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DESIGN AND EVALUATION OF INVENTIVE AVATARS FOR CREATIVITY AND INNOVATION

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Abstract: A challenge today is to create favorable conditions for creativity while enabling geographically distant people to work together. In this context, we study the virtual and digital self representation (i.e., avatar) as a medium for stimulating creativity, in line with the Proteus effect. This paper proposes a methodology for designing, evaluating and identifying relevant avatars adapted for creativity and innovation. The avatar platform we used allows one to create avatars that we evaluated on the basis of two different methods (questionnaire and pairwise comparison). Avatars obtained on the basis of these methods were then subjected to a verification phase to ensure that the user of the avatar has the same perception as evidenced by our methodology. The results demonstrate the validity of the methodology. The prospects of using avatars for creativity and innovation are discussed particularly in light of the Proteus effect.

Keywords: *creativity, avatars, design, innovation, evaluation*

1. Introduction

Today, companies must innovate and differentiate from their competitors. Creativity is the starting point to change the product range and offer new services. In this context, it is essential to find relevant new methods to stimulate creativity and foster innovation.
In addition, technological (networks, virtual environments, etc.) and organizational developments (collaborative design, distributed teams, etc.) create new challenges. Hence creative methods must be consistent with this new reality of work.
In this perspective, we propose to use virtual environments to connect geographically distant people, but also to support innovation. This article focuses, in particular on the avatar (i.e., digital self representation) as a potential vector for stimulating creativity.
However, what is the ideal appearance of an avatar in a context of creativity and product design ?

2. State of the art

The use of creativity methods is currently widespread in the field of engineering design (Bleuzé et al., 2014). Currently, companies view their process in terms of product lifecycle management (PLM) and seek to develop their products in a collaborative way. In this section, we firstly define creativity and collaborative creativity, then, in a second step we look at the influence of avatars on behavior for creativity.

2.1. Creativity

2.1.1. Classical approach

Creativity can be defined as the capacity to produce novel, original work that fits with task constraints (Lubart, 1994). Work refers to all types of ideas and productions across a multitude of domains of societal activity, such as paintings, drawings, and sculptures in the artistic field, stories, novels, or poems in the literary field, and theories, technical procedures, or inventions in scientific and industrial fields. A creative product or idea must be novel in the sense that it goes beyond a replication or copy of that which exists. Moreover, work concerning the attributes necessary for creativity has suggested that a combination of cognitive, conative and environmental attributes is important (Lubart, 1999; Lubart, Mouchiroud, Tordjman & Zenasni, 2003).

2.1.2. Collaborative creativity

Creativity has mainly been investigated from the viewpoint of individuals and the quality of the performance/artifact created. Creativity is a complex activity that involves a large variety of emotional, motivational, and behavioral regulations (Farzaneh et al., 2012). Although the richness of these responses is what motivates an engagement in ongoing activity, relatively few studies have been devoted to understanding their psychological foundation in terms of the dynamic character of the participant's interaction with the physical as well as social environments.

Companies are now globalized and experts are distributed on geographically distant sites. To gather experts physically reports to a puzzle and causes serious costs. Since it is urgent that these experts work in collaborative creativity group (Privitera, 2012; Lindemann et al., 2013), why not connect them through ICT?

Despite its interest, creativity remains an under-investigated topic in the area of Human-Computer Interaction, as compared to how this subject has been well established in the areas of psychology, social science and management science (Edmonds & Candy, 2005 ; Burkhardt & Lubart, 2010). Human-computer interaction research distinguishes in particular three different roles in regard to how tools can support creativity. They are (1) to help people develop skills related to creativity or creative thinking (e.g., Bonnardel, 2009); (2) to support people's creative process while engaging in a creation task (Bonnardel, 2012; Bonnardel & Sumner, 1996); and (3) to engage people in new kinds of experiences (Nakakoji, 2005).

2.2. The influence of avatars on behavior for creativity

2.2.1. Proteus Effect

In line with the proposals of the theories of *self-perception* (Bem, 1972) and *deindividuation* (Diener, 1980; Festinger, Pepitone & Newcomb, 1952), social cues in context of anonymity can modulate the behavior of individuals. Indeed, according to Bem (1972), the individual explains his attitudes and internal states based on observation of external identity cues. According to these propositions, Frank and Gilovich (1988) showed that participants wearing black uniforms show more aggressive behavior than subjects wearing white uniforms. This phenomenon was observed both in laboratory and in natural environment. Moreover, this self-perception process can be accentuated in situation of anonymity since "deindividuation increases the self-perception reliance on identity cues" (Yee, Bailenson, & Ducheneaut, 2009, p.292). For instance, it has been shown that anonymous participants exhibit more prosocial behavior when wearing a nurse costume rather than a Ku Klux Klan uniform (Johnson & Downing, 1979).

More recently, the proposals of these theories have been applied to the field of virtual environments. Indeed, the avatar can be seen as a strong identity cue, since it is an entire self-representation of the user in virtual environments. In situation of anonymity, the digital representation of self can thus influence the users and rationalize their behaviors to be consistent to the identity constituted by the avatar. This phenomenon, known as *Proteus Effect* (Yee & Bailenson, 2007), has been observed in several studies. For instance, attractive avatars lead to behave in a more intimate way in self-disclosure and interpersonal distance (Yee & Bailenson, 2007). It should be noted that this phenomenon is the result of mere exposure to a virtual mirror allowing the participant to see his avatar for about one minute. We can therefore consider that the Proteus effect is initiated almost instantly. In other studies, Yee and Bailenson (2007; Yee, et al., 2009) have also shown that tallest avatar led to the most confident behavior in a negotiation task with a confederate. The same goes with appearance of embodied female avatars, more or less sexy, which can impact perceptions and judgments towards women (Fox, Bailenson, & Tricase, 2013). In addition, the appearance of the avatar (doctor vs. Ku Klux Klan member) can influence the content expressed by the users in a writing task (Peña, Hancock, & Merola, 2009). In fact, the contents differ depending on the appearance of the avatar, the avatars members of the Ku Klux Klan leading to more productions incorporating negative elements (murder, vengeance, crime, and scorn). According to the authors, "using avatars with aggressive associations inhibit more positive thoughts" (Peña et al., 2009, p.14).

2.2.2. The use of avatars for creativity

Considering the early work on self-perception, deindividuation and recent studies on the influence of avatars, the modulation of thoughts and ideas depending on social cues could be highly relevant in the field of creativity. In a cognitive and ergonomic perspective, virtual environments - through avatars and Proteus Effect - could be a relevant vehicle for creativity and production of new and innovative ideas. Indeed, embodying a "creative" avatar could theoretically arouse more creative behaviors which lead to strongest generation of innovative ideas. Moreover, avatars are interface items that are considered particularly attractive, hedonic and persuasive (Nemery & Brangier, 2014). They are a central component of many gamification systems (Singer & Schneider, 2012; Hunicke et al., 2004). Gamification, which refers to the use of game design elements in non-game contexts (Deterding et al., 2011), is generally used to increase user experience and engagement (Dominguez et al., 2013). For all these reasons the use of avatars in creativity sessions seems promising and timely.

Therefore, our objective is to design a digital tool using avatars to improve creativity. To this end, we chose engineering students as a first population: indeed, creativity, which leads to invention and innovation, is a part of nowadays engineers' essential skills. That said, this objective raises a very important question: What is the right digital representation for creativity? And in particular, what is the right representation for the engineer's creativity?

Because the appearance of avatar is central in Proteus and self-perception processes, the first step consists in finding relevant digital representations of "creative people". However, since physical features and personality traits that characterize creative people are multidimensional and non-exclusive (e.g., Lubart et al., 2003), the prototypic avatar for creativity may not exist, but may emerge from specific users' representation of what "being creative" means. Thus, more precisely, our aim is not to find a digital representation for creativity *per se*, but to identify the cognitive representation of the engineers when they think about what a creative engineer looks like.

In consequence, this article proposes a method designed to find the right representation for creativity in a given population (i.e., engineers). In other words, this method allows to objectify a broad concept such as creativity and to provide relevant virtual representation.

3. Methodology

3.1. Context of the study: The CREATIVENESS project

The present study took place in the research program CREATIVENESS (*CREAtive acTIvities in Virtual ENvironmEntal SpaceS*). The objective is to study the effects of using new digital collaborative environments such as Second Life on the processes and performances in collective creative problem solving tasks. The expected outcomes of the project are new understandings to guide the use of virtual environment for creative work. Additionally, we will use the findings from this project and the technological innovations we develop to facilitate industrial applications, such as the creation of virtual meeting room services to offer the best conditions for teams to engage in creative work.

The virtual environment used for this project is Second Life (SL). The main reasons to use SL are the fact that it is readily accessible and the most widely used virtual world. It also has straightforward programmable scripting and programming possibilities that will allow the planned experimental conditions, and it is cost effective due to the large amount of content that is already available (clothing, buildings, indoor and outdoor settings, etc.). Second Life is also a good choice for examining forms of virtual creative expression (Ward & Sonneborn, 2009).

In sum, this project aims to provide the best conditions for teams who engage in a creative activity through the use of a digital environment. In Second Life, each user has the appearance of an avatar in the virtual environment.

3.2. Avatar corpus creation

Based on preliminary interviews with engineering students and teachers, we hypothesized that the image of the inventor (as opposed to the image of the artist for example) should carry the strongest creative potential in engineers' viewpoint, and therefore will be the most relevant representation of creativity for this population. Consequently, the first part of the experiment consisted in creating two corpora of avatars: one series of "inventor" avatars and one of "non-inventor" avatars. We also included avatars with an exuberant look, closer to the representation of the artist, as distractors with regard to the concept of the inventor (these avatars have not been included in the final categories). The Second Life Avatars design interface (Figure 1) allowed us to create and customize as desired our avatars. Body, head, eyes, ears, nose, mouth etc. can be changed, but also the outfits, accessories, haircuts etc. We created 40 avatars whose appearance was subsequently evaluated by our target population of engineering students.

Fig 1. Avatars design interface in Second Life

3.3. Online evaluation of the avatars

To assess the relevance of our two avatar corpora (non-inventor and inventor) we developed two methods. The first was a questionnaire composed of five items: (1) *This character is attractive*; (2) *This character seems to be able to cooperate with others during a brainstorming session*; (3) *This character could propose innovative ideas*; (4) *This character seems sociable and extroverted*; (5) *This character resembles an inventor*. Questions 2, 3 and 5 were directly related to the study purpose, while question 1 and 4 were included as control variables to avoid bias (e.g. check that the inventors we designed were not more or less attractive than the non-inventors avatars). Each participant could respond via a five points Likert-scale from "not at all" to "absolutely". This questionnaire was distributed online to 45 engineering students from Arts et Métiers ParisTech Engineering School.

The second one, inspired from *Facemash* (precursor of Facebook website) from Mark Zuckerberg (Figure 2), is a direct pairwise comparison method. The evaluator has to compare two avatars and choose, for each comparison, the avatar that best matches a given feature (i.e., looks like an inventor). Once an avatar is selected, the choice is recorded and a new comparison (with two new avatars) is proposed to the judge. Sixty-nine judges (engineering students, all different from the first sample) rated the avatars with this method.

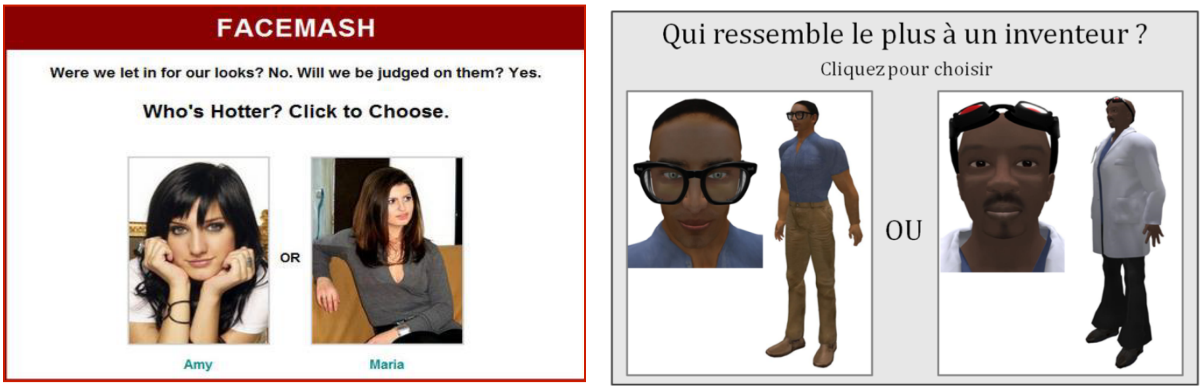

Fig 2. Direct comparison tool inspired by Facemash

3.4. Verification phase after avatar embodiment

This final phase was conducted in order to ensure that persons who embody the avatars perceive them the same way as external evaluators. Participants were 54 students / PhD students from Arts et Métiers ParisTech Engineering School (9 women, 45 men). None of them had participated in the avatars evaluation phases. Participants had never used Second Life before the experiment. So they began with a quick tutorial (about 5 minutes). Then they embodied for 15 minutes the avatars selected during the previous evaluation phases. These participants indicated on a 5-points Likert scale, if their avatar (1) looked like an inventor, (2) was capable of producing innovative ideas and (3) was attractive. The objective of this verification phase was to test avatar perception after embodiment and without prior priming on the concept of "inventor". Indeed, users were not informed of the category (inventor vs. non-inventor) of their avatar either before or during embodiment.

4. Results

4.1. Questionnaire

4.1.1. Organization of the questionnaire items

The perception of the "inventor" appearance proved to be positively correlated to the ability to produce innovative ideas (r=.79; p<.001). In other words, the more the avatar is seen as an inventor, the more it is perceived as susceptible to produce innovative ideas, and vice versa. In addition, the perception of the avatar as susceptible to produce innovative ideas was positively correlated with its ability to cooperate with other group members (r=.46; p<.01). Thus, we observe that these three items, directly related to the perception of creative skills (i.e., inventor, innovative ideas and cooperation), are organized along the same "creativity" dimension (Cronbach's alpha = .73).

Moreover, the perception of attractiveness and extrovert trait of the avatar are positively correlated (r=.58; p<.01) and do not show correlation with other items. This second dimension, independent of the first, generally corresponds to the social and relational aspect of the avatar (i.e., attractive, sociable, extroverted).

4.1.2. Categorization of avatars

Avatars were categorized according to their score in item 5 of the questionnaire (i.e., *This character resembles an inventor*). In each category, we selected the four most representative avatars (i.e., the four avatars getting the highest scores for the inventor category, the four avatars getting the lowest scores for the non-inventor category) (Figure 3).

Fig 3. Examples of avatars categorized as inventors and non-inventors

Avatars designed as inventors were perceived as resembling significantly more to inventors (M = 5.22, SD = 1.52) than avatars designed as non-inventor (M = 2.48, SD = 1.36), $t(56) = 7.21$; p <.001. In addition, the inventor avatars were perceived as more likely to produce innovative ideas (M = 4.71, SD = 1.48) than non-inventors avatars (M = 3.48, SD = 1.52), $t(56) = 3.17$; p <.01. We also note that the inventor avatars were perceived as more likely to cooperate in Brainstorming situation (M = 4.14, SD = 1.48) than non-inventor avatars (M = 2.96, SD = 1.55), $t(56) = 2.93$; p <.01. Non-inventor avatars were also perceived as more sociable and extroverted (M = 4.67 ; SD = 1.70) than inventor avatars (M = 3.62 ; SD = 1.77), $t(56) = 2.29$; p <.05. However, non-inventor avatars and inventor avatars did not differ significantly on attractiveness (M = 3.03, SD = 1.68 vs. M = 3.07; SD = 1.79), $t(56) = 0.09$; p = .92.

In short, the perception of avatars categorized as inventors or non-inventors differs in a meaningful way in terms of creativity and group collaboration. It is also interesting to note that the perception of the avatar as an inventor and the perception of attractiveness are independent (Figure 4).

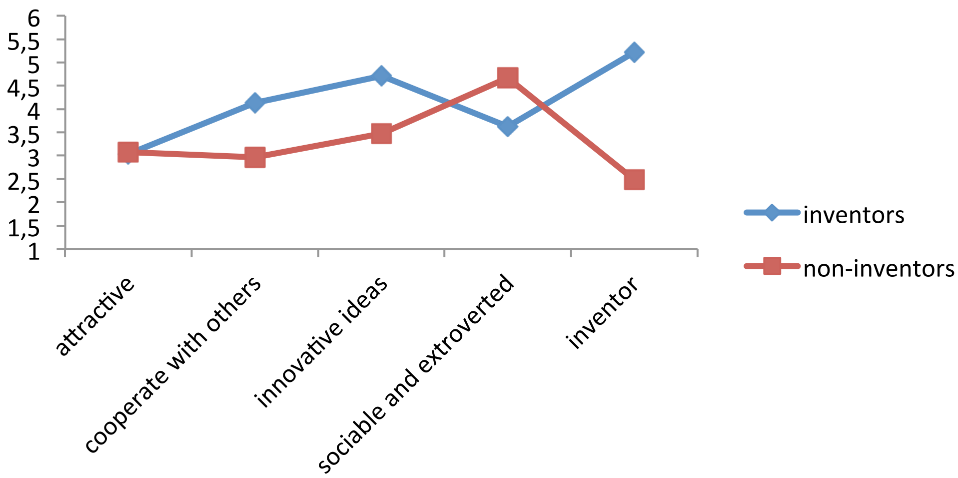

Fig 4. Average score per question for avatars of inventor and non-inventor categories

4.2. Direct comparison

Direct pairwise comparison led to the same categorization as the questionnaire and thus brought out the same pool of avatars. The avatars who scored high on items of the "creativity" dimension were found at the top of the comparison ranking. Indeed, responses to item 5 of the questionnaire and ranking results of the comparison are positively correlated (r=.75; p<.001). More precisely, scores of direct comparison are positively correlated to the "creativity" dimension (r=.77; p<.001), but are not correlated to the second dimension which includes the other items (r=.025; p=.89).

Consequently, the validity of the dual evaluation device is satisfactory. This second assessment tool, based on a different method of presentation than the questionnaire (i.e., avatars are assessed in a comparison mode and thus not in absolute terms) ensures the relevance of the categories identified on the basis of the questionnaire.

4.3. Verification phase after avatar embodiment

The inventor avatars were more perceived as inventors (M = 5.33, SD = 1.57) than non-inventor avatars (M = 3.00, SD = 1.32), $t(34) = 4.81$, p <.001. In addition, the inventor avatars were perceived as more likely to generate innovative ideas (M = 4.72, SD = 1.56) than non-inventor avatars (M = 3.44, SD = 1.42), $t(34) = 2.56$, p <.05. Moreover scores of perceptions of the avatar (inventor and innovative ideas) are positively correlated, r = 0.62, p <.001. We also note that inventor (M = 3.55, SD = 1.68) and non-inventor avatars (M = 3.16, SD = 1.54) obtained statistically equivalent scores of attractiveness, $t(34) = 0.72$, p = .47.

These results indicate that the methodology led to the expected perceptual effects. We now have to study the subsequent behavioral effects of the inventor vs. non-inventor avatars.

5. Discussion and prospects

This paper proposes a new methodology for evaluating the appearance of creative avatars. Based on this methodology we have identified creative avatars by varying a relevant dimension for our population. For engineering student, avatars which look like "inventors" (e.g., looking like Einstein, wearing lab coat or using scientist' instruments) are perceived as the most creative and seen as the most likely to produce innovative ideas. Moreover, these inventor avatars were relevant for users who embody them. In conclusion, we can therefore consider that our two evaluation methods coupled to an embodied verification phase, are valid. In addition, this methodology can be adapted to the selection of other avatars based on other dimensions and with different populations. A complementary method to evaluate the perception of avatars could consist in exposing users to avatars and ask them to freely elaborate on "what this character make [them] think of". This exploratory procedure could enable designers to identify stereotypes voluntarily or involuntarily activated in users perception (e.g., in addition to the stereotype of the inventor, some of our avatars may have primed other concepts, such as ethnic or sociocultural stereotypes).

The following step of our research consists in testing whether the digital representations of inventors produce an effective Proteus Effect, i.e. if they enable the engineering students to be more creative. We are currently conducting an experiment using the avatars selected with the methodology presented in the present article. In this experiment, groups of engineering students brainstorm in a collaborative task during 15 minutes in a virtual room. Each participant embodies an avatar rated as an inventor or as non-inventor. Following previous works in the field of Proteus Effect and self-perception, we assume that both creative performance and innovative ideas should be increased in the inventor condition.

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