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Research Article

Effect of Social Actors Perceived Agency on Social Presence in Computer-Mediated Communication

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Nowadays, both text-based and 3D online applications rely on conversational agents and autonomous characters to interact with users. Previous experiments demonstrated that perceived agency, that is to say, one's belief in interacting with a computer- or another human-controlled entity could impact social interaction. At present, theories and results still diverge and no consensus has been reached. Therefore, we developed an experiment to investigate the effect of perceived agency and emotional communication on social presence. Participants were told that they would play an online image recognition game against a computer- or a human-controlled opponent. In both cases, participants faced a computer-controlled opponent designed to provide a challenging yet balanced competitive experience. Depending on the experimental conditions, participants were able to communicate with their opponents using emoticons between the game rounds. Results demonstrate a significant main effect of emotional communication on the three dimensions of social presence we considered in this experiment. An interaction effect between perceived agency and emotional communication was observed in copresence, another core dimension of social presence. The impact of emotional communication on participants' sense of copresence depends on the perceived agency of the opponent. A significant increase was observed for participants facing a computer-controlled opponent when emotional communication was allowed. The sense of copresence was even higher when they were facing a computer-controlled opponent rather than a presumed human-controlled one. These results are discussed with regard to theories of social interaction in computer-mediated communication.

1. Introduction

Conversational agents, increasingly used in online applications [1], might raise some concerns for both the general public and companies because of their dehumanized nature. While several of these conversational agents are currently text-based, there is an increasing interest in expressive and animated virtual humans [2, 3]. Recent studies aim at investigating the impact of conversational agents on user experience and especially on the sense of social presence. The systematic review of Oh et al. [4] identifies some of its predictors. Three categories are reported: immersion, individual differences, and context. While several previous investigations focused on immersion-related predictors such as visual representation, individual differences and demographic predictors remain underinvestigated in comparison. Finally, context predictors are receiving more attention from the research community over the years. In this paper, we will focus on the impact of perceived agency, a context predictor referring to the perceived nature of the interactant (computer or human).

We investigated the effect of the perceived agency of a social actor on users' sense of social presence and engagement during an online competitive experience. Since social presence can be experienced through both highly immersive media (e.g., virtual, augmented, and mixed reality) and ordinary media (e.g., text, audio, and video content) [4, 5], we decided to rely on a simple 2D game to minimize the impact of immersion-related predictors on social presence and thus efficiently measure the desired effect. In addition, it is worth noting that prior experience and expectations about virtual humans may vary considerably among potential participants in an online study. Walther [6] demonstrated that text-based media could provide a similar sense of social presence compared to nonmediated face-to-face communication. In our study, the presumed nature of the social actor was induced by informing participants that they would play against another player or a computer, before the experiment. The online application consisted of a competitive image recognition game to ensure the participants were involved. Depending on the experimental conditions, the image recognition task was followed by a direct and synchronous computer-mediated communication (CMC) phase [7] with the conversational agent using emoticons to vary the perceived behavioral realism level. While in some experiments behavioral realism refers to complex nonverbal communication using virtual characters, here it is driven by emotional communication based on emoticons. The purpose of these emoticons was to simulate usual nonverbal face-to-face interaction through facial expressions in a text-based CMC [8].

The remainder of this study is on social presence, perceived agency, and related computer-mediated communication theories. Section 3 presents the design and the protocol of the experiment. Results are analyzed in Section 4 and discussed in Section 5. Section 6 presents the limitations of the study and Section 7 concludes this paper.

2. Related Work

2.1. Social Presence. Social presence is often considered a subdimension of the sense of presence [9–11]. Although often associated with immersive virtual environments, both the senses of presence and social presence can manifest themselves in any mediated communication [5]. The concept of social presence was used by Short et al. [12] to describe a psychological state that occurs during interpersonal interaction through telecommunication media. It was defined as "the degree of salience of the other person in the interaction and the consequent salience of the interpersonal relationships." More recently, and in a nonexhaustive way, social presence has also been defined as the sense of "being there together" [13] or as "a psychological state in which virtual social actors are experienced as actual social actors in either sensory or non-sensory ways." [5]. The closely related concept of co-presence is defined as one of the six dimensions contributing to social presence by Harms and Biocca [14]. Copresence was introduced by [15] to describe a psychological state of connection between social actors: "copresence renders persons uniquely accessible, available, and subject to one another." According to this definition, co-presence refers to a direct interaction between social entities. Because it requires users to be simultaneously present, this concept is more restrictive than social presence which can occur without direct interaction (e.g., listening to a prerecorded voice message). According to Harms and Biocca [14], the sense of co-presence is a combination of the awareness of being with another person and of the sense that this person is aware of our own presence. In their model of social presence, they also identify five additional dimensions. In the frame of our experiment, along with the sense of copresence, we considered three of these dimensions potentially impacted by emotional communication, namely: perceived affective understanding (PAU), perceived emotional interdependence (PEI), and perceived behavioral interdependence (PBI). Harms and Biocca [14] describe the perceived affective understanding dimension as users' ability to understand their interactant's emotional and attitudinal states, as well as their perception of the interactant's ability to understand their own emotional and attitudinal states, while the perceived emotional interdependence dimension refers to the mutual dependence of these emotional and attitudinal states. The perceived behavioral interdependence dimension corresponds to the way users' behavior is mutually impacted. The attentional allocation (AA) and the perceived message understanding (PMU) dimensions were not considered in this study. The AA dimension requires continuous interaction between players and the PMU dimension is suitable when direct communication is allowed.

In their systematic review, Oh et al. [4] introduced three categories of social presence predictors. The immersion category refers to the technological characteristics of the media including general modalities, visual representations, interactivity, haptic feedback, depth cues, audio quality, and display. The context category is related to social entities' personality and traits, the perceived agency of the interactants, physical proximity, task type, and social and identity cues. Finally, the individual differences category includes demographic variables and psychological traits of the users.

Previous research on social presence mostly investigated the impact of two immersion predictors categorized as modality and visual representation. Research on immersion modalities compared face-to-face communication and computer-mediated communication (CMC) or text-based CMC [16]. While face-to-face communication usually induces a higher level of social presence, it should be noted that several media relying on richer communication modalities, such as audio and video content or virtual characters outperform text-based CMC [17, 18]. However, Walther [6] points out that users can adapt to the communication medium and are able to gather verbal and textual cues accumulated through computer-mediated communication to process social information. Furthermore, it seems that immersive and virtual reality technologies are not mandatory when it comes to inducing a high sense of social presence. According to Oh et al. [4], it is likely that once a certain immersion threshold is reached, further improvements will not necessarily lead to increased social presence.

Contextual predictor studies, on the other hand, mainly focused on the personality and traits of virtual humans and the agency. In this context, agency refers to the nature of social entities: avatar (user-controlled character) versus agent (autonomous character) [19]. While social behaviors occurring during face-to-face communication might also occur in computer-mediated communication with virtual characters, previous experiments report mixed results regarding the impact of agency on users' sense of social presence [11, 18, 20]. Our study was designed to investigate psychological and behavioral differences occurring when playing and interacting with a presumed human social entity or with a computer. Therefore, the following section focuses on the impact of perceived agency in computer-mediated communication on social presence.

2.2. Perceived Agency. According to Nowak and Biocca [11], the concept of agency could be conceptualized as the intentional force that drives the actions of an entity. It should not be confused with the sense of agency, summarized as the feeling of control when performing actions and considered as a dimension of the sense of embodiment in immersive virtual environments [21, 22]. In the context of our study, the notion of agency relates to the nature of social entities: humans and computers, avatars and agents. It should be noted that this notion is used to describe situations in which users are actually confronted with a human or a computer, or in which they have only been told that they are. To disentangle this ambiguity, some studies used the term "perceived agency" when participants were facing the same kind of social entity, but introduced as a human- or a computer-controlled interactant depending on the experimental condition [11, 18, 23, 24]. The same concept has also been called "agency beliefs" [24] or more recently "perceived identity" [25].

Nowak and Biocca [11] investigated the effect of perceived agency and visual realism (anthropomorphism) on social presence. While they observed a significant effect of anthropomorphism, participants responded socially to both human and computer-controlled social entities and no effect of the perceived agency was observed. However, the experiments of Guadagno et al. [24] demonstrated that participants who thought they were facing another human considered the behavior of the social entity as more realistic and they experienced more social presence. This experiment highlights that, for the same level of behavioral realism, presumed computer-controlled entities could be perceived as less realistic. Hoyt et al. [23] studied the effects of perceived agency on social influence. Participants performing a task while being observed by an avatar led to higher social inhibition, whereas this effect was not observed when they were observed by agents. Moreover, Felnhofer et al. [26] showed that virtual humans presented as avatars induced more empathy than agents, which led participants to greater prosocial behavior. However, no effect was observed on social presence in this study. Similarly, Kothgassner et al. [27, 28] did not observe any effect of perceived agency on social presence when participants were exposed to social exclusion situations. In the field of game studies, Gajadhar et al. [29] compared the effect of three game configurations on social presence. They investigated the effect of playing against a presumed computer-controlled opponent (who was in fact an actual player), against another player located in a different room, and against another co-located player. Participants reported a higher sense of social presence when they were told that they were playing against another player. It is also worth noticing that players who believe they are playing against another human may experience higher presence, flow, enjoyment [30], and physiological arousal [31].

Miwa and Terai [32] showed that the presumed nature of the interactant had more influence on users' behavior than its actual nature. Participants tend to behave in a more cooperative way when they thought they were interacting with a human partner. However, Hwang and Won [25] demonstrated that participants were more creative (more and better ideas) during a cooperative task when they believed they were collaborating with a computer-controlled entity using a text-based CMC (chatbot). Authors suggested that working with a computer-controlled agent may have reduced participants' concerns about their teammates, leading to more efficient brainstorming. Bailenson et al. [20] studies also revealed some differences in participants' proxemic behavior. In their first experiment, participants maintained a higher interpersonal distance with an avatar than with an agent. The second experiment revealed that participants had more limited expectations about the agent's behavior. The authors stated that participants considered that the agent would not exhibit any avoidance behavior. As a result, they moved away from the agent when it was approaching, whereas they expected the avatar to stop in order to avoid invading their personal space.

Von der Pütten et al. [33] and Appel et al. [18] designed experiments to investigate further the impact of perceived agency to challenge the main, and somewhat contradictory, social psychology theories attempting to describe social behaviors associated with humans and computers. On the one hand, the ethopoeia theory claims that computers and agents, even without visual representation, may elicit social behaviors that would naturally be expected when interacting with another human being [34–36], such as politeness [37, 38]. On the other hand, the social influence threshold model states that human-controlled entities are considered social entities, while computer-controlled ones require some behavioral realism to elicit social reactions [39]. Von der Pütten et al. [33] used a virtual human introduced as an avatar or as an agent, but an autonomous agent was used in every condition. They also compared the impact of behavioral realism with the addition of behavioral feedback during the conversation. Several measures were considered, including social presence, but almost no significant differences were observed in whether the virtual character was introduced as an agent or an avatar. According to the authors, these results tend to corroborate the concept of ethopoeia. On the other hand, Appel et al. [18] compared the impact of perceived agency using two mediums presenting different degrees of social cues: a text-based CMC and a virtual human CMC. The interactant was introduced as a human or a computer-controlled entity in the text-based condition and as an avatar or an agent in the virtual human condition. They observed a higher sense of social presence when participants thought they were interacting with another human. This result tends to corroborate Blascovich's model [39]. However, the lack of significant results regarding the other measures is considered in this experiment (virtual character perception and self-reported rapport.); authors argued in favor of Nass et al.'s theory [34]. These theories will be discussed further in the next section, as they provide theoretical frameworks closely related to perceived agency and social presence.

2.3. Ethiopia or Social Influence Threshold. Ethopoeia was the foundation of the Computers Are Social Actors (CASA) school of thought considering that social rules and expectations are mindlessly applied to computers, making human-computer interaction fundamentally social [40, 41]. Following this theory, people would interact in a similar way regardless of the nature of the social entity as soon as it provides social cues. A revised version suggested the potential impact of behavioral realism [35]. While humans and computers would still elicit similar social behaviors, social entities providing more social cues would elicit more social responses in return. Appel et al. [18] observed that a virtual human, providing more social cues than a text-based CMC, elicited more social reactions. Thus, the authors claim that the more the computers present human-like characteristics, the more likely it is to induce social behaviors. This revised version of the ethopoeia concept shares some similarities with the social influence threshold model introduced by Blascovich [39]. They used this theoretical model as a framework for their research in social psychology using immersive virtual environments [42, 43]. This model states that human-controlled entities would elicit social reactions even if their behavioral realism remains quite low. On the other hand, the threshold of social influence could only be reached if the autonomous social actor has sufficient behavioral realism to achieve a certain level of social verification (social presence) allowing social influences to occur. In other words, a human would reach the social influence threshold more easily than a computer, the latter having to demonstrate more behavioral realism to compensate for its perceived agency.

Both theories emphasize the fact that computers can be considered social entities and both of them underline the impact of behavioral realism on social reactions. However, while the revised ethopoeia theory states that increasing the behavioral realism could elicit more social reactions, the threshold of social influence theory states that a threshold must first be reached to allow for social influences to occur. The meta-analysis of Oh et al. [4] highlighted that older research on agency tends to corroborate the threshold model of social influence [39], where behavioral differences were observed when participants were facing human- and computer-controlled entities. However, more recent studies tend to corroborate the revised ethopoeia model [35] where no significant differences were observed. Oh et al. [4] argued that users' expectations may have changed over time regarding autonomous agents' behavior following recent technological improvements. As mentioned in the previous section, the results of Von der Pütten et al. [33] seem to support the ethopoeia model, as no difference was observed between the presumed human- and computer-controlled social entity, as well as the revised ethopoeiatheory, because of the observed effect of behavioral realism on social reactions. While the experiment of Appel et al. [18] seems to support the threshold model of social influence considering the significant difference observed in terms of social presence in favor of the presumed human-controlled virtual character, most of their other measures corroborate the ethopoeiatheory.

More recently, some researchers have hypothesized or reported results that could not be fully predicted by current models. Potdevin et al. [44] compared a 3D conversational agent and a video capture of an actor. They hypothesized that when both the virtual character and the actor exhibit intimate behaviors (e.g., open gestures, head nods, and head tilts), participants would perceive greater intimacy from the virtual character. This assumption was based on the intensification of the perceived intimacy effect in computer-mediated communication, where users tend to reciprocate with more intimate disclosures [45]. This effect of intensification in computer-based communication in comparison with face-to-face communication was introduced by Walther [46] as "hyperpersonal communication." While the results of Potdevin et al. [44] did not validate their hypothesis, they still observed that perceived intimacy is lower when facing the actor not exhibiting intimate behavior than when facing the 3D agent.

Regarding social interactions when talking about sensitive topics, Lucas et al. [47] demonstrated that participants who believed they were interacting with a virtual agent in the context of health-screening interviews showed increased willingness to disclose and decreased fear of self-disclosure. In this particular context, virtual agents offer anonymity that encourages social conversation. Moreover, Guadagno et al. [48] observed that an agent expressing a basic nonverbal behavior could lead to better social evaluations than a presumed avatar. In their experiment, participants were told that they would face either a virtual agent or an avatar controlled by another person. In both cases, the virtual character was controlled by a research assistant. Depending on the experimental condition, the virtual character was smiling or not. Results revealed that social evaluations, such as empathy perception, were enhanced for participants believing they were facing an agent displaying a smile and were reduced when they thought they were facing an avatar. Higher empathy was associated with greater connection and higher trust for the virtual character, as well as more satisfaction, comfort, and enjoyment during the interaction.

Our literature review highlighted the divergent results of previous studies regarding the impact of perceived agency on social presence in computer-mediated communication. Currently, no consistent results have been observed for both text-based and virtual human-based CMC. Some research tends to corroborate the revised ethopoeiatheory, while others observed outcomes in line with the threshold model of social influence. Furthermore, we presented some experiments that tend to go beyond these theories where virtual agents are more likely to elicit social behaviors than presumed human-controlled social entities. In this context, we developed an online image recognition game where participants thought they were facing a computer-controlled opponent or another player. Depending on the condition, participants were able to communicate using smileys between game rounds to investigate whether an emotionally responsive opponent would induce a higher sense of social presence and whether this effect is driven by the perceived agency of the social entity.

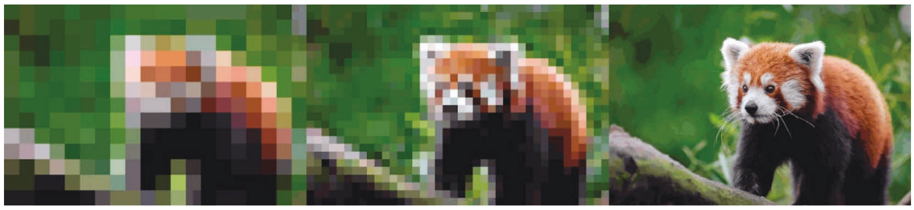

FIGURE 1: Example of a red panda picture used in the recognition game.

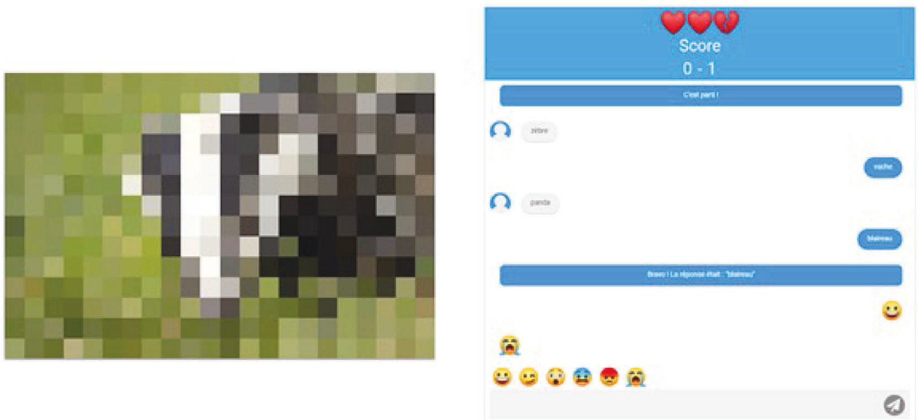

FIGURE 2: Interface of the web application developed for the experiment including the emoticons for the PH-EC and C-EC conditions.

3. Materials and Methods

We designed an online application where participants were competing against an algorithm in an image recognition game. To manipulate the perceived agency, participants were told that they were facing either a computer-controlled opponent or another player. In both conditions, participants were facing a computer-controlled entity. The game consisted in guessing the name of a well-known animal progressively appearing on their screen through an increase in the pictures' resolution (Figure 1). Participants were able to answer in a text chat with a limited number of answers for each picture to avoid any direct communication with the opponent. Unlike the experiment of Paetzel et al. who used an image guessing game to study conversational agents [49], our participants were not able to interact continuously. Half of the panel was able to interact with the opponent using emoticons (Figure 2) between the rounds (emotional communication). The social presence and engagement of the participants were assessed after they played the game. We divided the panel into four groups following a between-subject design based on the two independent variables of this experiment (perceived agency and emotional communication):

(i) Presumed human-controlled opponent with emotional communication (PH-EC): participants were told that they were facing a human-controlled opponent and were able to communicate using emoticons between the rounds.

(ii) Presumed human-controlled opponent (PH): participants were told that they were facing a human-controlled opponent and were not able to communicate.

(iii) Computer-controlled opponent with emotional communication (C-EC): participants were told that they were facing a computer-controlled opponent and were able to communicate using emoticons between the rounds.

(iv) Computer-controlled opponent (C): participants were told that they were facing a computer-controlled opponent and were not able to communicate.

3.1. Web Application. The experiment was based on a web application. Visualization and interaction were performed through the Internet browser installed on participants' computers using a keyboard and a mouse. The web application was compatible with most current web browsers. It should be noted that we decided to disable any touch screen compatibility, and thus tablets or smartphones, in order to limit the screen sizes variability and the differences in typing speeds. The interface of the application presents two distinct areas (Figure 2): animal pictures are displayed on the left side, while the text chat, where participants can write their answers and read their opponents' ones, is displayed on the right side. This side of the graphic interface also includes their remaining lives for the current trial (number of potential attempts) and their total score. Participants who played in the emotional communication groups (C-EC and PH-EC conditions) were able to send emoticons between the rounds using the text chat. They had to play for a total of 10 rounds ensuring that every participant played for the same amount of time. Each round lasted 10 seconds and participants had three lives per round. The round begins with a low-resolution picture. The resolution is gradually increased as the round progresses until it becomes perfectly defined (Figure 1). Pictures were presented in random order and fairly simple to distinguish because they were selected based on the contrast between the animal and the background. The algorithm of the opponent was designed to provide plausible answers with a coherent delay between each proposition.

When emotional communication was enabled between the rounds (PH-EC and C-EC conditions), participants were able to send one of the six emoticons. Three of them are associated with positive emotions/behaviors (joy, wink, and surprise), and three with negative ones (fear, anger, and sadness). We strived to develop a believable behavior for the computer-controlled opponent. In case it interacted first with the participant, the pseudorandom algorithm responsible for the selection of the emoticon was based on the result of the previous round, the total score of the game, and the number of rounds remaining. Conversely, if the computer responds to the participant, the algorithm considered the emoticon and there were few probabilities of sending back another emoticon of the same category (positive or negative). This algorithm was adjusted during the pilot tests until participants considered that the emoticon selection and timing were plausible.

3.2. Participants. 128 participants aged 18 to 63 ($M = 31.45$, $SD = 13.14$) took part in the experiment (49 females and 78 males). Volunteers were hired through the university's mailing lists and social networks. Other than being of legal age, there was no inclusion criteria for this study. Participants under 18 who played online game were not considered in the data analysis.

3.3. Procedure. Prior to the experiment, participants were informed via a consent form that their data would be processed and reported anonymously. They were also told that they were free to stop the experiment without giving a reason. Finally, they had to accept that the experiment was designed to be carried out by a single person, without any help from people around.

Participants were randomly assigned to an experimental condition and received instructions accordingly to play the game. A video was displayed to explain the game mechanics. The progressive revelation of the picture with the animals to be recognized, the way to send answers, the limited number of lives, and the possibility to send emoticons (for two groups of participants out of four) were explained in the video. Then, participants were told that they were about to play against either a computer-controlled opponent or another player depending on the experimental condition. Then, they played the ten rounds consisting in guessing the progressively appearing animal as described in the previous section. At the end of the game, participants had to complete a postexperiment questionnaire to collect their demographic information and to assess their sense of social presence and engagement.

3.4. Measures. We used four dimensions out of six of the networked minds measure of social presence [14], namely, copresence (CP), perceived affective understanding (PAU), perceived emotional interdependence (PEI), and perceived behavioral interdependence (PBI) (Table 1). As introduced in the related work section on social presence, we selected these dimensions as they appeared to be relevant regarding the context of this experiment. Additionally, the focus attention (FA) dimension of the User Engagement Scale [50] was used to assess engagement (Table 2). Objective data were recorded during the experiment. We measured participants' response time, the number of sent messages, and the number of emoticons when emotional communication was enabled for the participants in the PH-EC and C-EC groups.

3.5. Hypotheses. Based on our literature review and considering the design of this experiment relying on an online application, we formulated four hypotheses regarding the impact of perceived agency on social presence and engagement. We hypothesized that in a general way playing against a presumed human-controlled opponent would induce higher social presence (H1) and engagement (H3), but that adding social cues to allow for emotional communication (emoticons) would induce a higher sense of social presence with a presumed computer-controlled opponent in a text-based CMC game. These hypotheses contradict to some extent the ethopoeiaand the social Influence threshold theories (see section 2.3). As previously mentioned, these theories both emphasize the fact that computers can be considered social entities and both of them underline the impact of behavioral realism on social reactions. However, while the revised ethopoeiatheory states that increasing behavioral realism could elicit more social reactions [35], the threshold of social influence theory states that a threshold must first be reached to allow for social influences to occur [39]. Subsequent research hypothesized and reported results that could not be fully predicted by current models. These studies revealed that participants experienced higher intimacy [44] or increased willingness to disclose [47] when facing 3D virtual agents. Moreover, an agent expressing a basic nonverbal behavior (smile) could lead to better social evaluations than a presumed avatar. Therefore, we formulated H2 and H4 to verify if this effect holds in text-based CMC.

(i) H1: the belief of playing against another player induces a higher sense of social presence than with a computer-controlled opponent.

(ii) H2: emotional communication via emoticons induces a higher sense of social presence when one believes to play against a computer-controlled opponent than against a human-controlled opponent.

(iii) H3: the belief of playing against another player induces a higher engagement than with a computer-controlled opponent.

(iv) H4: emotional communication via emoticons induces a higher engagement when one believes to play against a computer-controlled opponent than against a human-controlled opponent.

Table 1: Social presence questionnaire [14]. Items range from 1 to 7.

Copresence (CP)
I noticed my opponent.
My opponent noticed me.
My opponent's presence was obvious to me.
My presence was obvious to my opponent.
My opponent caught my attention.
I caught my opponent's attention.
Perceived affective understanding (PAU)
I could tell how my opponent felt.
My opponent could tell how I felt.
My opponent's emotions were not clear to me.
My emotions were not clear to my opponent.
I could describe my opponent's feelings accurately.
My opponent could describe my feelings accurately.
Perceived emotional interdependence (PEI)
I was sometimes influenced by my opponent's moods.
My opponent was sometimes influenced by my moods.
My opponent's feelings influenced the mood of our interaction.
My feelings influenced the mood of our interaction.
My opponent's attitudes influenced how I felt.
My attitude influenced how my opponent felt.
Perceived behavioral interdependence (PBI)
My behavior was often in direct response to my opponent's behavior.
The behavior of my opponent was often in direct response to my behavior.
I reciprocated my opponent's actions.
My opponent reciprocated my actions.
My opponent's behavior was closely tied to my behavior.
My behavior was closely tied to my opponent's behavior.

Table 2: Engagement questionnaire [50]. Items range from 1 to 7.

Focus attention (FA)
I lost myself in this gaming experience.
I was so involved in gaming task that I lost track of time.
I blocked out things around me when I was playing the game.
When I was playing the game, I lost track of the world around me.
The time I spent playing the game just slipped away.
I was absorbed in my gaming task.
During this gaming experience, I let myself go.
I was really drawn into my gaming task.

4. Results

Data were tested for normality and homogeneity of variance. Shapiro–Wilk tests revealed that some variables were not normally distributed ($p < 0.05$). However, considering that Levene tests showed that variances were not significantly different, we used parametric tests to analyze the data. Differences are considered significant when $p < 0.05$. A two-way between-groups analysis of variance was conducted to explore the impact of perceived agency and emotional communication on the copresence (CP), perceived affective understanding (PAU), perceived emotional interdependence (PEI), and perceived behavioral interdependence (PBI) dimensions of social presence, as well as on the focus attention (FA) dimension of engagement (Table 3).

Table 3: Descriptive statistics (means and standard deviations) for the social presence dimensions (copresence (CP), perceived affective understanding (PAU), perceived emotional interdependence (PEI), and perceived behavioral interdependence (PBI)) and engagement (focus attention (FA)) for each condition of the experiment (presumed human opponent with emotional communication (PH-EC), presumed human (PH), computer with emotional communication (C-EC), and computer (C)).

	PH-EC		PH		C-EC		C	
	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ
CP	3.27	1.02	3.20	0.64	3.59	0.76	2.93	0.75
PAU	2.70	0.54	2.54	0.60	2.63	0.53	2.27	0.57
PEI	2.27	1.03	2.07	0.94	2.16	0.90	1.70	0.71
PBI	2.32	1.07	2.02	0.88	2.30	0.78	1.89	0.72
FA	3.23	0.92	2.97	0.93	3.09	0.65	3.22	0.89

4.1. Social Presence. Two-way between-group analyses of variance were conducted to explore the effect of perceived agency and emotional communication on the dimensions of social presence considered in this experiment.

The interaction effect between perceived agency and emotional communication on CP (Figures 3(a) and 4) was statistically significant, $F\,(1, 124) = 4.21$, $p = 0.042$. The main effect for the perceived agency, $F\,(1, 124) = 0.03$ $p = 0.855$, did not reach statistical significance. There was a statistically significant main effect for emotional communication, $F\,(1, 124) = 6.57$, $p = 0.012$. Considering the significant interaction between the independent variables, we can state that the effect of emotional communication on copresence depends on the perceived agency. Participants experienced a higher sense of copresence when emotional communication was allowed only when facing a computer-controlled opponent.

The interaction effect between perceived agency and emotional communication on PAU (Figure 3(b)) was not statistically significant, $F\,(1, 124) = 0.99$, $p = 0.321$. The main effect for the perceived agency, $F\,(1, 124) = 3.00$, $p = 0.086$, did not reach statistical significance. There was a statistically significant main effect of emotional communication, $F\,(1, 124) = 7.17$, $p = 0.008$. The effect size was small (*partial eta squared* = 0.055). Participants better understood their interactant's emotional and attitudinal states when emotional communication was allowed.

The interaction effect between perceived agency and emotional communication on PEI (Figure 3(c)) was not statistically significant, $F\,(1, 124) = 0.61$, $p = 0.435$. The main effect for the perceived agency, $F\,(1, 124) = 2.25$, $p = 0.136$, did not reach statistical significance. There was a statistically significant main effect of emotional communication, $F\,(1, 124) = 4.22$, $p = 0.042$. The effect size was small (*partial eta squared* = 0.033). Participants felt a higher emotional interdependence when emotional communication was allowed.

The interaction effect between perceived agency and emotional communication on PBI (Figure 3(d)) was not statistically significant, $F\,(1, 124) = 0.14$, $p = 0.711$. The main effect for the perceived agency, $F\,(1.124) = 2.25$, $p = 0.637$, did not reach statistical significance. There was a statistically significant main effect of emotional communication, F (1,

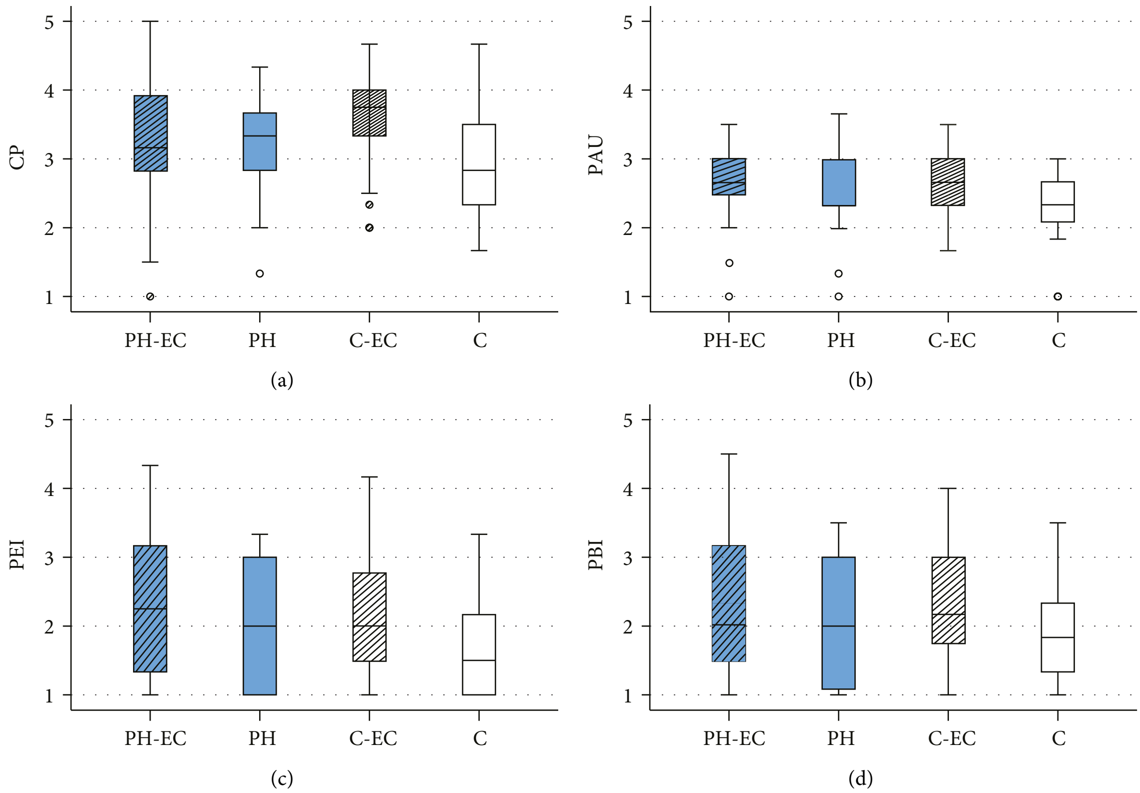

Figure 3: Social presence boxplots for the four conditions of the experiment: presumed human opponent with emotional communication (PH-EC), presumed human (PH), computer with emotional communication (C-EC), and computer (C). Blue boxes indicate presumed human conditions and hatched boxes indicate conditions with emotional communication. (a) Copresence (CP) mean scores, (b) perceived affective understanding (PAU) mean scores, (c) perceived emotional interdependence (PEI) mean scores, and (d) perceived behavioral interdependence (PBI) mean scores.

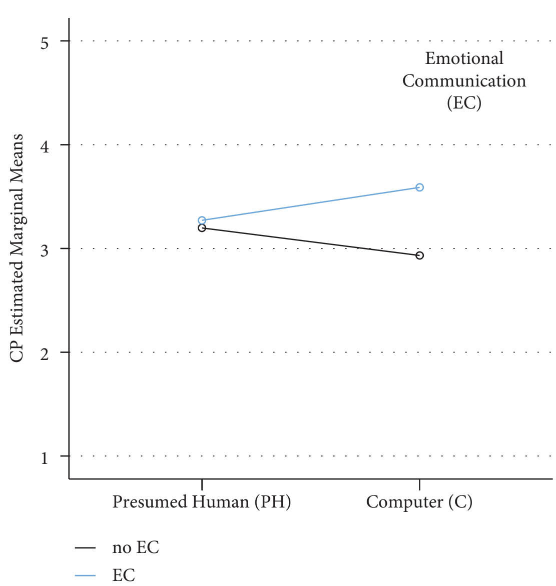

Figure 4: Copresence (CP) estimated marginal means.

124) = 5.29, $p = 0.023$. The effect size was small (*partial eta squared* = 0.041). Participants felt that their behavior was more mutually impacted when emotional communication was allowed.

4.2. Engagement. A two-way between-groups analysis of variance was conducted to explore the effect of perceived agency and emotional communication on the FA dimension of engagement. The interaction effect between perceived agency and emotional communication was not statistically significant, $F(1, 124) = 1.67$, $p = 0.199$. The main effects for perceived agency $F(1, 124) = 0.13$ $p = 0.718$ and emotional communication, $F(1, 124) = 0.17$ $p = 0.680$, did not reach statistical significance. Given that the analysis revealed no significant interaction effect or significant main effect, neither the perceived agency nor emotional communication had a significant impact on participants' engagement.

4.2.1. Correlations. The relationship between CP, PAU, PEI, PBI, FA, and objective data (response time, number of messages, and number of emoticons), was investigated using the Pearson product-moment correlation coefficient. Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity, and homoscedasticity. Notably, we observed a moderate positive correlation between CP and the number of emoticons, $r = 0.331$, $n = 64$, $p = 0.008$, a moderate positive correlation between PAU and the number of emoticons, $r = 0.336$, $n = 64$, $p = 0.007$, a tendency for a small positive correlation between PEI and the number of emoticons, $r = 0.236$, $n = 64$, $p = 0.060$, and a moderate positive correlation between PBI and the number of emoticons, $r = 0.430$, $n = 64$, $p < 0.001$.

5. Discussion

This experiment was designed to investigate the effect of the perceived agency of a social entity on social presence and engagement in an online competitive experience. Participants took part in an image recognition game against a computer-controlled opponent, although half of the panel was told that they were facing another player. Two groups out of four were able to communicate between the rounds using emoticons. We expected that participants who thought they were facing another player would experience a higher sense of social presence and engagement. However, we expected that facing a computer-controlled opponent exhibiting plausible and coherent emotions through emoticons would lead to a bigger increase in social presence than presumed players exhibiting the same kind of emotional communication.

5.1. Engagement. First of all, we observed no significant differences between the groups regarding the focus attention dimension of engagement we considered in this experiment. This aspect will not be discussed further, as the lack of significant results led us to reject both H3 and H4. Nevertheless, it should be noted that these results are not in line with previous work where engagement was more important when participants played with other human-controlled entities [51]. However, the context was different as participants were facing actual players (not presumed human opponents) in 3D games. Lim and Reeves [31] also observed higher physiological arousal, a notion closely related to engagement, when participants thought they were interacting with another human. In the frame of our experiment, the application we designed may have led to a similar level of engagement because of the limited number of cues provided to the participants regarding their opponent's involvement in the competitive task.

5.2. Social Presence. We observed no significant main effect of perceived agency on the dimensions of social presence we considered in this experiment. Our results led us to reject our first hypothesis (H1). Considered alone, the perceived agency of the opponent (human- or computer-controlled) did not significantly impact participants' sense of copresence, their affective understanding, and both their emotional and behavioral interdependence. These results are in line with the study of Von der Pütten et al. [33], but contradict to some extent the work of Appel et al. [18]. Indeed, while the perceived agency had almost no impact on most of their dependent variables, they observed a significant main effect on social presence in text-based CMC and with 3D virtual characters.

Although we observed no main effect of perceived agency on social presence, we recorded multiple main effects of emotional communication on social presence. When emotional communication was enabled, that is to say when participants were able to send emoticons to their opponent, higher perceived affective understanding (PAU), perceived emotional interdependence (PEI), and perceived behavioral interdependence (PBI) were reported regardless of the perceived agency. In other words, emoticons improved participants' perception of the emotional state of their opponent and they experienced a higher mutual dependence on their emotional state and their behavior. While these results might sound obvious as participants were not able to communicate directly in both the presumed human (PH) and computer (C) controlled conditions with no emotional communication, it is worth noting that we observed some participants inferring the potential reaction of their opponent even when no emotional communication was allowed.

The lack of a significant main effect regarding the impact of perceived agency on social presence in our experiment tends to corroborate the ethopoeiatheory [34, 40] where computers are considered as social actors that would elicit social behaviors. Furthermore, the main effects of emotional communication on three dimensions of social presence also corroborate the revised ethopoeiatheory, which claims that social entities providing more social cues would elicit more social responses in return [35]. Correlation analyses further support the link between emoticon-sending behavior and social presence. These results tend to contradict the threshold model of social influence [39] which states that human-controlled social entities will elicit more social behaviors than computer-controlled ones when presenting the same level of behavioral realism until a threshold of social influence is reached. According to this theoretical model, computer-controlled entities would have to compensate for their low agency by providing more social cues. In our experiment, even when participants were not able to communicate using emoticons, we observed a similar social presence level in a text-based application providing a limited number of social cues. Therefore, it is unlikely that a threshold could have been reached to achieve a similar level of social presence. Nevertheless, it should be kept in mind that the threshold model of social influence was originally developed for studies based on immersive virtual environments providing several social cues not existing in a text-based CMC.

The main finding of this study is the interaction effect observed between perceived agency and emotional communication on the copresence dimension of social presence. The impact of emotional communication on copresence depends on the perceived agency of the opponent. Looking at the descriptive statistics, participants experience a slightly higher sense of copresence when they thought they were facing another player. However, when emotional communication was allowed, participants experienced a higher overall sense of copresence when facing a computer-controlled entity, while there was almost no difference for the presumed human-controlled opponent. This result validates our second hypothesis (H2) and is in line with the initial hypothesis of [44] stating that, in some situations, a computer-controlled social entity could elicit more social behaviors than another human. This particular result on the copresence dimension of social presence is not consistent with the aforementioned theories. On the one hand, results commonly attributed in the literature to the ethopoeiatheory do not present significant differences between human- and computer-controlled social entities. According to this theory, computers could elicit social behaviors that would normally be expected in human social interaction, but here we measured a higher sense of copresence with a computer-controlled opponent presenting a similar behavioral realism. On the other hand, this result does not contradict the threshold model of social influence. Even if we consider that the threshold of social influence could have been reached thanks to emotional communication, the same remark applies, as this theoretical model does not explain either why we observed a higher sense of copresence with the computer-controlled social entity.

The higher sense of copresence reported by the participants when facing a computer-controlled opponent is difficult to explain. There must be several reasons potentially explaining such a result. We argue that the behavioral realism perceived by the participants, when emotional communication was enabled with a plausible emoticon selection, was unexpected and somewhat beyond their expectations when facing a computer-controlled opponent. Therefore, we consider that our main finding is not that computer-controlled social entities with plausible behavioral realism could induce a higher sense of copresence than human-controlled social entities with similar behavioral realism, but rather that computer-controlled social entities with behavioral realism beyond users' expectations could induce a higher sense of copresence than human-controlled entities. While this mismatch in expectations may act in favor of the computer-controlled entity, it is also possible for the opposite phenomenon to occur. In our opinion, Potdevin et al. [44] measured this opposite phenomenon as a lower sense of social presence was observed when participants faced a video capture of an actor not exhibiting any intimate behavior (e.g., open gestures, head nods, and head tilts). In this particular case, the actor's behavior probably failed to meet the participants' expectations. A similar interpretation could apply to the work of Guadagno et al. [48]. They observed that a virtual human who smiled at the participants improved social evaluations when it was introduced as a computer-controlled character and degraded them when it was introduced as a human-controlled character.

It appears that in some situations, computers are social actors and are even more likely to elicit social behaviors than humans. These situations could result from behavioral realism that would exceed users' expectations, leading to a significant increase in their sense of copresence.t

6. Limitations and Future Works

We decided to rely on an image recognition game that was accessible online to be able to carry out this experiment during the lockdown period due to the sanitary situation. Contrary to most text-based computer-mediated communication that allows direct communication between users, we decided to enable only emotional communication through emoticons between the rounds of the game for a couple of reasons. First, communicating and perceiving emotional states during social interactions has a significant impact on social presence. We wanted to focus on the potential interdependence of perceived agency and emotional communication. Therefore, we considered emoticons as the equivalent of nonverbal communication in text-based CMC. Second, developing an algorithm to ensure plausible answers was feasible using emoticons, whereas it would have been more difficult to process participants' messages to send back plausible answers that would not reveal the real identity of the computer-controlled opponent. While we observed interesting and significant results, the proposed application presents a limited use case. We aimed at adapting this experiment in an immersive virtual environment with 3D virtual characters that provide more and richer social cues. Such an experiment will make it possible to investigate and discuss further the CMC theories and models. It would be particularly interesting to observe whether a similar increase in copresence is observed when computer-controlled 3D virtual characters exhibit social cues beyond users' expectations.

7. Conclusion

We developed an experiment to investigate the impact of perceived agency and emotional communication on social presence in an online image recognition game. Participants faced a presumed human-controlled opponent or a computer-controlled opponent. Our results demonstrated that several dimensions of social presence were impacted when emotional communication through emoticons was enabled. Participants experienced higher perceived affective understanding, perceived emotional interdependence, and perceived behavioral interdependence. The main finding of this study concerns the interaction effect we observed between perceived agency and emotional communication on participants' sense of copresence with their opponent. The impact of emotional communication on copresence depends on the perceived agency of the opponent. While emotional communication barely impacted copresence when participants were facing a presumed-human-controlled opponent, a significant increase was observed with a computer-controlled opponent when emotional communication was enabled. The sense of copresence was even higher with the computer-controlled social entity than with the presumed other player. We argued that social cues were beyond participants' expectations in the computer-controlled condition, creating in return a significant increase in their sense of copresence with the autonomous social entity. This particular result cannot be fully explained by theories of social interaction in computer-mediated communication, such as the ethopoeiatheory [34, 35] or the threshold model of social influence [39]. Furthermore, experiments should be conducted using media providing richer social cues, such as immersive virtual environments, to investigate whether our results also apply to 3D virtual characters, avatars, and agents.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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