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Virtual Intimacy, this little something between us

A study about Human perception of intimate behaviors in Embodied Conversational Agents

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ABSTRACT

Building a long-term relationship between human and virtual agent remains a challenge. This paper explores the influence of intimate behavioral cues and the impact of different interaction modalities (voice, text, gesture) on our perception of intimacy. We built a virtual Tourism Information (TI) counselor capable of intimate behaviors based on grounded theories of intimacy developed in psychology. We studied how external observers perceive the social behaviors of the agent during its interactions with a human tourist. Our originality is to evaluate the perception of social skills across the interaction. Our results show that nonverbal behaviors of the virtual agent reinforces the impact of verbal cues on human perception on virtual intimacy. Findings also suggest that textual medium of communication has a negative impact on the perception of virtual intimacy, whatever the level of animation and intimacy exhibited by the TI counselor.

CCS CONCEPTS

• **Human-centered computing** → **Social engineering (social sciences)**; • **Applied computing** → **Psychology**;

KEYWORDS

Social ECA, Virtual Intimacy, Multimodal Communication

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1 INTRODUCTION

Many companies acquire embodied conversational agents (ECAs) to expand their offers to continuous online-services. These systems, shaped to the brand's image, provide a professional expertise and allow companies to keep virtually in touch with their customers at any time. However, the establishment of a satisfying virtual customers-relationship between users and ECAs do not exclusively

depends on the virtual agent's expertise and definitively addresses social considerations [27]. Indeed, what makes the strength of a merchant is not only the product he sells or the service he offers. It is above all a question of human relationships. Tons of people daily return to "that bakery" because they appreciate the relationship they built with their baker thanks to few words every morning. The pursuit of more and more intimate interactions answers an inherent human need of social contact that is a main motor for our actions and influences our behaviors and attitudes [12].

In the literature in psychology, interpersonal intimacy refers to behavioral, physical, cognitive and emotional sharing experiences that involve both verbal and nonverbal communication [18]. Several social behaviors, such as smiling, self-disclosing, increasing physical proximity or amount of gaze, have been described to promote a greater level of intimacy between two individuals [2, 14]. Beale and Creed suggest that the affective dimension of ECAs has the potential to enhance human-computer relations, influencing user attitudes and behaviors [3]. In other words, virtual agents providing intimate interactions would be more susceptible to satisfy users' social needs.

In this paper, we present a study that interrogates human perceptions of ECAs' social behaviors in relation to intimacy. We collected human observers' perceptions of professional interactions between a virtual Tourism Information (TI) counselor and a human tourist. We aim to answer two questions: How does the presence of intimate cues in verbal and nonverbal communication of ECAs influence human perceptions? How do communicative modalities in ECAs (oral, text-based or body language) modify human perceptions?

2 RELATED WORKS

One long-term goal of our research group is to build an ECA with social competencies that enhance the interaction with the user and support the establishment of a social relation. To this end, we need to understand how verbal and nonverbal behaviors can convey intimacy in human interactions, prior to transposing such behaviors on ECAs. We first study the notions of intimacy in social sciences. We show how this notion is used in Human-Computer Interaction (HCI). We discuss its relation with other inter-relational concepts, such as *Rapport*, often considered in the context of Human-Agent interactions.

2.1 Intimacy

According to Prager [17], interpersonal intimacy refers to behavioral, physical, cognitive and emotional sharing experiences that involve both verbal and nonverbal communication. He showed that

intimate relationships are built on successive interactions. Prager [17] distinguished two subordinate levels: intimate behaviors and intimate experiences. Intimate behaviors lean on both verbal and nonverbal communication, whereas intimate experiences refer to perceptions of understanding and positive feelings. Thus, our goal is to study how humans perceive intimate behaviors and experiences in ECAs.

Several behaviors are known as conveying intimacy. Physical proximity, amount of gaze or smiling are nonverbal behaviors known to modulate the degree of intimacy [2]. Dialogical strategies such as self-disclosure, that is revealing a personal or emotional evaluation of an experienced situation, also contribute to manage intimate interactions [19]. Moreover, self-disclosure has been found to promote more connected and closer interpersonal relationships [14]. Laurenceau et al. [10] also showed that reciprocity and mutual implication of both partners play a key role in an intimate relationship. In other words, responsiveness and investment are subsequent dimensions of the intimacy necessary to establish intimate relationships. Reis and Shavers [21] additionally suggest that the perception of confirmation, reinsurance and comprehension from the other is a necessary condition to obtain warm and intimate interactions. The concept of intimacy is thus inherently present in social interactions. It is structured around a reciprocal expression of personal or emotional contents, and the perception of positive feelings and comprehension.

In our work, we propose to study intimacy in several types of non-verbal behaviors (gesture, posture, facial expressions, and gaze) and verbal behaviors (self-disclosing, engagement, reassuring, and re-affirmation). We then study how this sum of intimate behaviors affects the perception of intimacy.

2.2 Social Presence in HCI

Intimacy also appears to be a central concept in HCI: Gunawardena and Zittle [8] explained that it is tightly connected to Social Presence. Social presence is understood as "the sense of being with someone else" and occurs both in human and human-machine interactions [22]. Social presence effect leans on the capacity of human beings to reinterpret the mental properties, emotions and intentions of the interaction partner. Reeves and Nass showed that, even in the presence of a non-human interaction partner with limited social cues, people can perceive minded entities [20]. They theorized that people naturally initiate anthropomorphic interactions with machines. Humans act in a social manner and give machines humanoid traits and properties such as gender, personality, attitudes and intentions [15]. As an example, all of us probably already got mad at our crazy computer, thinking that it is bothering us purposely and acting like we would do it with a real person. Short, William and Christie identified intimacy as one essential characteristic of the medium to allow a feeling of social presence [22]. Additionally, Gunawardena and Zittle [8] reported the social presence phenomenon to be composed of two subsequent dimensions: intimacy and immediacy.

Such research contributions support the need for studying intimacy in the context of HCI. Indeed, intimacy is a major concept in our questioning around ECAs' social abilities and their recognition as social interactants for users.

2.3 Social Competencies in ECAs

Other concepts than intimacy are studied in Human-ECA interactions. Several teams studied social competencies in ECAs through the concept of rapport. [9, 24]). Rapport is a feeling of connection and closeness with another [28]. Tickle-Degnen and Rosenthal [26] described the nature of rapport in terms of a dynamic structure of three interrelating components: mutual attentiveness, positivity, and coordination. Both verbal and nonverbal behaviors play an important role in the management of rapport [13, 25]. Rapport and intimacy are theoretically distinguishable by the coordination component of rapport, absent in Prager's definition of intimacy. However, Cappella [6] underlined conceptual dissonance in the common definition of rapport and suggested a likely overlap between coordination and positivity. These results pointed out a theoretical convergence between intimacy and rapport. Furthermore, Zhao et al. [28] suggested that rapport plays a key role in the quality of the interaction with a virtual counselor. Thus, rapport and intimacy both contribute to the expression of social competencies and promote warm relationships. As an example, SARA, the socially-aware robot assistant is able to manage during the interaction, an estimated level of rapport from user' behaviors [13]. According to this estimated rapport, SARA automatically adapts its conversational strategies, using self-disclosure or reference to shared experiences. These verbal behaviors, chosen by the authors to manage rapport, are also acknowledged as conveying intimacy.

Current research on rapport with ECAs mostly focus on the expression of social behaviors by the virtual agent. However, it would be necessary to understand how users perceive these behaviors. Curgeon et al. [7] suggested that an exploration of users' perceptions, feelings and thoughts would be required to get a better comprehension of users' point of view. Accordingly with this user-centered perspective, Bickmore, Schulman and Yin [4] investigated users' engagement during a task-related interaction with a conversational agent. This work revealed that when they were conversing with an agent delivering storytelling about itself rather than about someone else, users showed a greater engagement in the task resulting in better performances. Indeed, virtual systems using dialogical strategies, such as self-disclosure, are able to increase task-relevant performances of the individual and guaranty a better appreciation of the interaction. However, the social dimension of the virtual agent only appears through verbal behaviors. On the contrary, Ochs et al. [16] focused on the nonverbal expression of the virtual agent's social attitudes. Based on gaze aversion, head moves and orientation, gestures and facial expressions, they asked human participants to design different social agents according to the social attitude they have to exhibit. However, Ochs et al. are interrogating human perceptions only during the conception process, whereas human feelings remain unknown when interacting with the socially expressive agent.

We claim that it is required to investigate perceptions, feelings and thoughts of humans facing an interaction between a virtual agent and its interlocutor. The following section precise the modeling of verbal and nonverbal behaviors into the virtual agent used in our experiment.



Figure 1: Conversational interface.

3 THE VIRTUAL TOURISM INFORMATION COUNSELOR

We developed an embodied conversational agent which is a Tourism Information (TI) counselor, provided with ad-hoc knowledge about La Charité sur Loire, France. This agent was developed in two versions: one with intimate behaviors and the other with neutral, meaning non intimate, behaviors.

3.1 Technology

Our virtual TI counselor is an experimental version of an existing ECA created by DAVI®, a software editor company specialized in the conception and animation of conversational agents.

In collaboration with 3D computer graphic designers, we produced videos showing a role-play interaction between our virtual TI counselor and a human tourist. The agent was positioned in the middle of the scene, behind a selling counter, facing the human interlocutor (located on the right side of the screen, see Figure 1). We were particularly focused on the visual rendering and the animation of the virtual agent to enable the expression of intimate behaviors. DAVI® provides a large set of all-body animations created with the animation motor engine Unity®. For the purpose of this study, we created additional animations with specific features inspired from the literature in psychology. The virtual agent's animations involved postures, gestures, head moves, facial expressions and gazes. The nonverbal animation of the TI counselor was described in a pre-calculated time-line in Unity®. Its verbal animation involved dynamic text-based chat boxes and the use of a synthetic French female voice.

3.2 Intimacy Operationalization

3.2.1 Virtual Intimacy (VirtI). Prior to animating our virtual agent with intimate conversational and nonverbal behaviors, we defined a theoretical model of virtual intimacy (VirtI), based on the concept of intimacy in the literature in psychology. We consider three factors in the definition of VirtI: "honesty and genuineness", "positivity" and "mutual comprehension". The factor Honesty and Genuineness refers to spontaneous expression of emotional and personal experiences, feelings or intentions as proposed by [18]. The factor Positivity is related to positive feelings and investment in the interaction with the other [18]. Finally, the factor Mutual

comprehension refers to the perception of confirmation, reassurance and comprehension from and toward the other, as proposed by [21] and [10]. We used these three factors of VirtI as a basis to operationalize intimate conversational and nonverbal behaviors in our TI counselor.

3.2.2 Conversational behaviors. We relied on information provided by the Tourist Information Office of La Charité sur Loire and its TI counselors' feedbacks to draft our scenario. In this French-speaking language scenario, the virtual TI counselor is answering tourist's queries about cultural activities and lunch recommendations. We duplicated this scenario in two versions, respectively related to a neutral and an intimate condition. However, the touristic content and the information provided by the counselor remain unchanged between both conditions.

In the neutral condition, the virtual counselor provides only task-related touristic information. As an example, the agent can provide information about a Japanese restaurant.

In the intimate condition, we supplement the task-related content of the virtual counselor with intimate conversational cues. The social cues we selected to reflect VirtI were specific words, verbal expressions or rephrasing, that serve as supplement to the informative content. We categorized the intimate cues according to the factor of VirtI they refer to. Intimate cues related to self-disclosure or shared opinion belong to the factor "honesty and genuineness". Personal advices and recommendations, proof of investment and the use of active voice "I" correspond to "positivity" whereas expressions of approbation refer to "mutual comprehension" factor (e.g."you are right"). Indeed, each social cue respectively refers to one factor. We equally distributed into the scenario the intimate cues related to each factor to prevent a differential effect of factors on human perception. Thus, we introduced twenty-four intimate cues along the intimate version of the scenario and each factor was represented by eight social cues.

3.2.3 Nonverbal behaviors. Our virtual TI counselor's animation involves postures, gestures, head moves, facial expressions and gazes, in both neutral and intimate conditions. However, the features of the animation differ according to the experimental condition.

In the neutral condition, the nonverbal behavior of the virtual agent comes synchronously with the verbal content and refers exclusively to task-related information. The counselor only plays descriptive gestures, neutral facial expressions and half-randomized eyes-contact. The agent makes eye contact at least once during each speech turn, but it does not maintain the contact during the whole interaction. The virtual counselor in the neutral condition also have a repertory of basic postural and head moves.

In the intimate condition, the nonverbal behavior of the virtual agent comes synchronously with the verbal content and is associated with both task-related information and intimate conversational cues. The animations chosen for the intimate virtual counselor were built from the literature review (see [2, 16]). They answered four specific animation criteria: (1) Gestures are larger and more oriented toward the interlocutor than in the neutral condition. They can be either descriptive or rhetoric and empathize the agent's conviction in the talk. (2) The virtual agent plays head-tilts and head nods. (3) Eyes-contact frequency is higher in the intimate

condition than in the neutral condition. (4) The TI counselor, in the intimate condition, manifests a set of emotional facial expressions, involving smiles of various intensity, eyebrows moves, confusing and questioning expressions. Each nonverbal behavior is associated with one or more factors of VirtI. As an example, smiling can be assigned to one of the three factors according to the context, whereas, head nods are only allocated to "mutual comprehension" factor.

In the following section, we present a study that aims to question human observers' perceptions about the virtual TI counselor combining verbal and nonverbal intimate behaviors during the interaction. Our goal is to understand how human beings perceive these intimate behaviors when exhibited by a virtual agent, to inform the construction of future socially aware ECAs. Moreover, we question the influence of the communication modality on the perception of VirtI.

4 EXPERIMENTAL STUDY

4.1 Participants

107 participants (53 females) have been recruited from on-line platforms (Prolific, Facebook and Amazon Mechanical Turk). Participants were from 18 to 69 years old (Mean age = 30.57) and were French native speakers.

4.2 Experimental design

The study was designed as a 2 (*Intimacy*: neutral vs. intimate) x 2 (*Embodiment*: non-animated vs. animated) x 3 (*Communication Modality*: text-based vs. oral vs. text-based and oral) mixed-factorial design, in which only the independent variables *Intimacy* and *Embodiment* follow a between-subject presentation.

Our first independent variable *Intimacy* was manipulated through the virtual TI counselor's behavior, following the description of the intimacy operationalization, in section 3.2. Specifically, the expression of VirtI was systematically involving both verbal and nonverbal behaviors.

Our second independent variable *Embodiment* was manipulated through the interface, including or not on the screen an animated representation of the virtual counselor. In the animated condition, the agent had a 3D-animated representation, whereas in the non-animated condition, The virtual agent was represented by a static picture of itself.

The last independent variable *Communication Modality*, was manipulated through the medium of verbal communication allocated to the TI counselor. According to the condition, the virtual counselor could communicate either through (1) a text-based chat-box, (2) its synthetic voice or (3) a combination of both. In this last case, the verbal content provided from both media was identical and appeared synchronously.

4.3 Procedure

The experiment took the form of an on-line survey, administrated on a crowd-sourcing platform. Each survey was organized as followed: participants were first informed of the aim of the study and were asked to answer a consent form. Prior to start the experimental task, they were given explanations and guidelines about it.

Then, participants performed the experimental task. When the task was done, demographic informations (age, sex, profession) were collected from participants. Finally, participants who seriously and entirely performed the task were greatly thanked and were given a completion URL to be granted from the platform. Study details and contacts were also shared to participants.

The experimental task was structured around blocs, successively presented to participants. Each bloc was representative of one experimental condition (for details, see section 4.2 Experimental design) and contained a video of the interaction between our virtual TI counselor and a tourist. The video was followed by a questionnaire that interrogated the perception of VirtI from the participant.

The questionnaire used to collect participants' perception and feelings about VirtI from the virtual counselor is detailed in the next subsection.

4.4 Measurements

There are many self-reported scales in the literature in psychology that evaluate the degree of intimacy that one person maintains with someone else [11]. These scales are focusing on the human one's perception, and to our knowledge there is no scale questioning the perceived degree of intimacy that an ECA maintains with another one human. For the need of the study, we built a Virtual Intimacy Scale (VIS) to collect Human's perception of VirtI from a virtual TI counselor in interaction with a human tourist.

We relied on the literature in psychology to create the VIS questionnaire. Mainly, the VIS is inspired from the FAP Intimacy Scale [11]. Leonard et al. described the scale as "a self-report measure that adequately captures intimacy-related behavior". It consists of 14 items divided into 3 factors that are respectively "Hidden thoughts and feelings", "Expression of positive feelings" and "Honesty and genuineness". However, factorial analysis of the three factors showed close results for both "Hidden thoughts and feelings" and "Expression of positive feelings", suggesting a potential overlap of these factors. We combined the factors "Hidden thoughts and feelings" and "Expression of positive feelings" into a unique factor, named "Positive feelings" in the VIS, and conserved the factor "Honesty and genuineness". Based on the conceptualization of intimacy in the literature in psychology, we felt that the scale did not enough refer to the dimension of comprehension and reinsurance. Thus, we relied on the 7-items "Intimacy" factor of the Triangular Love Scale [23] to add a third factor to the VIS, namely "Mutual comprehension".

We combined items from both scales and made some arrangements: some items were excluded from the questionnaire because they were redundant between scales or inappropriate in a context of interaction with a virtual entity. Other items were also modified to better fit with the situation. The items syntax was adjusted, not to self-report but to report the virtual counselor's behavior. Finally, all the remaining items were translated in French language. The VIS is currently including 15 items, into 3 factors : (1) Honesty and Genuineness includes 5 items (e.g. "The virtual TI counselor acted spontaneously with the tourist"); (2) Positive Feelings includes 4 items (e.g. "The virtual TI counselor enjoyed its interaction with the tourist"); (3) Mutual Comprehension includes 6 items (e.g. "The virtual TI counselor paid attention to the tourist"). A measure of

Cronbach's alpha showed satisfiable reliability into the 15-items combination ($\alpha = 0.89$) and into each of the items combination per factor, respectively factor 1 $\alpha = 0.75$, factor 2 $\alpha = 0.77$ and factor 3 $\alpha = 0.79$.

Items were administrated using 0 to 100 percent sliders, to increase the precision of the perceived level of intimacy collected.

We also added a rate of explicit VirtI to our VIS questionnaire. The global VirtI rate based on the 15-items was an implicit measure of the VirtI perception, whereas, the explicit rate was rather a subjective measure in which the intimacy was explicitly evoked. Correlation analysis showed satisfiable coefficient of correlation between these two measures of virtual intimacy ($r = 0.69$). We interpreted this satisfiable correlation as an evidence of validity for our VIS, so that, statistical analysis were exclusively conducted on the global VirtI rate and on the VirtI rate for each of the three factors.

An additional information recall task composed of 2 items completed the VIS questionnaire. This task aimed to give some clues about the attentional level allocated toward the virtual agent's behaviors, according to the experimental condition. Both items were multiple-choice questions respectively related to verbal (e.g. "Among these propositions, what is the topic of the interaction you have just seen before?") and nonverbal content of the virtual counselor (e.g. "Among these propositions, which one matches with the behavior of the TI counselor?"). However, since the agent did not play any nonverbal behavior in the Non-animated conditions, the attentional task were only about verbal information in these conditions.

4.5 Hypothesis

Firstly (H1), it is hypothesized that human observers will perceive the VirtI conveyed by the virtual TI counselor. Thus, the level of perceived VirtI will be superior in intimate conditions than in neutral conditions.

Secondly (H2), it is predicted that human observers will perceive better the VirtI conveyed by the virtual TI counselor when the intimacy will be expressed both verbally and non-verbally by the virtual agent. We hypothesized that the VirtI rate will be higher when the TI counselor is presented in intimate and animated conditions, than in intimate but non animated conditions.

Contrary to text-based modality, we believe (H3) the oral modality of verbal communication in the interaction will reinforce the perception of VirtI when the virtual TI counselor will be intimate and animated. Thus, we hypothesized that when the virtual TI counselor is presented in intimate and animated condition, the VirtI rate will be superior using oral modality than text-based modality of communication.

Finally (H4) it is assumed that text-based modality of communication will minimize the attentional level allocated to nonverbal behaviors of the virtual TI counselor. It is hypothesized that when the virtual counselor will be intimate and animated, the error rate for the nonverbal recall task will be higher in the text-based modality condition, than in both other conditions of Communication Modality.

Next section reports our results regarding the perception of VirtI in human-ECA interaction.

5 RESULTS

Prior to test our hypothesis, we explored the distribution of the data. Results from Kolmogorov-Smirnov test supported the assumption of normality. Satisfying a normal distribution, global VirtI score from the 15-items and VirtI score from the 3 factors-items were explored. A mixed-design ANOVA with modality of communication (oral, oral and text-based, text-based) as a within-subjects factor and intimacy (intimate, neutral) and embodiment (animated, non animated) as between-subjects factors was used. Additional t-tests were also conducted for 2 by 2 comparison between conditions.

The significance level for all the analysis was set at $\alpha < 0.05$. We studied effect sizes using Cohen's d and eta-squared (η^2).

5.1 Impact of conveyed intimacy by virtual agent on user perception

The ANOVA conducted on global virtI rate, obtained from the 15-items rate, revealed a main effect of Intimacy ($F(1,103) = 25.000$, $p = 0.000001^*$, $\eta^2 = 0.20$). Global virtI rate was higher in intimate conditions ($M = 69.24$, $SD = 12.71$) than in neutral conditions ($M = 56.58$, $SD = 15.47$).

We explored this phenomenon on virtI rate from factors-items rate and we found consistency of this main effect along the 3 factors: ANOVA conducted on virtI rate related to Factor 1 "Honesty and Genuineness" showed a significant difference ($F(1, 103) = 46.059$, $p = 0.000001^*$, $\eta^2 = 0.31$) between intimate ($M = 60.86$, $SD = 16.97$) and neutral conditions ($M = 40.95$, $SD = 16.65$). The one conducted on virtI rate related to Factor 2 "Positivity" showed a significant difference ($F(1.103) = 11.57$, $p = 0.001^*$, $\eta^2 = 0.10$) between intimate ($M = 73.72$, $SD = 13.25$) and neutral conditions ($M = 63.49$, $SD = 17.71$). The third ANOVA conducted on virtI rate related to Factor 3 "Mutual comprehension" showed a significant difference ($F(1.103) = 9.168$, $p = 0.003^*$, $\eta^2 = 0.08$) between intimate ($M = 73.25$, $SD = 13.25$) and neutral conditions ($M = 64.99$, $SD = 17.71$).

These results corroborate with H1 showing that intimate conditions are perceived as conveying more virtI than neutral conditions.

Although no more main effect was expected, multivariate analyses on global virtI rate revealed a second main effect of Communication Modality ($F(2,206) = 5.427$, $p = 0.005^*$, $\eta^2 = 0.05$). Global virtI rate in text-based modality conditions ($M = 61.11$, $SD = 14.50$) was significantly lower than in oral modality conditions ($M = 63.83$, $SD = 14.96$) and than in oral and text-based modality conditions ($M = 63.79$, $SD = 16.45$).

This main effect of Communication Modality remained significant when ANOVAs were conducted on the virtI rate for factor 1 "Honesty and Genuineness" ($F(2,206) = 5.104$, $p = 0.007^*$, $\eta^2 = 0.05$) and on the virtI rate for factor 3 "Mutual Comprehension" ($F(2,206) = 4.470$, $p = 0.013^*$, $\eta^2 = 0.04$).

Interestingly this result showed that whatever the condition of Intimacy nor Embodiment, the perception of virtual intimacy was significantly lower when the TI counselor provided only text-based modality of communication.

Finally, ANOVA conducted on global VirtI did not reveal any main effect of Embodiment ($F(1, 103) = 0.108$, $p = 0.743$, ns). There was no significant difference between animated ($M = 63.33$, $SD = 15.83$) and non animated conditions ($M = 62.49$, $SD = 14.97$). When considered alone, Embodiment did not significantly influence the

global virtI rate. Furthermore, no significant effects were neither found considering the virtI rate for factor 1 to 3.

5.2 Impact of the agent's intimacy and animation on user's perception

ANOVA only revealed a significant effect of interaction between Intimacy and Embodiment ($F(1, 103) = 4.546, p = 0.035^*, \eta^2 = 0.04$), when considering the virtI rate for factor 3 "Mutual Comprehension" (Figure 2). LSD Fisher post-hoc analyses showed a significant difference ($p = 0.035^*$) between intimate animated ($M = 77.25, SD = 12.97$) and intimate but non animated conditions ($M = 69.25, SD = 12.38$).

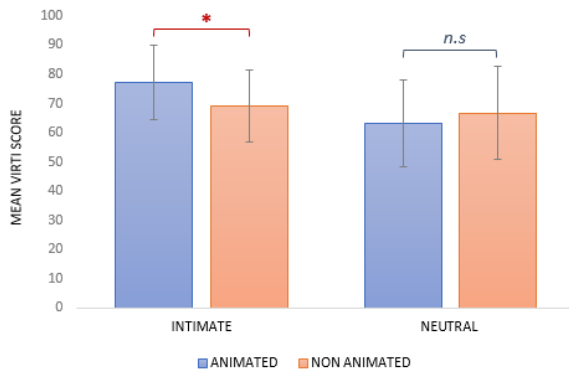


Figure 2: Perception of Mutual Comprehension according to the agent's intimacy and animation.

These mixed results, partially confirm our H2 expecting that participants would report higher level of virtI when the intimate TI counselor is animated than when it is not.

Finally, ANOVAs showed no significant interaction effects between Intimacy and Communication Modality, whatever the dependent variable considered.

5.3 Impact of conveyed intimacy by virtual agent, its embodiment and its modality of communication on user perception

ANOVAs were performed to test the interaction effect between Intimacy, Embodiment and Communication Modality. No significant interaction effect was found whatever the dependent variable considered.

Additional independent-samples t-test indicated that "Mutual Comprehension" factor score was significantly higher for intimate animated condition ($M = 77.55, SD = 14.17$) than for intimate but non animated condition ($M = 69.76, SD = 12.43$) for oral modality of communication ($t(55) = 2.21, p = 0.031^*, d = 0.58$). We observed a similar result for oral and text-based modality of communication ($t(55) = 3.40, p = 0.001^*$).

When we consider only the TI counselor who was intimate and animated, global virtI score was significantly lower for text-based modality ($M = 68.82, SD = 14.33$) than oral modality ($M = 71.84, SD = 13.08$), ($t(24) = 2.64, p = 0.014^*, d = 0.53$) and had a tendency to

be lower than oral and text-based modality of communication ($M = 72.00, SD = 11.41$), ($t(24) = 2.64, p = 0.054, d = 0.53$), see Figure 3.

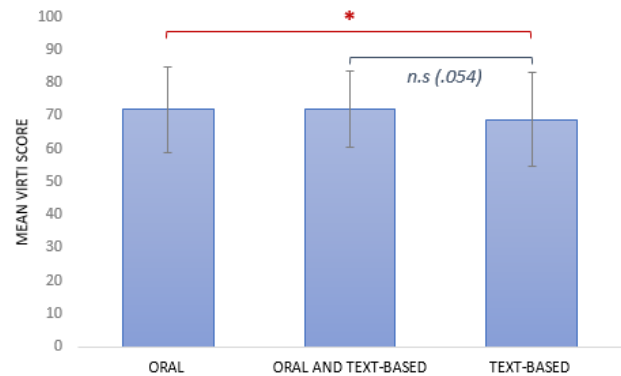


Figure 3: Intimate and animated TI counselor : Perception of global virtI score according to Communication Modalities.

However, when we focused on factor 1 "Honesty and Genuineness", we found that values were significantly higher in oral and text-based condition ($M = 65.65, SD = 14.44$) than in oral condition ($M = 60.47, SD = 19.86; t(24) = 2.40, p = 0.024^*, d = 0.48$), or than in text-based condition ($M = 57.03, SD = 20.21; t(24) = 3.19, p = 0.004^*, d = 0.64$). To the contrary, when we focused on factor 2 "Positivity", we found that values were significantly lower in oral and text-based condition ($M = 68.26, SD = 21.43$) than in oral condition ($M = 77.50, SD = 14.08; t(24) = 3.71, p = 0.001^*, d = 0.74$) or than in text-based condition ($M = 75.12, SD = 15.49; t(24) = 3.19, p = 0.045^*, d = 0.64$). Finally, analysis revealed that virtI rate related to factor 3 "Mutual Comprehension" was significantly lower in text-based modality condition (textitM = 74.44, $SD = 14.91$) than in oral and text-based modality ($M = 79.77, SD = 9.37; t(24) = 2.57, p = 0.017^*, d = 0.51$) or than in oral modality condition ($M = 77.55, SD = 14.17; t(24) = 2.39, p = 0.025^*, d = 0.48$).

These results partially corroborate our H3, expecting that virtual intimacy would be more perceived when the intimate and animated TI counselor provides oral communication modality than both other modalities.

5.4 Impact of Intimacy and Modality of Communication on information recall

Accordingly with our hypothesis, we conducted descriptive analysis and Khi^2 tests to evaluate the influence of Intimacy and Communication Modality on nonverbal recall task.

Participants made a mean error rate of 0.25. However, we reported a different distribution of error rates between both conditions of Intimacy, respectively 0.05 and 0.44 in intimate and neutral conditions. Khi^2 tests confirmed that whatever the used modality of communication, the error distribution was significantly higher in neutral conditions than in intimate conditions ($\chi^2(1) = 82.79, p = 9.E-20^*$).

We also study the influence of the communication modality on participants' error rates. Mean error rates were respectively 0.40, 0.42 and 0.44 for oral, oral and text-based, and text-based conditions.

Inconsistently with our expectations, we found no effect of the communication modality, even when the TI counselor was intimate.

Finally, we did not find any significant difference between conditions in the verbal recall task.

6 DISCUSSION

The aim of the present study was to foresee the impact of verbal and nonverbal intimate cues into virtual agents' behavior, on human perception of virtual intimacy. On the other hand, this experiment aimed at investigating whether communication modalities of an ECA could influence the perception of this virtual intimacy.

Our findings supported that people judged the virtual TI counselor more intimately when providing intimate behaviors than neutral behaviors. This result is consistent with our hypothesis (H1) and confirm a suitable modeling and operationalization of the intimacy cues of our TI counselor. We claim that our model of virtual intimacy inspired from interpersonal relationship literature [2, 10, 14, 19] allows the design of behaviors that encourage a social recognition of the ECA.

6.1 Contribution of nonverbal behaviors in the perception of virtual intimacy

Since the virtual TI counselor could exhibit nonverbal behaviors, or not, we expected that the combination of both verbal and nonverbal cues would have a more powerful impact on human perception of intimacy, than verbal behaviors alone. Interestingly, we found such effect only when we interrogated the Mutual Comprehension factor of virtual intimacy. The agent was perceived more intimately when it was intimate and animated than when it was intimate but non animated. Accordingly to our hypothesis (H2), nonverbal behaviors of the virtual agent reinforces the impact of verbal cues on human thoughts. To the views of our findings, we propose that the power of nonverbal social cues is dependent of the variety and the number of intimate cues exhibited. Contrary to verbal cues that were rigorously equally-distributed between factors, nonverbal cues were rather dependent of the dialogical context and were not exhibited equivalently between factors. Further, Mutual Comprehension factor was probably the richer factor in term of nonverbal cues as it was associated with head nods and tilts, smiling, eye contact and confused facial expression.

The results are interesting and suggest that nonverbal behaviors associated with intimacy do not contribute equally to Honesty and Genuineness, Positivity and Mutual Comprehension dimensions. They invite further work to better understand the intimacy concept, its expression and the contribution of different cues to the perception of intimacy during an interaction with a virtual other.

Furthermore, we wonder to what extent perceptive mechanisms involved in a human-ECA interaction are similar to those involved in human-human interactions. We definitively believe that an experiment involving a human TI counselor and a tourist would allow a comparison of socio-perceptive mechanisms engaged during an interaction with an ECA or with another human being. To conclude, the clarification of the virtual intimacy concept and the better comprehension of human perceptive mechanisms are in our mind, two essential considerations for building a long-term relationship between humans and ECAs. Indeed, intimacy is known as a main

component of social presence [8] and we are convinced that only ECAs that are sources of social presence can be recognized as credible and social partners for human users.

Additionally, our results showed that the impact of nonverbal behaviors on human perception previously described for Mutual Comprehension factor, completely disappeared when the TI counselor communicates through a text-based chatbox.

This suggests that when people are facing intimate and animated ECA with a textual medium of communication, two parallel processes occur and people seem to focus on the task-oriented processing and not on the interaction-oriented processing. Thus, they probably give priority to textual contents at the cost of nonverbal elements of the interaction. Indeed, reading has been demonstrated to be an archaic and automatic process that interferes with processing other information about the world [1]. Thus, there would be a competition between reading processes and perceptive processes during the interaction.

Indeed, in absence of communication modality considerations, results from the information recall task demonstrated that people get better performances at recalling nonverbal behaviors exhibited by the agent, when this agent is intimate than when it is neutral. This suggest that intimate manifestations during the interaction draw the individual's attentional focus on the animated embodiment of the agent. In contrast, we thought that when using a text-based medium of communication, the attentional focus would be mainly allocated to reading process, so that people would make more errors at recalling nonverbal behaviors. However, we failed at demonstrating a higher error rate when the TI counselor was intimate and using text-based communication, compared to oral or text-based and oral communication. This could be possibly explained by the lack of sufficient data. Indeed, our results exclusively lean on half the data since only half participants were facing an animated TI counselor. Another explanation would be that when the TI counselor is using a text-based medium, participants would maintain low-level processes that allow the perception of nonverbal behaviors, however high-level mechanisms related to the social print of these behaviors would be inhibited by reading process.

6.2 Influence of the communication modality on perceived intimacy

Surprisingly, our findings demonstrated that the perceived social dimension of an ECA is not limited to its behavioral cues but also involves side-properties such as the medium chosen to communicate with the interlocutor. In this vein, Biocca, Harms and Burgoon [5] affirmed that social presence greatly depend on the context of interaction, the individual property and the medium itself.

Here, we found that whatever the presence or absence of intimate cues, people considers the virtual TI counselor to be less intimate when it provides text-based communication, compared to oral communication or a combination of both media. This observation suggest that, independently of its negative impact on the perception of nonverbal behaviors, the textual medium of communication breaks down the feeling of intimacy during the interaction. This observation could perhaps be explained by the lack of naturalness and warmth of the textual medium compared to oral communication.

Consistently, we showed that when the TI counselor exhibit intimate verbal and nonverbal behaviors, the use of a text-based medium of communication deteriorate the virtual agent's score of virtual intimacy, compared to both other media. However, we additionally studied the impact of the communication modality separately on each dimension of the virtual intimacy and found differential effects. Although text-based modality of communication was associated with the lowest scores of intimacy when considering factors Honesty and Genuineness and factor Mutual Comprehension, this observation was not replicated for the Positivity dimension of virtual intimacy. As we previously suggested, virtual intimacy seems to be a multidimensional concept on which the virtual agent's modality of communication cannot have a unique impact. In the light of these results, we need further investigations to define the balance and the sensitivity of each factor in the concept of virtual intimacy.

6.3 Limitations and perspectives

Nevertheless, our work addresses methodological limitations.

This study has been designed as an exploratory experiment and as a first step of a larger project that aims at investigating the impact of social abilities of a virtual agent on user's behaviors, feelings and thoughts in a context of ecological interaction. Although our results confirm that a human observer perceives intimacy from a virtual agent, there is no evidence that he will similarly experience virtual intimacy when interacting with this virtual agent in an ecological context. Indeed, socio-attentional mechanisms related to the perception of intimacy might be different whether we are observer or actor of the human-ECA interaction. Thus, future research will be directed at investigating whether users perceive virtual intimacy when they interact with an intimate virtual agent, and whether the perception of virtual intimacy influences users' behaviors, feelings and thoughts toward the ECA. To this end, we want to interrogate tourists' perception and behaviors during and after the use of an interactive device providing a TI counselor with intimate behaviors.

In addition, our experiment raises an issue in term of intimate behaviors automation. Until now, our study led on a pre-computed scenario, in which dialogical contents as well as verbal and non-verbal intimate cues were manually executed. However, we believe that already-computed scenarios are incompatible with managing social behaviors of the virtual agent. However, intimacy is known as a dyadic concern which involves both partners of the interaction [17]. Thus, the emerging of a long-term relationship between ECAs and users, built on intimate interactions, needs the ECA to adapt its behavior during the interaction. The virtual agent should manage its expression of intimacy, according to the user's attitudes and the social tone of the interaction. In this vein, Matsunaya et al. [13] paved the way of social agents capable of managing their own behavior on the basis of users' behavior. Our further investigations will focus on the automatic generation and the regulation of virtual intimate behaviors during the interaction.

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