Social presence and artificial opponents

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Abstract In this paper, we argue that playing board games is a form of entertainment that provides participant's with rich social interactions. However, when we try to replace one of the players with an artificial opponent, the social interaction between players is negatively affected by the social inability of nowadays artificial opponents. Currently, the social presence that human players attribute to artificial opponents is quite low. In order to tackle this problem, we investigate the topic of social presence, its definitions and which are its contributing factors. Also, we looked at nowadays social interactions with artificial agents and how these kind of agents deal with long term interactions. This related work along with some previous studies contributed to the development of a set of five guidelines intended for improving social presence in board game artificial opponents. Finally, in order to illustrate how one can implement such guidelines, we give an example of how we implemented them in a scenario where a digital table is used as an interface for a board game and a social robot plays Risk against three human opponents.

1 Introduction

Board games have always been associated with rich social environments. Playing board games is generally a social event where family and friends get together around a table and engage in face-to-face interactions, reading each others gestures and facial expressions. Examples of such rich social interactions can be identified when

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we look at more recent examples of board games. Players laugh with each other when someone makes an ugly drawing playing Pictionary, yell at each other when someone makes a bad deal at Monopoly, use their facial expressions to bluff while playing Poker, or can even mock somebody who does not know the answer to a simple Trivial Pursuit question.

However, the static nature of tabletop games can limit the scope of realisable games [42] when compared to console or PC games. An area named computer augmented tabletop games [43], tries to maintain the social aspects of these traditional board games and augment them with computerized benefits. Computer augmented tabletop games gives us the best of two worlds: the interaction and communication between the players, who sit around the same table, facing each other at an intimate distance, and the computing support that can enhance games with visual and audio effects or relieve players from tasks such as score keeping. One of the benefits from this hybrid form of interaction is the possibility of creating artificial opponents. However, opponents in such novel environments are still scarce and generally don't have any kind of embodiment or believable social behaviour. The social inability of current artificial opponents results in humans perceiving them as not socially present.

This paper addresses the possibility of using todays technology to maintain users perceived social presence towards an artificial opponent steadier over longer periods of time. In order to do so, we start by reviewing some literature on social presence and performing some initial studies. Then, we establish guidelines for creating socially present board game opponents and following these guidelines, we have developed a scenario where an artificial opponent plays Risk against three human players. These guidelines and the reported scenario presented in this paper provide useful information on how to develop the next generation of board game opponents that aim to be socially present.

2 Related Work

Humans consider many media devices as social beings [52]. Social agents or artificial opponents can be examined as one instance of this effect. In this section, we start by analysing the concept that measures the extent in which such effect occurs, the concept of Social Presence. Following, as research in artificial opponents is still very scarce in terms of social behaviour, in order to tackle the social deficits of existing artificial opponents, we will look at research in socially intelligent and embodied agents.

2.1 Social Presence

In 1950, the “Turing Test” [63] launched the debate on the potential that modern computers have to mimic humans. Later in 1996, Reeves & Nass [52] demonstrated that computer interfaces can generate strong and automatic social responses from minimal social cues, and that most of the times these responses occur with the user being quite aware that he is facing a machine and not a social being. This phenomenon seems to exist even with today’s less sophisticated computers, but it appears stronger when computers use natural language, interact in real time, have an embodiment, or exhibit a believable social behaviour.

People treat media entities in social manners, while knowing that these entities do not have real emotions, ideas or bodies. They could ignore these entities as they are not real, but they do not because they attribute social presence to them. Studying social presence can contribute to the understanding of human social behaviour while using these types of technologies and achieving a sense of social presence is the design goal of many types of hardware and software engineering. Social presence theory can allow researchers and designers to guide their design and to anticipate and measure differences on new types of social technology. Instead of using trial and error exploration, a better understanding of what social presence is and how we can improve it can save valuable time and money and improve the end-product in the design of new media technologies [41].

Many studies regarding social presence are found in new forms of human-human communication such as computer conferencing [56]. But social presence is also used to measure individual’s perception of a particular interactive media, be it a virtual reality environment [28, 61] or the interaction with a social robot [59].

In the rest of this subsection we will look at definitions of social presence and what are its contributing factors.

2.1.1 Definitions

The term “presence“ originally refers to two different phenomena [67, 10, 27], telepresence and social presence.

Telepresence can be defined “as the sense of being there”, and social presence, “the sense of being together with another”. Telepresence is a reoccurring concept in the area of teleoperator systems and was introduced by Minsky in 1980 [44]. Initially, Minsky described it as the sense of being at the location of a remote robot that the user is operating. This concept is also often used for the feeling of “being there” in virtual environments [67, 11].

The other phenomenon, social presence, was initially proposed by Short Williams and Christie [60] as “the degree of salience of the other person in the interaction and the consequent salience of the interpersonal relationships”. More recently, Biocca argued that since we are social beings the most common purpose of physical presence is to increase the sense of social presence [10]. Biocca [9] proposes a definition of social presence that is more oriented to human-computer interaction: “the amount of social presence is the degree to which a user feels access to the intelligence, intentions, and sensory impressions of another".

A distinct definition by Lombard and Ditton [41] defines presence as the perceptual illusion of non-mediation. The term perceptual is used to indicate that the feeling of presence towards an object or an entity, involves continuous real time responses from the humans sensory, cognitive and affective processing systems. Non-mediation is mentioned to indicate when the user fails to perceive the existence of a medium, or when the user reacts as if the medium is not in their environment.

Recently, in the field of virtual environments, more specifically cave like environments [18], Slater defined two distinct concepts [61] that are analogous to the concept of social presence: Place illusion and Plausability illusion. The first is about how the world is perceived and the latter about what is perceived.

Place illusion relates to the concept of Telepresence. It is defined as the feeling of being in the place depicted by the virtual environment, even though the user knows he is not there. Slater argues that place illusion cannot occur in computer games when they are played using desktop systems. However, he argues that in principle it is possible to simulate place illusion by playing a computer game inside an immersive or pervasive system.

Plausability illusion relates to the illusion that what is happening is really happening, even though the user knows it is not. It is also described as the extent in which the system can produce events that relate to the participant, and to the credibility of the scenario being depicted in comparison with user's expectations. In order to achieve Plausability illusion, credible scenarios with very little room for error and with plausible interactions between participants and entities in the environment are required. In our case, the focus is in modelling socially believable artificial opponents for board games, where the virtual environment is mainly comprised by a virtual opponent. Here, plausability illusion directly relates to definitions of social presence whereas seen above, can be shortly described as "the sense of being together with another". Slater also argues [61], that plausability illusion (social presence, in our case) is a more fruitful and challenging research area than place illusion or telepresence.

2.1.2 Contributing Factors to Social Presence

Social presence can be used to measure the individual's perception of a particular interactive media, be it a virtual reality environment [28, 61] or the interaction with a social robot [59]. Properties of the medium or the agent, context of interaction and individual differences will change the way we experience social presence, this presence can be superficial or strong enough to elicit powerful emotional reactions, such as crying at a movie screening or smiling at a computer character. In the remaining of this subsection we gather the factors that influence the perception of social presence in artificial opponents. We divided these factors into three distinct dimensions. Factors presented on the first dimension are related to the method of interaction. The second dimension focuses on users' individual differences. And the last dimension centers on factors that affect the believability of the artificial opponent.

Interactivity

Interactivity is referred by most authors as the primary cause of presence. If users cannot interact with an artificial agent, they usually do not consider it as a social entity. There are different modes of interacting with a virtual agent, but in terms of social presence, face-to-face interaction is still considered the gold standard in communication, against which all platforms are compared [1]. Social presence is assumed to be highest when two people are within reach of each other interacting on a task [11]. As such, virtual agents that do not use the rich set of social behaviours and cues involved in face-to-face interaction are assumed to support less social presence. One reason why face-to-face interaction is preferred is that a lot of familiar information is encoded in the non-verbal cues that are being exchanged.

Face-to-face interaction is generally accompanied with verbal communication. Machines are still quite limited in understanding the human counterpart in this respect, both in terms of speech recognition and dialogue systems. However, there are already some successful cases of virtual agents that are able to verbally interact with humans in very contextualized scenarios [2]. The output of such systems is generally implemented by using pre-recorded utterances or by text-to-speech systems. Voices with higher audio realism and fidelity increase the illusion of interaction with a social entity [41]. High quality text to speech systems are widely available nowadays but using them with emotional capabilities has not evolved greatly since 2005 [64]. Voice is a potent social cue, it can even evoke perceptions that a machine has multiple distinct entities [45] or even personalities [21] so it is an highly important factor for the perception of social presence.

Interactions should also feel natural and quick. Systems should have quick feedback, for the user to feel immediacy of control, as delays between actions and reactions can diminish the sense of presence [41]. In robots or on-screen characters, having a responsive real time gaze system can alone produce a high sense of agency and increase the agent's perceived social presence [69].

In Table 1, a summary of the interactivity factors that we consider most relevant for improving social presence in board game artificial opponents, is presented.

Table 1 Factors relevant for achieving social presence in terms of interactivity

Interactivity
Face-to-face interaction
Verbal communication
Quick Feedback

Individual Differences

Different age groups can sometimes experience social presence with different intensities. Children may more easily perceive a machine as alive, as they have less difficulty in attributing human characteristics to virtual agents or robots [7]. Older people may be influenced by other factors, such as the need to overcome loneliness. Heerink et al. [27] assessed that loneliness directly influences social presence and the acceptance of a companion robot by older people.

The observer's ability to focus on the virtual environment and ignore distractions (selective attention) also increases presence [67]. When users focus more attention on a stimuli, they become more involved in their experience, which leads to an increased sense of presence. Conversely, personal problems or outside tasks can hinder the users' potential to feel presence. Users that are worried with personal problems or focused on outside activities will most probably attribute less attention to the task in hand.

When we are interacting with media applications we often feel emotionally connected to an event or a character. When the connection is strong enough the character can trigger emotional expressions from the human side. The intensity and valence of experienced emotions such as fear or strong empathy seem likely to affect presence [41]. Moods are also reported to change how we percept digital entities, if we are feeling sad or disturbed we may give less attention to digital media compared to when we are in a more relaxed state.

User's personality type is also an important factor for experiencing social presence. One experiment by Lee [37] shows that when users' personality matches a synthesized computer voice personality it positively affects user's feelings of social presence.

Knowledge and prior experience with the medium likewise influence the sense of social presence. Social presence varies across individuals and across time for the same individual. When we have been exposed for a long time to media artefacts we have a higher knowledge of interacting with it, and it is possible to have an increased feeling of social presence. However, most times continued experiences causes the well-known habituation or novelty effect [34], this effect causes an initially higher sense of presence that fades away as users become more experienced with novel technology. This novelty effect is present in almost all types of media, including artificial agents or robots [26].

In Table 2 we list the factors that influence social presence in terms of individual differences.

Table 2 Factors relevant for achieving social presence in terms of individual differences

Individual differences
Age and gender
Selective attention
Emotional State
Personality
Knowledge and prior experience

Believability

When we are watching a dramatic film, playing a video game or interacting with a virtual character, if the story or persona being presented to us makes sense and is consistent with the experience the story, or character is more likely to ring true for its users. Below, some factors that influence the believability of artificial opponents are described (also summarised in Table 3).

The ability to attribute mental states to oneself and to others is fundamental to human cognition and social behaviour [62]. Biocca [11], quoted the importance that theory of mind has in social presence. He defines social presence as the sense of "being together with another" and attributes this sense to the ability to relate to, or to construct mental models of another's intelligence. If we can interact with an agent and create a mental model of its behaviour it will helps us to anticipate the agent's behaviour and to judge its consistency.

The number and quality of the sensory channels are important for generating a sense of presence, but the consistency between all of the different modalities is one of the most important keys for achieving social presence: "the information received through all channels should describe the same objective world" [41]. If we do not meet this criterion, we emphasize the artificial and lessen the feeling of social presence. Correlations between actions and reactions should be credible when compared to events that would be expected in reality in similar circumstances.

Slater [61], refers that another important factor for presence is the existence of some events not directly related to the users' actions, showing some autonomy in the environment or character. In a cave like environment [25] participants spent approximately five minutes in a virtual bar interacting with five virtual characters. Participants reported to automatically respond to the virtual characters present in the bar in social ways. They attempted to engage virtual characters by saying "hello", and by waving at them. These virtual characters had limited social behaviour. However, mutual gaze combined with lucky randomness was perceived by participant's as the characters were watching and imitating them.

Embodiment is also important for designing a computer that aims at achieving a higher sense of social presence. In [32], participants felt a significantly stronger sense of social presence when they were interacting with a physically embodied Aibo robot than with a physically disembodied Aibo displayed on an LCD screen.

Research indicates that humans and computers can work together more effectively [59] if human-like cues extracted from usual social behaviour are employed. We use our emotions in our social world almost constantly. We use them for communication, signalling and for social co-ordination. This kind of natural social primitives can be interpreted by humans without the need to learn something new. As so, a human-like computer can cause social facilitation in users and endowing agents with emotional behaviour can contribute to the believability of a character and thus to the perceived social presence.

Table 3 Factors relevant for achieving social presence in terms of believability

Believability
Theory of mind
Consistency
Autonomy
Embodiment
Social and emotional behavior

2.2 Social Relationships with Intelligent Agents

Humans can build social relationships with a large variety of entities. In some cases, interaction with pets complements or even substitutes interpersonal relationships [66]. The same phenomenon is beginning to happen with digital entities. Social relationships can now be established with new forms of artificially intelligent beings, such as a simple desktop or laptop [52], virtual agents [16] and robots [14, 12, 32]. In this subsection we will look at some research examples where embodied agents, being it screen characters or social robots, are designed with some kind of social behaviour.

The term "socially interactive robots" has been used by Fong et al. [24] to describe robots for which social interaction plays a key role. These robots are important in application domains where social skills are required. These domains include those where the ability to cooperate with humans by helping them to fulfil a task [15] is important, or domains where the primary function of the robot is to socially interact with people such as companion robots [20] or robots for learning or education [4].

Breazeal argued [12] that it is still very difficult to develop a robot that behaves in a naturalistic manner similar to an adult. As such, and to take advantage of human social expectations, she created Kismet, a robot that behaves and is successfully perceived as an infant even by adults.

Leonardo [14] is another robot specifically designed for social interaction by means of facial expressions and life-like body poses. A social game that uses this robot along with speech and gesture recognition, was created. The objectives of the game were to teach the robot names and locations of different buttons placed in front of it, and then check to see if it knew the names by asking him to push the buttons again. Leonardo is constantly shifting its gaze between the object and the human to direct the human's attention to what it needs help with. The authors claim that these kinds of behaviour ensure that Leonardo acts as expected by a socially-aware play partner.

A social robot developed by Phillips Research, the iCat robot [65], can communicate information through multicolour LEDs in its feet and ears, can use natural language synthesis through its speakers, and is also capable of mechanically rendering facial expressions and give emotional feedback to the user. The iCat can be considered a social robot since it has many of the characteristics needed to simulate human-to-human interaction. This robot has been used to study the influence of many social aspects such as personality [13], emotional exchange [38] and social acceptance by older people [27].

Within 3D and virtual reality communities a large number of works also studies the incorporation of socially intelligent virtual characters into virtual and augmented reality environments [29]. However, like most studies conducted on social robots, they are mainly focused on interactions of a single user with a single character. Autonomous characters or robots generally lack the necessary social skills to interact in a group. One example that tackles this challenge is a multi-agent collaborative game called Perfect Circle [51] where the user controls a character that can interact with four other autonomous agents. The group formed by the player and the autonomous agents must search a virtual world for a magical item that enables them to complete the game. The autonomous agents are endowed with social skills that allow them to interact in groups with human members. In this game, the autonomous characters exhibit behaviours that depended and are in agreement with the group's composition, context and structure. To win in this simulation, players have to be aware of the social relations with the autonomous characters. Results in this study showed that the model had positive effects on users' social engagement, namely, on their trust and identification with the group.

These examples are somewhat successful in socially engaging users in short term interactions. Socially engaging users in long term interactions is a much more challenging task that is beginning to be researched in human-agent interaction.

2.2.1 Long Term Interactions

One of the first long-term experiments with social robots was performed using a service robot named CERO [30]. This robot assisted motion impaired people in an office environment. After participants fully integrated the robot into their work routine, researchers concluded that when robots interact with real people, they need to be aware of the shared social environment and be capable of social interaction.

Another long-term experiment was performed by Kanda et al. [33]. The study describes a field trial evaluation for two weeks with elementary school Japanese students and two English-speaking interactive humanoid robots behaving as peer English tutors for children. The study revealed that the robot failed to keep most of the children's interest after the first week, mostly because the first impact created unreasonably high expectations in the children.

A longer study was carried out at Carnegie Mellon University using Valerie, a "roboceptionist" [26]. Students and university visitors interacted with the robot over a nine month period. The results indicated that many visitors continued to interact daily with the robot, but over a certain period of time only few of them interacted for more than 30 seconds.

Some of the studies on long-term human-computer relationships are grounded on human social psychology theories, such as the work of Bickmore and Picard [8]. They developed a social agent and evaluated it in a controlled experiment with approximately 100 users who were asked to interact daily with an exercise system.

After four weeks of interaction, the social behaviours increased the participant's perceptions of the quality of the working alliance (on measures such as liking, trust and respect), when comparing the results with an agent without social behaviours. Besides, participants interacting with the social agent expressed significantly higher desire to continue interacting with the system.

So how do we design for long-term interaction? To develop artificial agents that are capable of building long-term social relationships with users, we need to model the complex social dynamics present in human behaviour [40]. For users to remain engaged for months, or years, social agents need to be capable of long-term adaptiveness, associations, and memory [24]. Also, if the interaction with a social agent is enjoyable throughout long periods of time, users may eventually spend more time interacting with them. This is an important step for designing artificial companions or, in our case, opponents that are capable of engaging users in the long term.

3 Towards Socially Present Board Game Opponents

Current artificial opponents lack social presence and when human players perceive artificial opponents as not socially present, their enjoyment while interacting with them decreases. Johansson [31] stated that "bots are blind and objective, while humans may decide to eliminate the bots first, just because they are bots". This sentence shows that, over repeated interactions, humans attribute very low sense of social presence to artificial opponents. To struggle this kind of degradation in interaction, in this section, we present five guidelines for designing more socially present board game opponents.

In this section, we will argue that to improve social presence an artificial board game opponent should:

1. *Be physically embodied and engage users in face-to-face interactions*
2. *Exhibit believable verbal and non-verbal behaviour*
3. *Comprise an emotion system*
4. *Have social memory*
5. *Simulate social roles common in board games*

3.1 Physical embodiment and face-to-face interaction

When playing board games against digital opponents the social possibilities are restricted. When someone plays against a human opponent, he/she can try to look for a hesitation or an expressed emotion that could indicate a bad move. In contrast when playing against a computer, in most cases, we can only see pieces moving on a graphical interface. Nevertheless, as we have seen in our related work we can already encounter some embodied artificial opponents. Artificial opponents are in most part represented by simple avatars (static pictures) or by two or three dimensional animated virtual agents. It has been reported in virtual poker environments that the simple addition of a picture to personify players can be considered as more likeable, engaging and comfortable [35]. We can also find examples where physically embodied agents (or robots) are used to simulate opponents. In our previous work, we have showed that by using a robotic embodiment, artificial opponents are reported to have an improved feedback, immersion and social interaction [48].

Facial features might be the most important factor to embody in most tabletop game opponents. Users are not distracted by the presence of a face or facial expressions. Instead, they are more engaged in the task because they can try to interpret faces and facial expressions. The embodied use of facial features, believable movement and the ability to express or recognize emotional content are also important factors for artificial opponents and for achieving a higher sense of social presence, as argued in subsection 2.1.2.

As such, a board game artificial opponent should have a physical embodiment and be able to engage in face-to-face interaction with one or multiple participants. Placing more than one person in media interactions can be an easy way to induce a sense of presence regardless of the other perceptual features of the world [28]. The number of entities (being them virtual or human), influence positively the perception of social presence in an interactive system.

3.2 Believable verbal and non-verbal behaviour

When we interact with virtual characters or robots, verbal communication offers the most attractive input and output alternative. We are familiarized with it, requires minimal physical effort from the user, and leaves users' hands and eyes free [68]. In [3], we analysed the verbal communication in a board game and identified the most relevant categories to simulate dialogue in an artificial opponent.

Non-verbal behaviour is used for communication, signalling and for social coordination. This kind of natural social behaviour can be interpreted by humans without the need to learn something new. As such, a human-like computer that can express patterned non-verbal behaviours can cause social facilitation in users. Believable non-verbal behaviours can show autonomy and contribute to the feeling of social presence towards an agent. In robots or screen characters, having a responsive real time gaze system can alone produce a high sense of agency and increase the agent's perceived social presence [69].

Besides choosing the best move to play, artificial opponents should grab players' attention by using both verbal and non-verbal behaviours. An opponent can for example show a sad expression attached with a sad speech when losing and a pride expression associated with an excited speech when winning. Showing these kind of behaviours should increase interactivity and believability (see 2.1.2) and users should be able to attribute mental states towards the artificial opponent and perceive it as a social entity.

3.3 Emotion system

Emotion is a relevant topic in multiple disciplines such as philosophy, psychology, neuroscience, machine learning and, most recently, in affective computing [50]. It is universally recognized that emotions have a powerful influence in our decision-making [19]. The same holds true when players make decisions while playing board games, they let their emotions take part in their decision process. Appraisal theories seem like the best alternative for influencing the decision process with emotions and for generating emotional behaviour in an artificial opponent. Appraisal is an evaluation of the personal significance of events as central antecedents of emotional experience. Appraisal theories specify a set of criteria or dimensions that are presumed to underlie the emotion constituent appraisal process. These theories [36, 57, 58] are built upon studying our brain processes and the difficulty of simulating appraisal models in computers is related to the complexity of the mental structures that need to be simulated. However, some projects [5, 6, 47] already successfully used an appraisal model, the OCC model [46], to simulate human cognitive processes in their applications.

In our previous work, a social robot provided feedback on the users's moves by employing facial expressions determined by the robot's appraisal system. This appraisal system was composed by an anticipatory mechanism that created expectations on children's upcoming moves, and then based on the evaluation of the actual move played by children, an affective state was elicited, resulting in different facial expressions for the robot. It was shown that the emotional behaviour expressed by this social robot increased the user's understanding of the game [38].

The importance of emotions for simulating social behaviour in an artificial entity was already mentioned in our related work where we identified emotional behaviour as one of the contributing factors for the perception of social presence (see 2.1.2) and in subsection 2.2 we discussed the importance that emotions have in socially intelligent agents. Summarizing, an artificial opponent should have an emotion or appraisal system in order to make better judgements and to simulate human emotions.

3.4 Social memory

In order to greet, recognise, gather a history or mention past events with users, an artificial opponent has to be able to recognize the user, or each user individually if playing against multiple opponents. In computer games, generally, players create a profile and when they login by using it, the system recognizes the user. The same concept can be used by an artificial opponent but more natural interactions are preferable. By using video sensors, artificial opponents can already deal with face detection and recognition. However, vision algorithms that deal with such problems are still quite unreliable.

An initial introduction or a greeting behaviour is appropriate and essential to take off most social interactions. We can obviously see this behaviour as constant in board game players. And if we want to create socially present artificial opponent's we should not skip this important phase. Once that initial greeting behaviour has occurred, remembering, deciding upon or mentioning our past history with others is one of the most important social features and maybe the most essential way of establishing and maintaining relationships. Sharing personal interests or preferences, as well as showing some understanding of others' interests or preferences is also a fundamental point in most social relationships.

Complex models of the human memory can already be seen in human robot interaction research . The importance of such mechanisms for fighting the habituation/novelty effect and for achieving longer term interactions, have also been reported [8, 39]. In board games, we can assess the importance of these mechanisms by some common game situations. Such situations include when players' speech and in-game actions are influenced by previous negative or positive relations established with others or by events that took place earlier in the game, or in previous games.

To create believable and socially present agents that play several games with the same participants, they should have social memory, i.e., recognize each user individually and remember its past interactions with him/her.

3.5 Simulate social roles

Our final guideline is inspired by a rule of thumb described by Eriksson [23], that games should allow different modes of play based on social roles. Risk and most board games already support multiple social roles in their game-play. The challenge in this case is not to build games that can support various social roles. Instead, the challenge consists of endowing artificial opponents with the capability of simulating such roles.

Examples of social roles in board games are: *Helper* – actively helping another player perform actions in the game; *Dominator* – trying to influence other players to perform specific actions for the player's own in-game benefits; *Negotiator* – negotiating between two other players; and *Exhibitionist* – performing actions in the game to gain the other players' attention.

During the length of a single board game, players constantly change between social roles. A player that is displaying the social role of helper towards one player can later on adopt the social behaviour of dominator towards that same person. Concurrent social roles can also happen while playing board games. Players can, for example, exhibit both the social role of negotiator and dominator to try to influence players using external negotiation. Such social roles should be taken into consideration when developing artificial opponents for board games.

4 Scenario

We developed a scenario where an artificial opponent plays the Risk board game against three human players. The goal of this artificial opponent is to be able to socially interact with multiple humans and still be socially perceived for extended periods of time. The human players use a digital table as the game's interface and Risk was chosen because it is a game where face-to-face interactions, social actions and strategic social reasoning are important components of the interaction.

In this section, we go through the guidelines presented on the previous section and explain how we chose to implement them. This scenario and guidelines were evaluated in [49].

4.1 Physical embodiment and face-to-face interaction

In our scenario, over one side of the table stays the social robot that interacts with three other players on the three other sides of the table (see Figure 1). With the use of a digital table, human players are able to freely communicate between them and still be aware of the game state as it happens in [22]. By using a digital table as compared to a vertical display, multiple players can more easily be engaged with both the game and by each other [55]. This includes the robot that inhabits the same physical space.

We have built a custom digital table and we are using a robotic head to embody our artificial opponent. By using a social robotic head, our board game opponent is able to engage in face-to-face interaction with multiple participants. For embodying our social Risk opponent we are using a social robotic head, the EMYS (EMotive headY System) robotic head [54]. EMYS is a robotic head that can perform facial expressions and gaze by using 11 degrees of freedom. Audio speakers are used because EMYS does not have integrated speakers. A kinect sensor is also used for speech direction detection.

One of the main limitation of our scenario is that our robot does not have any speech recognition capabilities. This was a design decision, since that with today's technology it would be almost impossible to recognize speech in a scenario where three different users may be talking concurrently. As such, for receiving user's input, our robot as in [17], only considers information provided by in-game actions. Users can only "communicate" with the agent by attacking it or by proposing an alliance using the interface on the digital table. The robot is able to perceive such events without using any kind of speech recognition. We believe that by making the proposal and acceptance of alliances occur in the virtual interface does not deteriorate the social experience and gives more contextual information about the task to the robot.

However, for achieving believable face-to-face interactions we have developed a gaze system that equips our robot with the capacity of interacting with multiple players simultaneously.

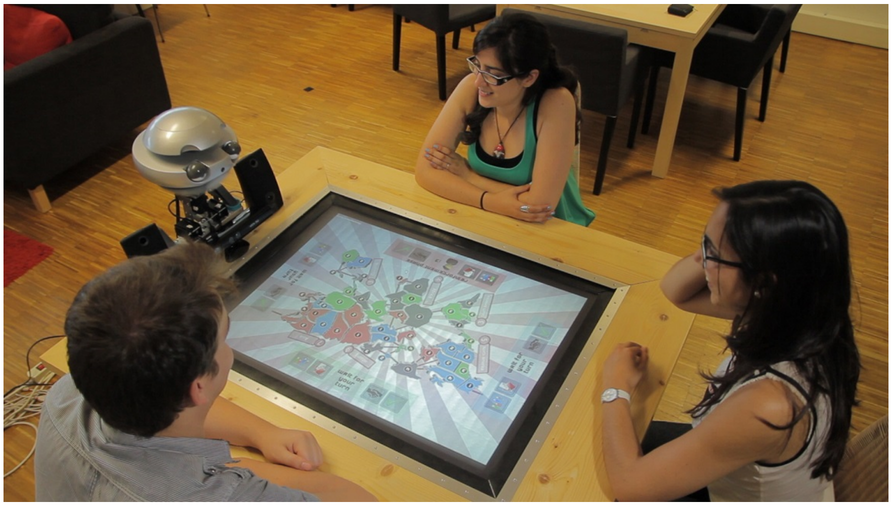

Fig. 1 Computer augmented Risk game

4.2 Believable verbal and non-verbal behaviour

The robot's non-verbal behaviour and gaze system is influenced not only by the agent's own appraisal system but also by the other players' voice and game actions.

The facial expressions and idle behaviours for our embodiment were developed by Ribeiro et al. [53, 54]. These authors, took inspiration from principles and practices of animation from Disney and other animators, and applied them on the development of emotional expressions and idle behaviours for the EMYS robot. The idle behaviour was adapted to our scenario to work in conjunction with the gaze system. Facial expressions are used in our scenario for establishing turn-taking and for revealing internal states like confusion, engagement, liking, etc.

The robot's non verbal behaviour also has a mood variable that can be either positive or negative. Like in our previous scenario [38], this variable is mapped to a positive or negative posture.

Regarding the robot's verbal behaviour we defined a typology of speeches adapted to the Risk game by separating utterances that human players vocalize in different categories [3]. This categorization helped us in pinpointing the most important behaviours in Risk but also a database of possible utterances. This database contributed for the creation of a believable vocalization system, as the utterances in this system were retrieved from real human social behaviour. In our scenario, a high quality text to speech is used to vocalize these utterances.

4.3 Emotion system

After performing studies on the original Risk game, we were able to extract the most relevant variables that influence human's appraisal or behaviour while playing Risk. These variables evolve during the game and some of them are stored in the agent's memory for future interactions. The way we compute these variables is scenario dependent. They are based on the results of our studies and are certainly a simplification of each of these processes. However, these variables make sense in many other scenarios and our methodology can provide readers with ideas of how to use it in other games or applications.

Our artificial opponent's emotion system is comprised by several variables that enable the agent to correctly appraise a situation. *Relevance* of an event influences our robot's dialogue system. Variables such as *power* and *concentration* influence the robot's gaze system and idle behaviour. Also, when generating dialogue or choosing the next move to play, our artificial opponent takes into account relationship variables established towards particular users. These variables are *familiarity*, *like/dislike* and *luck perception*.

4.4 Social Memory

In our application we simplified the recognition process by making each user login with their own private interface on the digital table. At that time the robot acknowledges the presence and position of a user, greets that particular user, and updates the history with him/her.

Some of the appraisal variables described in the subsection above evolve only during the game, but some are stored in the agent's memory for future interactions. Familiarity is one variable that is stored in the agent's memory and will be remembered in future interactions. Luck perception is also stored in memory, so the agent can assess and comment if a player was lucky in previous games. Like/Dislike variables are also stored so the robot discloses, for instance, that it holds a "grudge" against a particular player, because of previous games. The last data that is stored in memory are the results and dates of previous matches. This type of data is often mentioned in the beginning of the interaction, where the robot says for example: "One week ago I lost against all of you, this time I am going to win!".

4.5 Simulate social roles

In our observations of users playing Risk, we have noticed that users do indeed use the social roles identified by Eriksson and change between them throughout the game. Examples included players that in one phase of a game were exhibiting a Helper social role (actively helping another player without seeking any in-game benefit) and in later parts of the game a Violator role towards the same player (giving up in the game and trying to destroy another player just because of an argument).

Risk is a highly social game that supports various social roles in its gameplay. In our implementation, these roles arise by using our appraisal and behaviour variables to influence the robot's social behaviour. For example, when the agent "likes" other players it often demonstrates the social role of Helper by saying encouraging comments such as "It went well this turn!". Also, when the agent has a great advantage (high power) over the other players, it is more likely to adopt the Dominator role by, for example, threatening other players.

5 Conclusions

By taking considerations from our previous design experience with board game opponents, research on the contributing factors for social presence, state-of-the-art research in socially intelligent agents and long term interaction with social agents, we present a scenario where a social agent has the capacity of being perceived as more socially present by complying with a set of five guidelines.

These guidelines are presented in this paper, and by applying them to our particular scenario, we created a physically embodied artificial opponent that is able to engage users in face-to-face interactions, has an emotion system used for exhibiting believable verbal and non-verbal behaviours, has social memory, and uses all of these capabilities to simulate common board game social roles.

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