“It” + “I”: Virtual Embodiments as Hybrid Experiences

T. Giraud[1], A. Paljic[2] and L. Leroy[3]

[1]LIMSI-CNRS, France
[2]Ecoles des Mines, Paritech, France
[3]Université Paris 8, France

Abstract

A dichotomy exists in the way virtual embodiments are currently studied: embodied entities are considered by conversational approaches as other selves whereas avatar approaches study them as users’ hosts. Virtual reality applications such as in our case study often propose a different, in between embodiment experience. In the context of a virtual house for sale visit, this paper aims at examining the user’s self-reported embodiment perception resulting from such a hybrid experience. To induce variability in this embodiment experience, we manipulated avatar representations (high versus low anthropomorphism) and frame of reference (egocentric versus exocentric). Results show the importance of the entity humanness to foster both experiences. When controlled by humanness, having a conversational experience appears uncorrelated to an avatar experience. This highlights the need to study these hybrid experiences as a combination of both approaches.

Categories and Subject Descriptors (according to ACM CCS): I3.7 [Computer Graphics]: Three-Dimensional Graphics and Realism - Virtual reality / Animation.

1. Introduction

To embody is the act of giving a body to an agent, a person or a system. Use of embodiments in interactive applications has a long history in Virtual Reality. But as one tries to trace it, two distinct approaches stand out despite early unified frameworks [Tha96]. Works on autonomous virtual agents represent a first line of research [CSX04]. In this perspective, embodiment aims to provide a natural interface with agent functionalities by using human-human interaction routines [CSX04]. The other line of research deals with user embodiment, for example in collaborative interfaces [BBF*95]. These incarnations of user presence in virtual environments are called Avatars. One line of research questions how users can communicate through non verbal behaviours [GCP*99]. This academic dichotomy seems pertinent as it appears transposable from everyday life: we are used to own our body, and interact with others’ bodies. But with embodied entities, combinations of those experiences are possible. As an example, many computer games propose *gameplaies* combining autonomous and controlled aspects. The focus of this paper is on exploring the user’s embodiment experience resulting from the interaction with a hybrid embodied entity. This bodily entity is a parallel combination of user controlled aspects and autonomous behaviours. An experiment is presented to evaluate the hybrid construction of the embodiment perception. To induce variability in this embodiment perception, we manipulated avatar representations (high versus low anthropomorphism) and frame of reference (egocentric versus exocentric).

2. Background on the two paradigms

2.1 Conversational approach

Embodied entities used as autonomous partners are called Embodied Conversational Agents (ECAs). Today, numerous approaches exist to design and evaluate ECAs [RP04]. In this paper, we focus on the user perception of the agent embodiment. For conversational agent, this experience is firstly characterized by its naturalness. As they are designed to benefit from human to human interaction routines, naturalness is often linked to anthropomorphism. For example, users’ social responses increase with human-likeness computer representations [Gon08]. Biological movements are also crucial for anthropomorphism [DMT12]. To complete the ECA believability, it should respond in a social coherent manner in the task context. These are the form and behavioural aspects of ECA realism [BYMS06]. A social presence feeling results from this overall conversational naturalness. Biocca and colleagues defined it as “the feeling of being with another” [BHB03]. It induces the automatic generation of models of the intentionality of others. In a larger perspective, Vugt and colleagues propose a model which describes users’ engagement as a result of aesthetics, ethics, realism, similarity, relevance and valence [VKH*07].

2.2 Avatar approach

Avatars are digital body representations controlled by the user. They personify presence, location, identity, activity, etc [BBF*95]. This experience of controlling an embodied entity

has been studied in different ways. For example the Proteus effect is described as a user behaviour adaptation to conform to the avatar persona [YB09]. Users will express more dominance if acting through a tall avatar. Such influence is mediated by immersion variables such as presence [FBB09]. Also, Mohler and colleagues observe that distance judgments are more accurate when acting through an avatar body [MCTB10]. Displacements synchrony, body movements' synchrony and body representation increased accuracy independently. Extreme embodiment experience can lead to body ownership experience. Initially done with a rubber hand, the experience of virtual body ownership has been replicated on whole body ownership [PE08]. This was done by altering the normal association between touch and its visual correlate. A recent work by Kalckert and Ehrsson make clear the distinction between ownership and agency [KE12]. Overall, body representation, sensory and action synchrony as well as person perspective contribute to different components of the embodiment experience.

2.3 Hybrid works

These two paradigms are well defined and their research field very active. Works on embodiment take one or the other perspective, but rarely cross them. Few studies deal with this question of hybridization. Gerhard and colleagues propose a hybrid avatar/agent model to enable a continuous embodiment presence [GMH04]. This model is sequential: autonomous agents are used when users are away. As a sequential approach, the hybrid embodiment experience is not questioned. To our knowledge, no work on the study of this possible parallel combination of experiences exists.

3. Experiment

This study aims at exploring the embodiment experience from both paradigms in a use case which includes some hybrid embodiment aspects. Those aspects of conversational and avatar experiences are present at the same time inducing a possible mixed experience.

3.1 Application and materials

The experiment takes place in the context of a specific use case proposed by the industrial Saint Gobain Recherche: the exploration of thermal comfort in a virtual house. A character is used to represent the comfort by its autonomous reactions to the environment. The user controls the character displacements. This combination of controlled and autonomous aspects makes this use case relevant for our research. The application is composed of several components:

- A virtual house with a living room meshed by a set of temperature data. Temperatures result from a simulation to ensure their realism (e.g. colder near a window).
- A 3D virtual character which reacts to the environment. He has five waiting/idle behaviours triggered depending on the location: freezing idle if on cold temperatures to sweating idle if on hot temperatures.
- An immersive setup: users stand in front of a wall (2m*3m) with active stereoscopy and head tracking (Figure 1 (a)).
- A directional control of character displacements: users point with a Wiimote at a 2D mini-map of the sitting room to direct the character to a position (Figure 1 (d)).

3.2 Procedure and evaluation

To vary the embodiment experience, we designed four conditions (2*2 between subjects): Human (high anthropomorphic) / Sphere (low anthropomorphic) (Figure 1. (b)) * Egocentric reference frame / Exocentric reference frame (Figure 1. (c)) (Hu-Sp / Eg-Ex). In the egocentric reference frame condition, the user viewpoint is not collocated with the avatar body (1 meter behind) but is tethered to its displacements. Each participant is explained the use case scenario of the task: he visits a house for sale and has to explore the living room thanks to the 3D character in order to make an idea of its thermal comfort. Before starting the task, participants are invited to test the immersive system on a neutral scene (outside the virtual house) without the

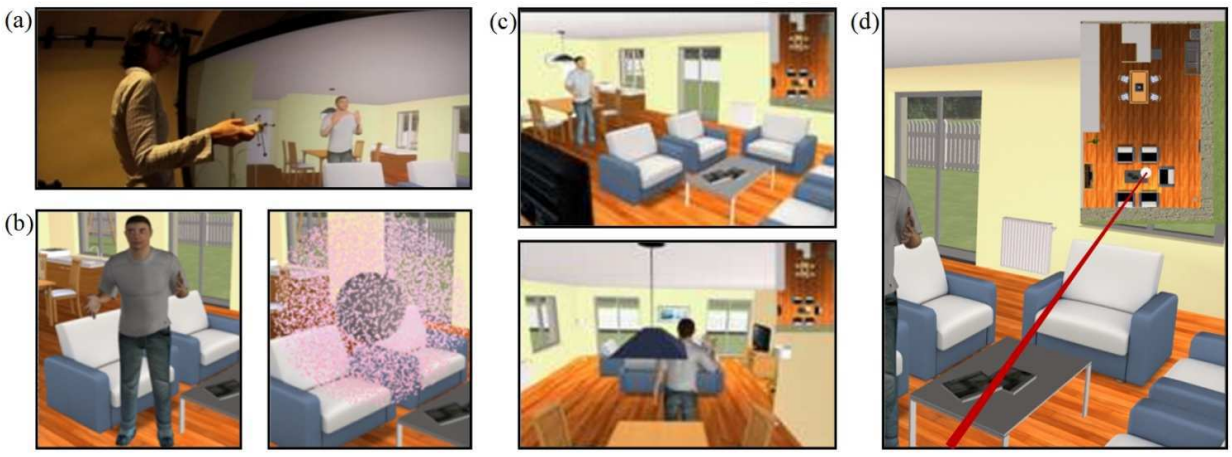

Figure 1. *(a) User in the immersive environment. (b) Left: High anthropomorphic character, Right:Low anthropomorphic character. (c) Top: Exocentric point of view, Down: Egocentric point of view. (d) Ray to point on the 2D mini-map to displace the character.*

character. Then the user begins the task, exploring the virtual environment by moving the character. This exploration session lasts 3 minutes. Once finished, participants are invited to fill in the questionnaire with all affirmations in a randomized order. This part takes approximately 10 minutes. This paper focuses on the self-report analysis measures.

3.2 Perceived embodiments

Perceived embodiments refer to the two ways an embodied entity can be traditionally perceived: as an avatar or an ECA. Two scales are proposed to measure each type of experience. One consequence of a conversational experience is the simulations of "other minds" and the attribution of intentionality. To evaluate this intentionality attribution three items are proposed (Table 1). The resulting average is the Intentionality variable (Int). An avatar experience results in a better projection in place of the body in the virtual world: better distance estimation and better immersion [LSK*08]. Three items are proposed to evaluate this projection feeling (Table 1). The resulting average is the Projection variable (Pro). Each item of these two dimensions is a Likert type affirmation. Answers are ranging from 1 (I fully disagree) to 5 (I fully agree). How these two scales interact is of particular interest.

3.3 Perceived humanness

As shown by Konijn and colleagues [VKH*07], the overall embodiment perception is a result of concurrent intermediate variables. In this paper, we focus on variables related to the humanness of the embodied entity: Realism (Rea), Anthropomorphism (Ant) and Similarity (Sim). Indeed these variables are known to foster the experience from both approaches [VKH*07]. Each scale is composed of four items, and each item is a Likert type affirmation (Table 1). They are ranging from 1 (I fully disagree) to 5 (I fully agree).

4. Results

36 subjects have realized our experiment ranging from 16 to 57 years old (M = 29, SD = 11.7) with 42% women and 58% men. 39% of respondents were having a strong background in informatics. All variables have normal distributions allowing the use of parametric tests. Scale reliability is evaluated with Cronbach's α. All scales range from acceptable to good with Cronbach's α ranging from 0.61 to 0.81. Table 2 presents Pearson and partial correlations between perceived embodiment variables Int and Pro with Humanness. The three variables correlate positively and significantly. When controlled by Humanness, Int and Pro are no more significantly correlated. Table 3. shows multivariate linear regressions with humanness variables in predicting perceived embodiment variables. Such analysis enables to understand the unique influence of each predictor taken into account the variance of the others.

A low level of multicollinearity was present among the six predictors and the two perceived embodiment variables (Variance Inflation Factor < 2.5). Multivariate linear regressions are done twice: first without and then with the three interaction terms (Rea*Ant, Rea*Sim, Ant*Sim).

Table 1. *List of items and the reliability of each scale.*

Scale	Items
Realism α = 0,71	The avatar has a natural appearance The avatar seems to be real The avatar seems to be fake * The avatar has an artificial appearance *
Anthropo-morphism α = 0,76	The avatar seems to be human The avatar behave as a human being The avatar seems to be different from a human* The avatar behave differently than a human being *
Similarity α = 0,71	The avatar and me are alike inside The avatar and me have common characteristics The avatar and me are different * The avatar and me are dissimilar */**
Humanness α = 0,80	The twelve items from Realism, Antrhopo-morphism and Similarity
Intention-ality α = 0,61	The avatar has intentions The avatar could want to do something The avatar thinks
Projection α = 0,81	The avatar reflects me The avatar represent my person I am feeling at the avatar's place

* These items results were inverted

** This item was removed from the scale due to bad fit

Significant predictors are highlighted in Table 3. Model 1.2 explains 45,6% of the Intentionality variation and model 2.2 explains 61,4% of the Projection variation.

Table 2. Pearson c*orrelations and partial correlations between perceived embodiments and humanness.*

Pearson		Hum	Int	Pro
Humanness	r	1	**,478***	**,620***
	p		**,003**	**,000**
Intentionality	r		1	**,492***
	p			,002
Projection	r			1
	p			
Partial (controlled by Hum)		Int	Pro	
Intentionality	r	1	,284	
	p		,098	

Table 3. M*ultivariate linear regressions.*

	Intentionality				Projection			
	model 1.1		model 1.2		model 2.1		model 2.2	
R^2	0,341		0,456		0,458		0,614	
	β	p	β	p	β	p	β	p
Rea	-,115	,46	-,083	,60	,117	,41	,234	,09
Ant	**,425***	**,02**	**,375***	**,04**	,165	,31	,080	,72
Sim	,278	,11	,294	,08	**,527***	**,00**	**,518***	**,00**
Rea*Ant			-,358	,12			-,036	,85
Rea*Sim			**,470***	**,05**			**,395***	**,05**
Ant*Sim			-,281	,07			**-,312***	**,02**

*. Significance at the 0.05 level

5. Discussion

In our case study, the Humanness of the embodied entity is positively associated with Intentionality (the scale associated with the perception of a conversational entity) as well as Projection (the scale associated with the perception of an avatar). Both are coherent results regarding the literature. The positive association between Intentionality and Projection appears to be mostly mediated by the humanness level. An interesting finding is the absence of correlation between them when controlled by humanness: attributing intentions to the embodied entity is not contradictory with self projecting in it. A question for future researches is to look at this pattern of relations with a more extreme avatar experience, for example by increasing the coupling between the user and the virtual body. In this case, increasing the conversational approach by autonomous behaviours might impair the avatar experience. For both perceived embodiment scales, the three Humanness subscales with their interaction terms explain a large part of their variances in the regression analysis. This result confirms the importance of these three dimensions as well as their complementarities. Looking at subscales of Humanness, it appears that both scales (Int and Pro) are differently predicted by Humanness. Intentions attribution is associated with the more explicitly related to Humanness scale (Ant). The interaction term Rea*Sim shows the relative importance of Similarity as a moderator, as shown by Vugt et al [VKH*07]. This means that giving a human shape and behaviors to the entity alone is not a guarantee of the intentions attribution: the perceived similarity should be high as well. The Projection scale is associated with Similarity as well as two interaction terms: Rea*Sim and Ant*Sim. To foster the avatar perception, increasing the similarity level should go along with increasing the entity realism and decreasing its human attributes. To enable to operationalize these results as guidelines for virtual embodiment design, the next step is to identify the embodied entity attributes (shapes, behaviours, controllers, etc.) influencing these self-reported dimensions. Taken together, these results outline the necessity to overcome the traditional dichotomy in embodiment studies. Owning our body and seeing other's bodies is a real life case which is no longer the rule in immersive virtual words. This is even true for robot in real life [RS07]. This study shows that these two experiences are not contradictory (one is not inhibiting the other). It highlights the need to study these hybrid experiences as a combination of both approaches.

Acknowledgment

The authors wish to thank Saint Gobain Recherche which has supported this research. They provided the industrial use case as well as the 3D environment associated with. Special thanks to Frédéric Achard who followed the project for his patience and insightful feedbacks.

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