants (10) found social robots to be **helpful in connecting people** at events by sharing similar interests, and by performing **collaborative tasks** together on a robotic application "*I believe doing everything collaborative will make people eventually talk, because collaboration and teamwork make people connect.*" (F, 36+ years). Similarly, participants suggested that playing games and sharing their contact information with the help of a social robot platform can be helpful in connecting with others.

Color Game as a helpful icebreaker. Most participants (9) believed Color Game was **helpful in breaking the ice**, and it made them to know something fun about the other player. The rest of the participants mentioned the game made them to share small fun information about themselves with those who they were familiar with from before "*this game has potential, I wouldn't mind playing it with strangers, the statements are fun.*" (M, 36+ years). The participants were observed to share smiles and shared friendly jokes throughout their interaction with each other. In one occasion, one player was surprised to find out the other player was interested to travel to the same country, so he suggested that they could travel together. Some observers were interested to get to know the players playing the game, and in one occasion, the observer asked the players to speak louder so he could hear the answers and get to know the player better.

Role of social robots as icebreakers at events. The participants mostly stated that playing games with the help of social robots can make them to **communicate** and **interact** better: "*Playing games is a fun and entertaining way to get to know someone and you are less pressured to ask the person stupid questions, but you can get to know him easier by just playing the game.*" (M, 25-30 years). The participants suggested social robots could be entertainers or guides to break the ice at events. This can indicate that the role of the robot can change based on the context. For instance, when Pepper is instructing the Color Game application, it can be an icebreaker, and when it is giving information to people it can be a guide.

Curiosity and interest towards Pepper. We observed that many people were interested in Pepper, and in some occasions, they approached the researchers to ask the purpose of the study. People showed their curiosity by touching the arms, head and fingers of Pepper, and they asked questions about its functionality. The honey pot effect was once again evident during the user study. Some people stopped to observe the interaction, some made funny comments with their friends while watching Pepper and other shared a laugh or smile while watching others talking with Pepper.

User experiences from interaction with Color Game. Mean evaluation of both pragmatic and hedonic attributes in UEQ-S showed that the majority of participants had **positive user experiences** from the game. Table 3 shows that pragmatic attributes received a higher rating than hedonic in our study, although the difference was small. For measuring user experience of products, UEQ-S lies between the scale of -3 (extremely bad) and +3 (extremely good).

Table 3. UEQ-S Values

Scale	Mean	Comparison to benchmark	Interpretation
Pragmatic Quality	1,5	Good	10% of results better, 75% of results worse
Hedonic Quality	1,3	Above Average	25% better, 50% of results worse
Overall	1,6	Good	10% of results better, 75% of results worse

Schrepp [29], implemented a benchmark for UEQ-S which was formed from a large sample of UEQ evaluation results from industry and science projects. Table 4 and figure 5 show the results of our user study based on this benchmark.

Table 4. Color Game against UEQ-S benchmark

Mean	Std. Dev.	Negative	Positive	Scale
1,2	1,3	obstructive	supportive	Pragmatic Quality
2,1	0,8	complicated	easy	Pragmatic Quality
1,4	1,3	inefficient	efficient	Pragmatic Quality
1,5	1,4	confusing	clear	Pragmatic Quality
2,0	1,3	boring	exciting	Hedonic Quality
0,4	1,1	not interesting	interesting	Hedonic Quality
1,4	1,6	conventional	inventive	Hedonic Quality
1,3	1,6	usual	leading edge	Hedonic Quality

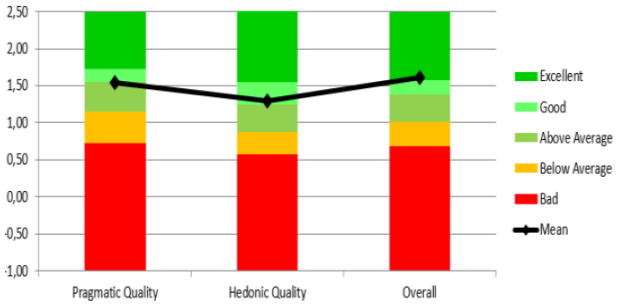

Figure 5: Color Game result against UEQ-S benchmark

Comparing the overall mean of the hedonic and pragmatic attributes with the benchmark shows that the overall mean is located in the Good and Above Average categories of the benchmark. This indicates that the participants had a positive experience from Color Game.

Attitude towards Pepper. By analyzing RAS survey, we found out the participants had positive attitude towards Pepper in general. The highest rated attributes were Complicated-Simple (M=6.6; SD=1.32) Unfriendly-Friendly (M=6.5; SD=1.04), and Dangerous and safety (M=6.3; SD=1.96). The lowest rated attributes were Untrustworthy-Trustworthy (M=4.8; SD=1.72), and Basic-Advanced (M=4.8; SD=1.57).

4.3.5 Overall attitude towards Pepper. Comparing the RAS scores of the Color Game evaluation to the initial User Needs Study showed that the scores were on a similar level (Figure 6) indicating that people had positive experience in meeting the robot and interacting its applications. Slightly higher scores were given for reliability and simplicity in the Color Game evaluation.

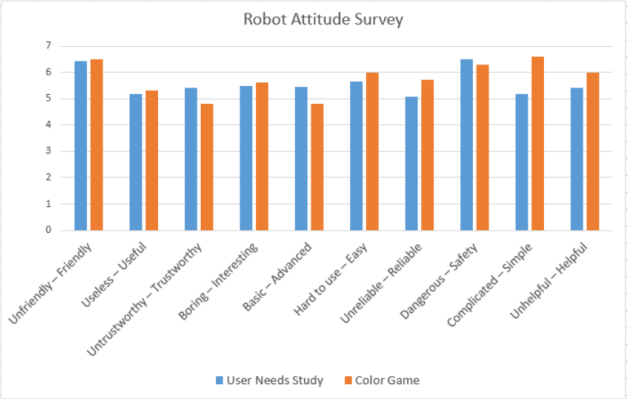

Figure 6: RAS comparison for the two user studies.

5. DISCUSSION

In general, we found that Pepper as the host of the event was capable of creating joyful and pleasurable experiences for the event attendees. Color Game created an atmosphere in which participants were more relaxed to socialize and get to know each other through a collaborative activity. This indicates that a social robot with the role of an icebreaker designed to evoke experiences of joy, fun and entertainment can affect the overall ambience of an environment and the overall experience of visitors of such a building. The robotic host of an intelligent building can thus provide the visitors with activities such as games and competitions that address both pragmatic and hedonic needs.

5.1 Experiences with Pepper as an icebreaker

Color Game as an icebreaker interaction concept. Our findings support the notion that social robots can serve as **facilitators of connectedness** at events as well as **icebreakers**. However, similar to previous studies [35], there were people who found socializing with strangers uncomfortable, which led us to create the interactive Color Game concept to make the process easier. Parallel to previous research [6], we found that playing collaborative ice breaking game could create a **source of interaction** even between two people playing the game. Color Game was able to break the ice between the players and it created a **friendly atmosphere** for participants to socialize and connect. As we expected, our findings were in line with a previous study [36], as we also discovered that **elements of fun and joy** made the event experience positive, relaxed, and comfortable for users. Elements of rewards and challenge made the game fun for users, as they became more engaged in the game that led them to have positive experiences.

Pepper as an acceptable icebreaker. Participants were interested in Pepper and they interacted with it with joy and **pleasure**. Pepper's gestures, movements and eye contact were appealing to most users and encouraged them to take the initiative to approach Pepper. We expect this to be due to the human-likeness and attractiveness of Pepper's appearance. As previous studies have found [9,37], robots with human-like **appearance** and **embodiment** can be attractive to people and will lead them to adapt and accept the robot better and have positive experiences during their interaction. However, in few occasions, we faced people who were hesitant to approach Pepper and interact with it. Some of them thought the human-likeness was scary and it made them afraid of the robot. We believe that enjoyment and pleasure during interaction with the robot has direct impact on the attitude of the users. Similarly, **level of joy, fun and interest** affect people's acceptance of social robots. We noticed that the more enjoyment participants encountered, the higher their perception and acceptance were towards social robots.

Physical and interactive qualities of Pepper. Compared to a display, the physical shape of the robot, its **behavior** and its **anthropomorphism** can make the robot unique and novel for people to approach. Moreover, the social interaction with a social robot have greater impact on the quality of the interaction. Physical embodiment of a robot can add to the level of enjoyment during interaction. Thus, a robot can be more engaging, informative, enjoyable and credible than a display [42].

Pepper and positive user experiences. Similar to previous study [38], we found that pragmatic qualities such as usefulness and easy interaction with the robot led to higher satisfaction and better experiences. Pepper's appearance, gestures, and Color Game features affected the hedonic experiences of participants. We found that both hedonic (enjoyment, sociability) and pragmatic qualities (usefulness, ease of use) are both equally important in HRI and they both affect the experiences of users in their interaction with the robot. Moreover, we believe the simplicity of the interaction concept was one of the factors that kept the users interested in the interaction with the robot.

5.2 Roles for social robots in smart buildings

Based on our findings, we envision that in the future it is possible for social robots to be utilized in the design of space ambiences in smart buildings [5]. The ambience of the smart space can adjust to different situations and to users' needs by using artificial intelligence and social robotics. Social robots could be **mediators of the space experience**, and act as **interactive hosts** of the space. As we witnessed in our study, and parallel to previous studies [9], social robots are capable of evoking positive, playful and social experiences for people.

The future smart buildings can be configured to have different modes, and a social robot can act accordingly by performing different roles. Similar to our study, in an event mode a robot can serve as a facilitator of social connectivity and utilize an application similar to the Color Game to draw people together and make socializing easier. On the other hand, the robot itself can be an entertainer or a guide in the space without using the Color Game application. Therefore, the robotic application can change the role of the robot to something other than its original affordance for interaction.

There are two possible scenarios for social robots to enhance the ambience experience of the smart building services. One possible scenario for intelligent social agents inside smart buildings is to enhance the **social ambience experience**. The robot can welcome everyone to the building and guide the visitors around. The robot can introduce people with each other and share their contact information with others who they are interested to connect with. The main social context of use is the encounter between

unacquainted people for whom the robot can offer an alternative way for connection and socialization.

Another possible scenario is for the intelligent social robot to create a **relaxed ambience experience** for the visitors of a building. The robot can interact with the users and invite them to try out some of the playful and fun applications implemented on the robot. These applications can be facilitated by the robot to make the interaction more appealing to people and reduce tension and stress level of visiting a new environment.

5.2 Design implications for use of social robots as acceptable facilitators of social connectedness

Based on our knowledge, currently there are not any design implications that can help designers, and developers to implement concepts for social robotics in the role of icebreaker and social facilitator of connectedness. Thus, we have formed a list of five important factors, which are based on the findings of our user studies. This list can contribute to the field of HRI and help to design and improve contents for social robotics' applications that aim to facilitate socialization among people. Moreover, following the list's suggestions can help save time, money, and resources in the future implementation.

1. Include entertaining features. Robots with entertainer roles, features, and applications will attract more attention and attract more people to interact with them. This may be because entertaining elements make the robot less threatening to people to approach the robot.

2. Design simplistic. During our Color Game user study, one factor that we got a lot of feedback on was the simplicity of the game. People enjoyed the simple and straightforward interaction. Simplicity of the applications may keep a person more engaged to complete a task on a robot. Complicated tasks can lead to cognitive load in users, and they may lose interest to continue their interaction.

3. Design multilingual applications. It is important to consider all user groups the robotic application is designed for. Although it is impossible to implement all languages in a concept, it is beneficial to identify the most commonly spoken languages of the target user groups and implement some of them in the design. This can be considered as a positively surprising factor for the users, and prevents disappointment that could lead to avoiding interaction with the robot.

4. Apply icebreaking elements. Social robots can break the ice between people through the activities they provide and facilitate. Thus, for robots used for this purpose, it is helpful to implement the robotic concepts that eases the process for people and make people comfortable. For example, it is beneficial to offer users topics of conversation, games and matchmaking functions.

5. Include collaborative attributes. In our studies, we witnessed people dancing, interacting, taking selfies and playing in groups with the robot. Therefore, the activities done with a social robot that aims to facilitate social connectedness should be designed so that they allow people to collaborate and cooperate during their interaction with the robot.

5.3 Limitations and challenges

During our studies, we faced several challenges. There were some technical limitations with Pepper, which made it sometimes hard to interact with during the user studies. The speech recognition was challenging in noisy and crowded situations. This made it hard for Pepper to distinguish the person interacting with it and it led to dissatisfaction from some users. Additionally, some people did not understand what Pepper said because the pace of the speech was fast for them. Moreover, the brightness of the tablet was set on low by default and it was hard for some people to read the instructions comfortably. The human-like features of the robot made it difficult for some people to approach and interact with it.

Moreover, due to lack of resources, we tested our concepts only at two events, which makes it challenging to be convinced about the accuracy of the findings. Moreover, the findings of our study may not be generalizable as the sample size was still relatively small. In addition, the novelty effect of a robot may have influenced our findings, and we did not explore the long-term experience of the concepts. In general, people show interest when they are introduced to a novel service and product, and the novelty factor fades away after they lose interest. Therefore, it is important to upgrade the applications so the robot stays appealing to people. Including more observational research method such as longitudinal studies can help to gather more data on the effects of social robots over the period of time in various contexts. Additionally, HCD approach requires iteration and re-design of the concepts, which was not possible due to lack of resources. Hence, we were not able to iterate and explore alternative concepts in addition to the Color Game.

6. CONCLUSION

Findings of this study indicate that it is possible for social robots to be used as facilitators of social connectedness and serve as icebreakers in events. Moreover, it may be possible for social robots to create pleasurable and positive ambience experiences for people in smart building environments. In order to introduce social robots in humans' lives, it is necessary to design robots that make people interested and attentive throughout their interaction. We have proposed a list of design implications that can be helpful in designing social robots in the context of social connectedness. The list can be helpful to the field of HRI for future development. The design implications include implementing entertaining features in robotic applications, simplistic design, collaborative features, icebreaking features, and designing applications to be multilingual. As devices are becoming smart nowadays, our living environment is also becoming smart. Therefore, social robots can become a part of our smart living environment and provide us with more social, entertaining, and pleasurable experiences. Social robots are now being used in various industries, and using them in a smart environment can be the start of a new and exceptional future for this industry. We expect this research can serve as a starting ground work for our future studies of social robots as interactive hosts of intelligent buildings.

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