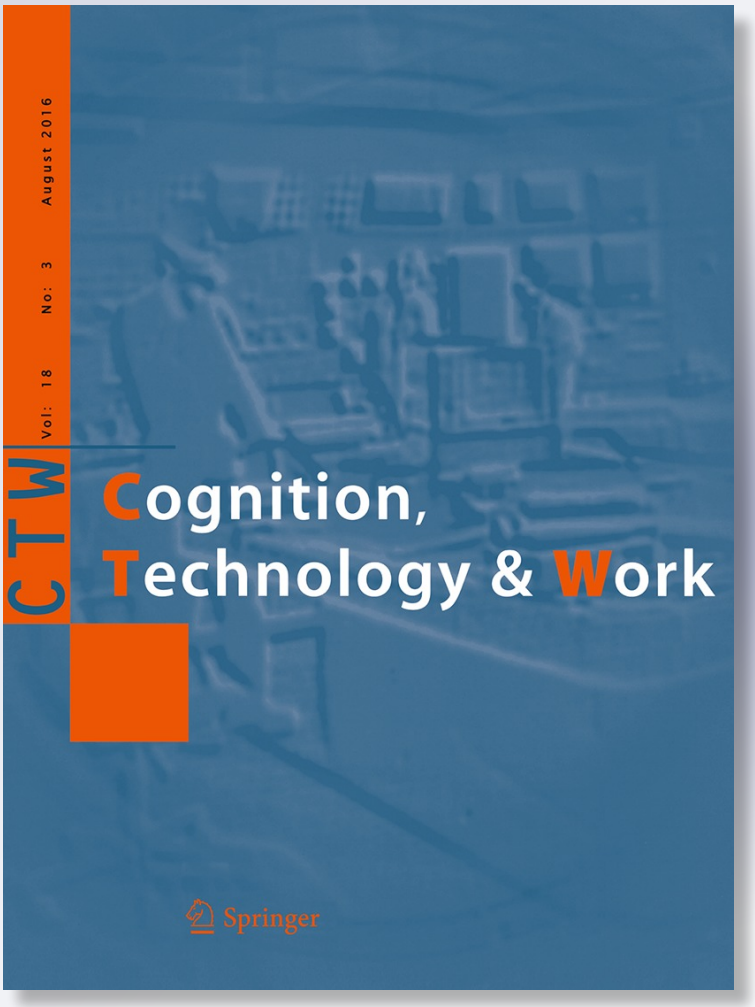
Using avatars to tailor ideation process to innovation strategy

Stéphanie Buisine, Jérôme Guegan, Jessy Barré, Frédéric Segonds & Améziane Aoussat

Cognition, Technology & Work

ISSN 1435-5558
Volume 18
Number 3

Cogn Tech Work (2016) 18:583-594
DOI 10.1007/s10111-016-0378-y



Springer

Cogn Tech Work (2016) 18:583–594
DOI 10.1007/s10111-016-0378-y

ORIGINAL ARTICLE

Using avatars to tailor ideation process to innovation strategy

Stéphanie Buisine[1,2] · Jérôme Guegan[1,3] · Jessy Barré[1] · Frédéric Segonds[1] · Améziane Aoussat[1]

Received: 4 March 2016 / Accepted: 13 May 2016 / Published online: 21 May 2016

Abstract To face innovation challenges of the twenty-first century, companies should learn from proven successful strategies and draw on technological evolutions as well. Our proposal consists in aligning ideation to innovation strategies through the use of avatars in a virtual world. On the basis of the Persona method and the Proteus effect, we design avatars' appearance so as to implement a Need-seeker or a Technology-driver innovation strategy. To test the effectiveness of this avatar-mediated innovation tool, we conducted an experiment in a French company. Two groups of highly qualified employees from the innovation department had to find applications for smart windows in public transportation. Both groups experienced immersion in a virtual transportation situation: one group embodied avatars resembling Inventors, whereas the other group embodied Personas representing users of public transportation. As expected, avatars' appearance proved to influence the creative production: the Inventor condition led to a techno-centered ideation profile, oriented toward technological solutions, while the Persona condition led to more user-centered, needs-oriented ideas. Consistently, Inventors' production tended to be better evaluated through industrial criteria and Personas' production tended to be better evaluated by transportation users. We discuss the use of avatar-mediated creativity as a strategic tool for companies seeking to innovate.

✉ Stéphanie Buisine
sbuisine@cesi.fr

[1] LCPI, Arts et Métiers ParisTech, Paris, France

[2] IRISE, EI.CESI, Nanterre, France

[3] LATI, Université Paris Descartes, Boulogne Billancourt, France

Keywords Need-seeker · Personas · Avatar · Proteus effect

1 Introduction

At the end of 2014, the annual study Global Innovation 1000 (Jaruzelski et al. 2014) reported on 10 years of strategy monitoring within the 1000 companies that invest highest on R&D worldwide and evidenced a set of key success drivers to innovation. In particular, it confirmed the comparative performance of three innovation strategies: Technology-driver (whose priority is to develop products of superior technological value), Market-reader (which focuses on creating value through incremental innovation and customization of products), and Need-seeker (which aims to find unstated customer needs of the future and to be the first to address them). Although the three strategies all possess their own success stories, a long-term analysis clearly shows that Need-seeker outperforms the two other strategies in terms of financial return on investment (Jaruzelski et al. 2014). Moreover, although the three strategies are distributed in roughly equivalent proportions worldwide (35 % Technology-drivers, 40 % Market-readers, 25 % Need-seekers), there are substantial differences related to geographical implantation of companies: for example, in France (Péladeau et al. 2013), Technology-driver remains the dominant model (60 %) and Need-seeker struggles to emerge (17 %). In contrast, Silicon Valley firms are almost twice as likely to follow a Need-seeker model (46 %) than the general population. Innovation analysts therefore recommend developing Need-seeker strategy in countries such as France in order to stimulate innovation and thereby economic growth (Péladeau et al. 2013).

Need-seeking is not straightforward since traditional methods for needs analysis rather turn into a Market-reader approach. There are relatively few methods supporting Need-seeker strategy: endeavors to link technology to future uses should be mentioned (Nelson et al. 2014), as well as the Lead-User method (Franke et al. 2006; Von Hippel 2005), which may be the most effective Need-seeker approach to date. By definition, lead users are precursors and are at the leading edge of important trends in the market. Involving lead users in an innovation project may grant access to needs that will later be experienced by many users and therefore may open successful innovation opportunities. However, diffusion of this method remains limited since lead users are difficult to find and require time—up to several months—to be found (Von Hippel 2005). Less costly methods might be found in design studios (Vyas et al. 2013) or in the Lean Startup framework (Ries 2011) in which designers and entrepreneurs often rely on Personas to imagine user-centered, undreamed of concepts that they subsequently test and improve through short iterations and continuous customer involvement. With regard to the Lead-User method, Personas may therefore be considered a lightweight trigger to Need-seeker innovation strategy.

2 The Persona method

The Persona is a concept formalized by Cooper (1999), Pruitt and Grudin (2003) and Pruitt and Adlin (2010a, b). It is a fictitious character representing a segment of population. According to Blomquist and Arvola (2002), "a Persona is an archetype of a user that is given a name and a face, and it is carefully described in terms of needs, goals and tasks". Representing a group through an archetype advantageously fosters empathy to designers and supports feeling and interpreting action, thoughts and emotions of the target segment (Antle 2006; Bornet and Brangier 2013). It supports user-oriented design, particularly when designers do not belong to the target user category (for example children; Antle 2008). Personas can be used all along the design process, in the design, implementation, or test and measure phases (Pruitt and Adlin 2010a). They can be materialized as posters or storyboards including a name, a face, a general biographical note (e.g., age, occupation, hobbies), and specific information related to the project (e.g., attitudes, expectations, and concerns regarding the target sector or activity).

On a theoretical viewpoint, Persona efficiency may be related to *priming* process. Priming refers to "the incidental activation of knowledge structures, such as trait, concepts and stereotypes, by the current situational context" (Bargh et al. 1996). Because cognition is organized in memory as a structure of knowledge, the mere activation of a concept or a stereotype activates some associated semantic information networks likely to shape ideation accordingly. Moreover, this activation may also lead to *behavioral assimilation*, i.e., an increase in the likelihood of behaviors congruent to the primed concept, which means that in an automatic and unconscious way, one's thoughts, ideas, and behaviors are influenced by the concepts activated by situational cues (Bargh et al. 1996; Dijksterhuis and Van Knippenberg 1998). This phenomenon may explain why Personas help designers imagine concepts that are adapted to users. More specifically, recent research (Bornet and Brangier 2015) suggests that the Persona method does not increase idea generation but improves idea selection process (more accurate filtering and selection of more relevant ideas).

Several studies have tried to enhance Personas' effectiveness by using technology: the concept of virtual Personas was introduced by Thalen and van der Voort (2014) as a tool intended for designers to make Personas perform use scenarios in a virtual world. Likewise, Bonnardel et al. (2016) used a virtual environment to compare a static Persona (displayed as a fact sheet like in the classical method) to a dynamic Persona represented by an avatar and animated by the experimenter according to a scripted scenario. They observed that the dynamic Persona tended to increase participants' creative performance. In the present study, we go a step further by developing Personas in the form of avatars that designers can *embody*. This procedure aims to combine the Persona method and the Proteus effect, as elaborated below.

3 The Proteus effect

Exposure to Personas is expected to lead to behavioral assimilation through priming process, but *embodiment* of Personas is expected to lead to even stronger behavioral effects. In the latter, Personas are not considered as external characters but are used as avatars, i.e., as representations of the self. Avatars are digital characters representing users' identity in a virtual environment (Meadows 2008). They are projections of users, or "tangible embodiment of their identity" (Yee et al. 2009). Through avatars, users can experience multiple identities or highlight certain aspects of their ideal self (Bessière et al. 2007). Thereby, avatars allow users to change their appearance, their social roles, and their identity in a virtual world. A recent line of research has also shown that avatars influence users' behaviors congruently to their avatar's identity. This behavioral modulation was named Proteus effect (Yee and Bailenson 2007, 2009) after the Greek God Proteus who possessed the ability of metamorphosis.

On a theoretical viewpoint, this phenomenon could be explained through the seminal proposals of self-perception theory (Bem 1972), according to which individuals explain their attitudes and internal states based on observation of external cues, just as an external observer would. This is why a change in self-representation may lead to a change in behavior. Moreover, in situations of anonymity and deindividuation (Postmes and Spears 1998) like in a virtual world, self-perception reliance on identity cues (and therefore on avatar's appearance) is enhanced (see Yee et al. 2009).

The Proteus effect was observed in several contexts: for example, attractive avatars lead to behave in a more intimate way in terms of self-disclosure and interpersonal distance (Yee and Bailenson 2007), and tall avatars lead to more confident behavior in a negotiation task (Yee and Bailenson 2007; Yee et al. 2009). It was also shown that the Proteus effect endures over time and affects subsequent offline behavior (Yee et al. 2009; Rosenberg et al. 2013; Yoon and Vargas 2014). This means that the appearance of an avatar influences users' behavior not only in the virtual world, but also in the real world. Finally, in a recent study (Guegan et al. 2016), we have shown that avatars looking like Inventors increase the creative performance of engineers. This benefit also endured over time, and participants allocated to Inventor avatars continued to perform better in a subsequent face-to-face creativity task.

4 Research question

To face innovation challenges, companies are prompted to adopt a Need-seeker strategy and develop a creative mindset centered on future user needs. However, being creative and keeping user needs in mind may appear as antagonist processes: the ideation phase of creativity requires to suspend one's judgment, while creating *for* users requires somehow to introduce evaluation criteria, which are detrimental to ideation (Osborn 1953). Although very popular in user-centered design, the Persona method was not validated by carefully controlled laboratory studies (Grudin 2010; Bonnardel et al. 2016). Because of this experimental weakness, the underlying processes of Personas and their impact on ideation and/or evaluation remain unclear. A recent exploratory study suggested that they may improve idea evaluation and selection, but not ideation (Bornet and Brangier 2015). In the present study, we implement the Persona method in a methodological framework involving the Proteus effect, which was recently used to foster creativity in engineering (Guegan et al. 2016). It was shown that the use of Inventor avatars was likely to increase engineers' creativity, in particular toward breakthrough ideas representing high degrees of R&D difficulty (Mantelet et al. 2016). Making engineers embody users may impact the creative process in its earliest stages: it may support a different mindset in engineers, helping them generate different kinds of ideas without focusing on evaluation criteria—or in other words, think *as* users and not *for* users.

Consequently, the present study was designed to address two challenges: the first one consists in implementing the Persona method in the framework of the Proteus effect and making engineers embody Personas through the use of avatars in a virtual environment. The embodiment process is expected to make engineers think *as* users, in line with the proposals of self-perception theory applied to avatars. In this respect, the second challenge consists in comparing the effects of such Persona avatars to Inventor avatars, which were previously shown as stimulating for engineers' creativity. This point is important since it may highlight the influence of digital representations on ideation process. Hence, our research question may be formulated as follows: Can innovation team's ideation process be oriented through avatars' appearance toward a Need-seeker or a Techno-driver innovation strategy? In particular, we expect to observe the following differences between the two conditions: Inventor avatars may foster technology-centered ideation in engineers, while Persona avatars may foster user-centered/Need-seeker ideation in engineers (Hypothesis 1). The creative performance, assessed by fluency scores, may not be different between these two conditions, but relevance of ideas may be higher with Persona avatars (Hypothesis 2).

This study is expected to contribute to research on the Persona method, by providing a new way to run it within a virtual world, research on avatar-mediated creativity, by providing a comparison between two implementations of the Proteus effect, and research on innovation process, by testing a new tool to develop opposite innovation strategies. To answer our research question and test our theoretical hypotheses, we designed an experiment with a major French company from the transportation industry.

5 Protocol

This experiment was conducted as part of a larger project dedicated to integrating the technologies of smart windows in public transportation. We organized two creativity sessions with participants from our partner company. The two sessions were conducted in a virtual world in order to situate ideation in the target application context (public transportation). The difference between the two sessions concerned avatars: one group was attributed Inventor avatars, and the other group was attributed Persona avatars.

5.1 Participants

Twelve highly qualified employees from a large company's innovation department participated in the experiment. They were all men, aged 22–59 ($M = 39$ years old), specialized in innovation, research and development, system engineering or support services. The sample included four directors and two managers. The two groups were composed so as to match professional profiles, hierarchical positions, and age of the participants (see Table 1).

5.2 Material

We created six Personas (i.e., 6 archetypal users of public transportation) based on field observations in public transportation and on marketing data provided by our partner about its end users. The selected Personas were a young working mother with a newborn (Anne), a middle-aged businessman (Jonathan), a retired elderly man with limited mobility (Joseph), a middle-aged train-manager (Eric), a 10-year-old girl (Noa), and a student (Baptiste). We created short information sheets (with each one's name, age, face, biography, and transportation habits) that were gathered in a booklet, and we finally created their avatars (Fig. 1). For this purpose, we used Second Life facilities because this virtual world is readily accessible and cost-effective due to the large amount of content already available (avatars, clothing, buildings, indoor and outdoor settings, etc.).

Inventor avatars (Fig. 2) were extracted from a corpus of 40 avatars designed for a previous experiment (Guegan et al. 2016) and validated through several online surveys for their capacity to activate the concept of the Inventor and its creative traits.

We decided to immerse the participants in the target situation, i.e., in public transportation. To this end, we designed and selected several environments within Second Life to be visited during the sessions (Fig. 3): we designed a static train station for the familiarization phase and selected a metro tour across Paris that the participants would take for the ideation phase.

5.3 Procedure

Both sessions took place in our laboratory, except for two group members who participated remotely (one in each session). Those who were in the laboratory were installed in individual boxes: even if the participants all knew each other, it was necessary that they ignored who was behind each avatar in order to foster deindividuation. For the same reason, the attribution of avatars to each group member was randomized. Each participant was provided with a computer connected to Second Life and a booklet containing a short tutorial and Personas' information sheets (in the Persona condition only). A facilitator was also present in the virtual world in order to guide the participants during the tour (e.g., give direction from the train station to the metro, ensure that all participants take the same metro) and deliver the instructions for idea generation steps. Facilitator's avatar was extracted from the pool of avatars previously validated as unrelated to Persona profiles or to Inventor appearance (Guegan et al. 2016). All online communication (instruction, discussion, idea generation) was performed through Second Life built-in chat.

The session began with a 20-min phase dedicated to familiarization with the virtual world, with each one's avatar, with control commands, and with communication through the chat. Then the participants took place in a metro traveling across Paris and started idea generation. Their goal was to "find applications of smart windows for privacy, well-being, security and activity of users of public transportation (train, tramway, metro)." More precisely, they were invited to think of six particular user categories. In the Persona condition, they had to imagine applications for each Persona of the group in turn (Anne, Jonathan, Joseph, etc.): for example, we used the following instruction, "Can you find applications of smart windows for the privacy, well-being, security and activity of Anne?" They

Table 1 Age, gender, and position of the participants in the two groups

Persona condition			Inventor condition		
Age	Gender	Position	Age	Gender	Position
54	M	Research and Development Director	59	M	Technology anticipation and Innovation Director
46	M	Purchasing and Supply Sourcing Director	48	M	Industrialization Director
45	M	Innovation Resource Manager	40	M	Sales Manager
32	M	Sub-system Engineer	43	M	Train System Engineer
22	M	Innovation and Research Analyst	30	M	Inventor
24	M	Ergonomist	22	M	3-D modeling Engineer and Ergonomist

Fig. 1 Persona avatars: Anne, Jonathan, Joseph, Eric, Noa, and Baptiste (in this order)

Fig. 2 Inventor avatars

had access to each Persona's information sheet in the booklet. In the Inventor condition, user categories were induced in more abstract terms (a mother, a businessman, an elderly person, etc.): for example, we used the following instruction "Can you find applications of smart windows for the privacy, well-being, security, and activity of a mother?" Ten minutes were dedicated to each user category, which resulted in a total of 60 min idea generation for each group.

At the end of the session, participants were invited to fill in an online questionnaire. The whole experiment lasted 90 min.

5.4 Data collected

Written production extracted from Second Life chat (which contained the ideas generated by the participants, as well as the discussions and instructions from the facilitator) was

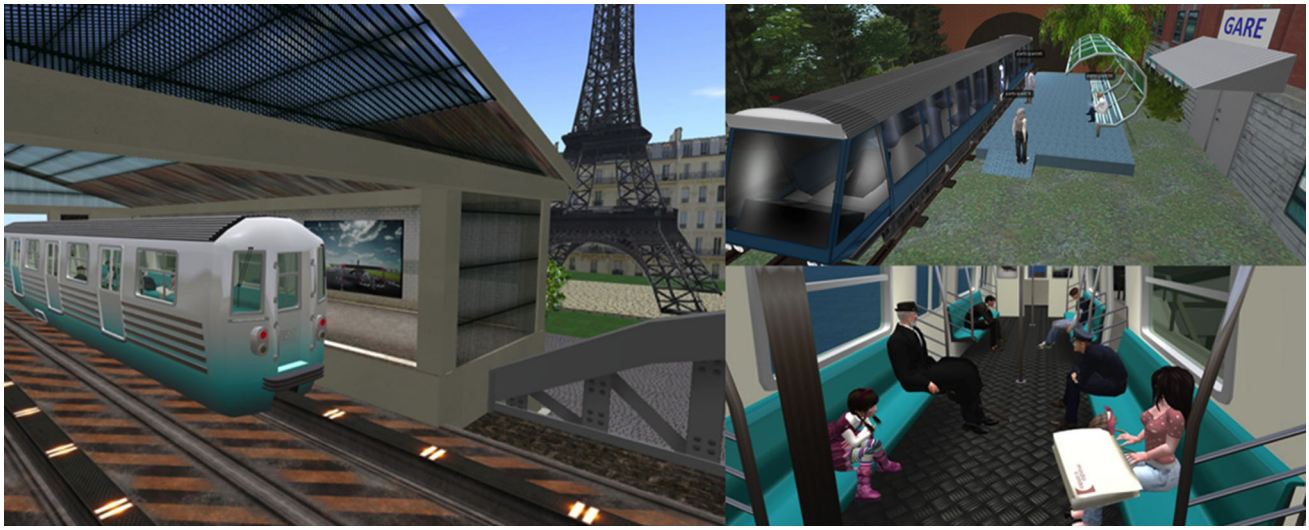


Fig. 3 Virtual environments used in the experiment

first analyzed by our partner company's innovation department: they used their domain-relevant knowledge and industrial criteria to provide meaningful elicitation of the ideas. In the aftermath, we analyzed the creative production of the two groups through the following variables:

- Fluency, which corresponds to the number of ideas.
- Idea content, which consisted in qualitative analysis of vocabulary and in idea categorization under three subsets: User needs (ideas expressed with no reference to any product or to the way to fulfill these needs, e.g., "he's bored with the journey"), Product functions (desired features of products but with no reference to concrete solutions, e.g., "entertainment on the windows"), and Technical solutions (direct reference to technologies or components, e.g., "PlayStation 4 on the windows"). Idea categorization was performed by a judge who was blind to the conditions (Personas vs. Inventors).
- Usefulness in industrial viewpoint: our partner's innovation department rated each idea with its own criteria (e.g., improve security, traffic flow, passengers' comfort, control of ambience, energy saving) declined throughout product lifecycle (e.g., at the platform, when stationary, during travel). This process resulted in a list of 28 criteria; hence, each idea was evaluated on a 0 to 28 scale according to the number of criteria achieved.
- Usefulness in users' viewpoint: ideas were also evaluated by a sample of 15 users of public transportation, matching the target user categories (three mothers, three businessmen, two elderly persons, one train manager, three young girls, and three students). Each respondent rated the ideas targeted to his/her user category in a 1 to 5 usefulness scale.

A series of subjective variables were also assessed through the following items, to which participants had to rate their agreement on 7-point Likert-type scales:

- Self-rated creativity: *I had a lot of ideas; I had high-quality ideas*;
- Motivation—we used a scale extracted from the literature in computer-supported creativity (Buisine et al. 2012; Schmitt et al. 2012): *I was motivated to do well; I tried to do my best; I would like to know my performance; I would like to know the others' performance; I would like to carry on using this tool;*
- Satisfaction: *I found this method more satisfactory than other creativity methods I know;*
- Perception of one's avatar: *I consider that I embodied my avatar; I gave ideas adapted to my avatar; I could not identify individuals, only their avatars; My avatar was attractive; My avatar looked like the character in the booklet, OR My avatar looked like an inventor.*

6 Results

6.1 Idea production

The whole corpus consisted of 398 ideas (208 for the Persona condition, 190 for the Inventor condition). Normality of distribution of variables was checked with Shapiro–Wilk test and homoscedasticity with Levene's test before running Student's t test to compare the two

conditions investigated (Persona avatars vs. Inventor avatars). For each variable, t tests were performed at the individual level, i.e., considering a sample of $N = 12$ participants. Individual fluency was not significantly different between the two conditions ($t(10) = 0.32$, $p = .755$, Persona: $M = 34.7$, SD = 15.8 vs. Inventor: $M = 31.7$, SD = 16.5). Persona condition resulted in a relatively well-balanced production in terms of idea categories (43 % User needs; 21 % Product functions; 37 % Technical solutions), whereas Inventor condition was characterized by a dominance of Technical solutions (62 %) to the detriment of User needs (9 %). Participants in the Persona condition generated significantly more User needs than those in the Inventor condition ($t(10) = 3.67$, $p = .004$, Fig. 4), but the difference was not significant for Product functions ($t(10) = 0.86$, $p = .412$) nor Technical solutions ($t(10) = 1.07$, $p = .309$). Table 2 provides examples of ideas from the three categories.

The Inventor condition was characterized by significantly more technical vocabulary than the Persona condition ($t(10) = 3.48$, $p = .006$). We identified a total of 51 ideas containing technical terms in the Inventor condition (e.g., "energy management", "infrared system", "active noise control", "LCD crystals", etc.) against six such ideas in the Persona condition.

In the Persona condition, which was expected to trigger empathy, many ideas and comments were expressed in the first person: 48 ideas in the first person and a total of 59 personal pronouns and adjectives in the first person (e.g., I, my, we). However, many ideas were also expressed in the third person, when they concerned Personas embodied by another participant. Besides, participants in the Inventor condition also expressed 31 ideas in the first person and used a total of 48 first-person personal pronouns and adjectives. Hence, the number of ideas in the first person was not significantly different between the two conditions ($t(10) = 0.73$, $p = .484$).

Interestingly, participants in the Persona condition did not produce more ideas for themselves (i.e., for the Persona they embodied, $M = 6.5$, SD = 3.1) than for others (i.e., for each other Persona, $M = 5.6$, SD = 2.7, $t(5) = 0.879$, $p = .420$).

Following ratings of usefulness performed by our partner company, we observed that ideas produced in the Inventor condition tended to be better evaluated with regard to industrial criteria than those of the Persona condition ($p = .08$ with the median test). Regarding usefulness in users' viewpoint, we also observed a marginal effect of the condition, but in the opposite direction: ideas generated in the Persona condition tended to be better rated by users of public transportation than those of the Inventor condition ($t(14) = 1.84$, $p = .087$). Figure 5 summarizes usefulness results.

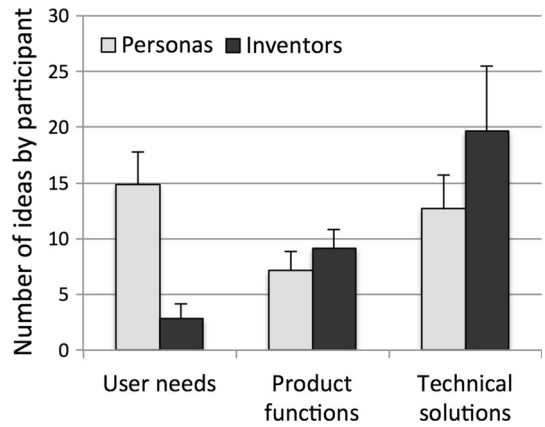


Fig. 4 Mean and standard error of the number of ideas generated by participant in each category (User needs, Product functions, Technical solutions) as a function of the condition (Persona vs. Inventor)

6.2 Subjective variables

Shapiro–Wilk test showed that four subjective variables out of nine were not normally distributed (Motivation, Ideas adapted to avatar, Deindividuation, and Avatar resemblance). Hence, we used nonparametric Mann–Whitney U test to analyze subjective variables. These data (Fig. 6) show intermediate-to-high levels of self-rated creativity (quantity: $M = 5.3$, SD = 1.37; quality: $M = 4.5$, SD = 1.17), high levels of motivation ($M = 5.8$, SD = 1.03), and satisfaction with the method ($M = 5.4$, SD = 1.51). None of these variables show any significant difference between the two conditions (Persona vs. Inventor).

Conversely, four variables related to avatar rating showed marginal or significant differences between the two groups. Participants in the Persona condition experienced stronger embodiment of their avatars ($p = .041$), thought that their ideas were more adapted to their avatar ($p = .002$), and tended to find their avatars more attractive ($p = .065$) and closer resembling to their intended character ($p = .026$) than participants in the Inventor condition. Deindividuation was very high ($M = 6.25$, SD = 1.36) and not significantly different between the two conditions.

Finally, we analyzed with Spearman's nonparametric test the general correlation matrix including all individual data, i.e., fluency scores and subjective ratings. The results notably show strong positive correlations between fluency and self-rated quantity of ideas ($r = 0.86$, $p < .001$), embodiment and resemblance to the intended character ($r = 0.63$, $p = .027$).

7 Discussion

The two sessions examined in this experiment proved successful in many respects. First of all, many subjective dimensions were similarly high in the two groups (feeling

Table 2 Examples of ideas generated by each group in the three categories

	Persona condition	Inventor condition
User needs	I need a peaceful atmosphere	I cannot read on my smartphone with this changing light
	He needs to be informed in real time about the journey	Breastfeed my baby
	This is what I want: fresh air from the outside	Being able to see the driver, it's reassuring!
Product functions	A window ideal for a nap: I lay and I sleep	Create a place visually and acoustically confined
	A support for creation instead of communication	Get information about the monuments I see through the window
	Self-cleaning windows	Use windows as a messaging zone with my fellow passengers
Technical solutions	Signals indicating seats occupied should be visible from the outside	Charge my smartphone via solar cells integrated to the windows
	A film with a headphone output close to the window	When I see a nice view, I click on the window and receive the picture on my smartphone
	A heating window for the winter	Show acceleration and braking through bar graphs for people to anticipate and hang on

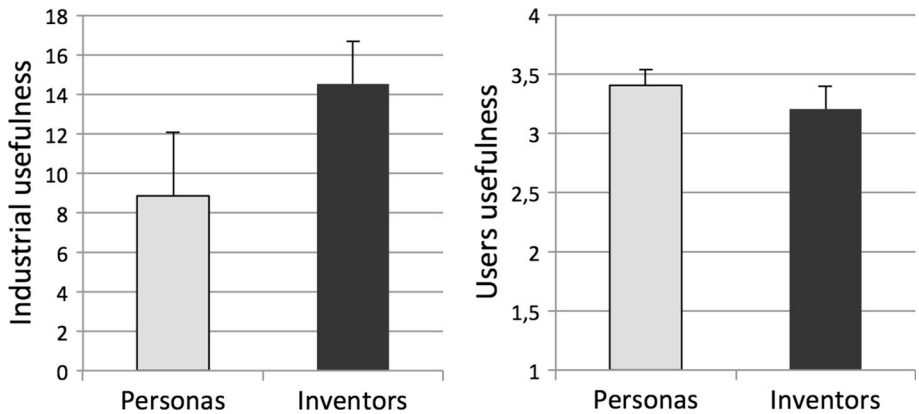


Fig. 5 Mean and standard error of usefulness ratings in industrial viewpoint (*left panel*) and users viewpoint (*right panel*) as a function of the condition (Persona vs. Inventor)

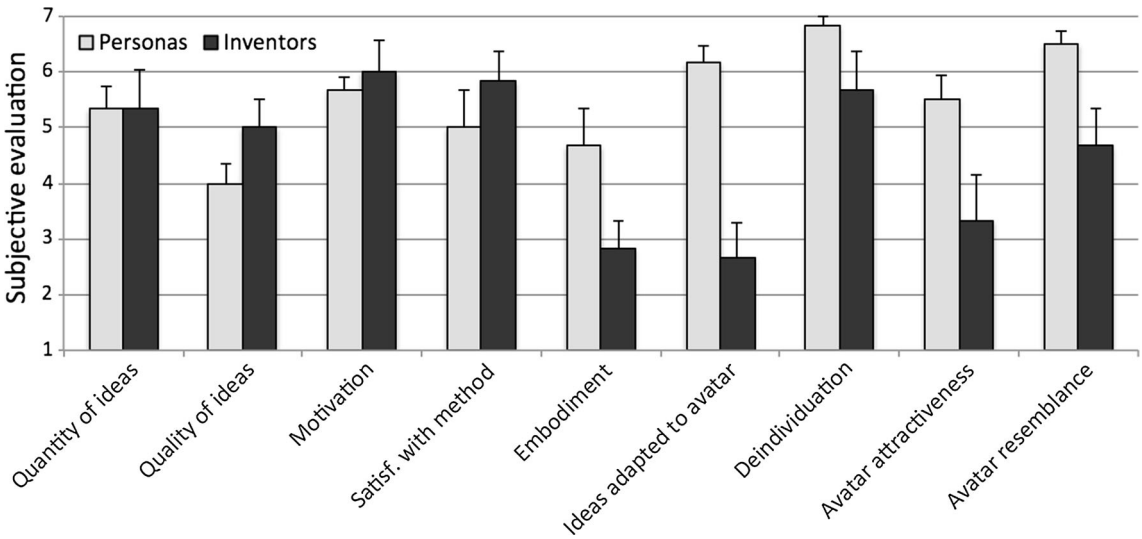


Fig. 6 Means and SE for subjective evaluations as a function of the condition (Persona vs. Inventor)

of being creative, motivation, satisfaction), and all reveal a clearly positive experience. Moreover, fluency scores of the two groups were equivalent, although our previous study had shown that Inventor avatars increase engineers' creativity (Guegan et al. 2016). This suggests that Personas stimulated creativity as well and did not make participants overly focus on evaluation criteria.

Beyond fluency, Hypothesis 1 predicted that Inventor avatars would foster technology-centered ideation and Persona avatars Need-seeker ideation profile. Our data confirmed that participants in the Persona condition generated significantly more ideas related to user needs, and participants in the Inventor condition used significantly more technical terms. Hypothesis 1 is only partly validated since Inventors did not produce significantly more ideas related to technological solutions. However, the results nonetheless support the influence of avatars' appearance on participants' ideation profile. Engineers belonging to the same homogeneous parent population may generate markedly different ideas as a function of the avatar they embody in a virtual world.

Hypothesis 2 predicted that ideas generated in the Persona condition would be more relevant than those from the Inventor condition. We tested this hypothesis on two different sets of variables: usefulness scores on the basis of industrial criteria and usefulness scores on the basis of users' criteria. We observed that these two variables produced opposite tendencies, with Personas' proposals better evaluated by end users and Inventors' proposals better evaluated by the company. Hypothesis 2 is not validated, but we may link this pattern of result to Hypothesis 1: avatars' appearance influenced not only the quantity of ideas generated, but also their quality. Participants produced ideas congruent to the appearance of their avatars: in the Persona condition, they generated more need-related ideas, and their ideas appeared more relevant (or more useful) to end users. Conversely in the Inventor condition, ideas matched more closely to industrial usefulness criteria.

Therefore, we cannot conclude that one condition outperformed the other one; it all depends on the criteria applicable: Persona avatars may support a Need-seeker strategy, while Inventor avatars may support a Technology-driver strategy. Consistent with previous work on avatars, this phenomenon shows that the use of virtual environments can provide relevant methodological support to develop innovation strategies and collaboration. Masking group members' identities through avatars is also likely to create new dynamics, which could be very useful to address innovation problems with a new viewpoint and/or change routines and habits among people who are used to working together face to face.

Our assumptions were mainly based on the process of avatar embodiment and its effects on cognition and behavior. We may first underline that participants experienced a significantly stronger feeling of embodiment in the Persona condition, which may appear counterintuitive at first sight because their characters (a girl, a mother, an elderly man…) were far from their real identity. In contrast, they did not feel strong embodiment with Inventors who were objectively closer to their actual socio-professional profile (engineers in innovation department). Moreover, the correlation matrix showed that embodiment was correlated with the resemblance between avatars and their intended characters: resemblance with the Personas described in the booklet or with the concept of the Inventor, respectively. Given that Inventor avatars had previously been validated through several online surveys, we speculate that the significant difference between Personas and Inventors along the resemblance dimension could be attributed to the information sheets associated with Personas and missing for Inventors. From this body of results, we may suspect that embodiment might be independent from actual real identity (one does not feel stronger embodiment with an avatar that resembles him/her) and might be enhanced when the user is provided with biographical data about the character, like the information sheets we included in the booklet. This phenomenon may explain our counterintuitive result on embodiment scores, but further research would be necessary to better understand the key factors of embodiment.

The theoretical framework of this study involves both priming processes related to the Persona method and the Proteus effect related to avatar embodiment. In the Persona condition, the Proteus hypothesis in line with self-perception theory (Yee and Bailenson 2007, 2009) would have predicted different ideation patterns for self (i.e., for the Persona embodied) than for others. However, our observations do not support this assumption. The Persona method process might have masked the differences between the embodied avatar and the other Personas. Indeed, the instruction and the material associated with each character remained equivalent, which could have led participants to pay constant attention to all Personas. It is thus possible that the self-perception process, even if it was involved, did not create significant differences between Personas embodied or not. If the Proteus framework contributes to explaining the differences between Persona and Inventor conditions, this is not the case for the consistency of ideation among Personas. In this respect, explaining the effects of avatars through priming processes (Peña et al. 2009; Peña 2011) may better account for the ideation patterns we observed. In this alternative interpretation, the same and only process (priming) is involved with all kinds of Personas (i.e., materialized as posters, cardboards, storyboards, or avatars). This raises the issue of the role of avatars with comparison to traditional media: Do avatars,

which somehow make Personas lively, increase priming intensity and thereby Personas effectiveness? Are priming processes stronger in a virtual immersive world than with static paper stimuli? Further research should provide some answers, in order to better understand the influence of avatars on cognition and behavior, as well as the underlying mechanisms of behavioral priming which remain unclear (Doyen et al. 2012), but also to identify more precisely the processes involved in the Persona method. Given the growing use of Personas and of new technologies for remote collaboration in innovation projects, these considerations may also be worthy of investigation.

Another thought-provoking result concerns empathy. It appears that the first person was similarly used for ideation in the two groups. The spontaneous use of the first person by Inventors suggests that the participants felt like projecting themselves into users' experience despite their intended (and realistic) Inventor position. This observation is in line with current design approaches contributing to raise awareness about intended user groups, even in technology-oriented projects. Consistently, one of the participants to the Inventor condition suggested at the end of the session that we should integrate "other passengers (a young girl, a train manager, a businessman)" into the simulation, ignoring of course that we had organized a Persona condition with his colleagues. Such hints further confirm the need for structured methods to support engineers' empathy for users beside their propensity to develop technological innovations. Beyond the theoretical issues remaining to be clarified, this study suggests that avatar-mediated creativity may be a valuable starting point for teams volunteering to diversify toward Need-seeker strategy.

7.1 Limitations of the study

This study was conducted with a small number of participants, which calls for further replication and cross-validation before the results can be theoretically interpreted with confidence (Campbell and Stanley 1963; Cook and Campbell 1979). Internal validity of this research should be increased with a larger sample of participants and external validity with participants from other professional contexts (e.g., other companies, other sector, other countries). Among the potential sources of bias of this study, we may also mention that random attribution of avatars to group members can have produced differential effects on participants, in particular in the Persona condition in which some of them had to embody a child, a woman, or an elderly user, while others were attributed avatars that were closer to their actual identity. The absence of biographical data in the Inventor condition may also have produced a bias, since some Inventors could have been described as striving to care for end users of their products. Finally, the virtual environment used for the sessions was chosen to immerse the participants in the application context (public transportation) but did not include challenging situations, such as crowded compartment or traffic incident. A more complete simulation of everyday transportation conditions may have differently stimulated participants' creativity.

8 Conclusion

Avatar-mediated creativity constitutes a promising tool to renew creative practices in companies, and also to anticipate user experience by supporting empathy, inspiration, and engagement (see Visser et al. 2007). This study showed that all the participants highly appreciated the experience, judged the tool as more satisfactory than usual creativity methods, and declared to be willing to use it again. Another advantage of virtual creativity sessions as implemented in this study is the possibility to seamlessly integrate remote collaborators. The fact that we had in each group a remote participant did not seem to affect either the creative performance or the subjective evaluations of the group members. We suspect that they even did not notice it. Yet, providing efficient means of working with geographically distant collaborators is a growing demand of extended enterprises, in particular at reduced cost. In this respect, our setting required time to design, but the platform we used is free, runs on standard computers, and is of growing interest to professional organizations (see Détienne et al. 2013). In virtual creativity sessions, real-world location of participants is no longer an issue since the group members meet in an environment that is more meaningful to the task at hand than any co-located meeting room. However, if the virtual environment provides a convenient meeting point for an extended creative group, its influence on ideation should also be further investigated. In our experiment, since the two groups were immersed in the same virtual environment, we could not capture its impact on the outcome of the session. Yet, it may have influenced cognition and behavior through priming processes as well (Peña and Blackburn 2013).

Finally, avatar-mediated creativity offers a new way of stimulating and focusing ideation in accordance with project's priorities or corporate strategy. The present study showed that the appearance of avatars was likely to shape ideation patterns toward Need-seeker or Technology-driver strategy. In the particular case addressed in this paper, we understood in light of the evaluation criteria set by our partner that their approach was actually Technology-driver, like the majority of French companies (Péladeau et al. 2013). Our ambition was not to amend their corporate strategy of course, which is defined by top management at group level. Our ambition was to instill user-centered ideas

into the innovation process, to enable participants to think and behave differently online—and hopefully offline. The participating team has now specified their short-term developments on the target project and possesses a considerable pool of middle- and long-term ideas. We believe that the brief incursion they made in a virtual world is likely to pay off in the future in the real world. Only time will tell.

Acknowledgments This research was partly funded by project CREATIVENESS (CREative AcTIvities in Virtual Environment SpaceS), ANR-12-SOIN-0005.

References

Antle AN (2006) Child-personas: fact or fiction? In: Proceedings of the 6th conference on designing interactive systems, pp 22–30, ACM Press

Antle AN (2008) Child-based personas: need, ability and experience. Cogn Technol Work 10:155–166

Bargh JA, Chen M, Burrows L (1996) Automaticity of social behavior: direct effects of trait construct and stereotype activation on action. J Pers Soc Psychol 71(2):230

Bem D (1972) Self perception theory. In: Berkowitz L (ed) Advances in experimental social psychology, vol 6. Academic Press, New York

Bessière K, Seay AF, Kiesler S (2007) The ideal elf: identity exploration in World of Warcraft. Cyber Psychol Behav 10(4):530–535

Blomquist A, Arvola M (2002) Personas in action: ethnography in an interaction design team. In: Proceedings of the second Nordic conference on human–computer interaction, pp 197–200, ACM Press

Bonnardel N, Forens M, Lefevre M (2016) Enhancing collective creative design: an exploratory study on the influence of static and dynamic personas in a virtual environment. Des J. doi:10.1080/14606925.2016.1129145

Bornet C, Brangier E (2013) La méthode des Personas : principes, intérêts et limites. Bull Psychol 524(2):115–134

Bornet C, Brangier E (2015) The effects of personas on creative codesign of work equipment: an exploratory study in a real setting. CoDesign. doi:10.1080/15710882.2015.1112814

Buisine S, Besacier G, Aoussat A, Vernier F (2012) How do interactive tabletop systems influence collaboration? Comput Hum Behav 28:49–59

Campbell D, Stanley J (1963) Experimental and quasi-experimental designs for research. Rand-McNally, Chicago

Cook TD, Campbell DT (1979) Quasi-experimentation: design and analysis issues for field settings. Houghton Mifflin Company, Boston

Cooper A (1999) The inmates are running the asylum. Macmillan, New York

Détienne F, Cahour B, Legout MC, Gourvennec B, Relieu M, Coppin G (2013) Interactive frames constructed in Second Life meetings: a study in educational and professional settings. Cogn Technol Work 15:445–455

Dijksterhuis A, Van Knippenberg A (1998) The relation between perception and behavior, or how to win a game of trivial pursuit. J Pers Soc Psychol 74(4):865–877

Doyen S, Klein O, Pichon C-L, Cleeremans A (2012) Behavioral priming: it's all in the mind, but whose mind? PLoS ONE 7(1):e29081

Franke N, Von Hippel E, Schreier M (2006) Finding commercially attractive user innovations: a test of Lead-User theory. J Prod Innov Manage 23:301–315

Grudin J (2010) Why Personas work: The psychological evidence. In: Pruitt J, Adlin T (eds) The Persona lifecycle: keeping people in mind throughout product design. Morgan Kaufmann Publishers, San Francisco, pp 643–663

Guegan J, Buisine S, Mantelet F, Maranzana N, Segonds F (2016) Avatar-mediated creativity: when embodying inventors makes engineers more creative. Comput Hum Behav 61:165–175

Jaruzelski B, Staack V, Goehle B (2014) Proven paths to innovation success. Strategy + Business, vol 77, pp 2–16

Mantelet F, Segonds F, Maranzana N, Guegan J, Buisine S (2016) Virtual environment in the early design phases: how to be more creative? International Virtual Concept Workshop on "Major Trends in Product Design"

Meadows MS (2008) I, Avatar: the culture and consequences of having a second life. New Riders, Berkley

Nelson J, Buisine S, Aoussat A, Gazo C (2014) Generating prospective scenarios of use in innovation projects. Le Travail Humain 77:21–38

Osborn AF (1953) Applied imagination. Principles and procedures of creative problem-solving. Charles Scribner's Sons, New York

Péladeau P, Romac B, Rozen A, Sevin C (2013) L'innovation dans les entreprises en France. Booz & Company Inc, Paris

Peña J (2011) Integrating the influence of perceiving and operating avatars under the automaticity model of priming effects. Commun Theory 21:150–168

Peña J, Blackburn K (2013) The priming effects of virtual environments on interpersonal perceptions and behaviors. J Commun 63:703–720

Peña J, Hancock J, Merola N (2009) The priming effects of avatars in virtual settings. Commun Res 36:838–856

Postmes T, Spears R (1998) Deindividuation and anti-normative behavior: a meta-analysis. Psychol Bull 123:238–259

Pruitt J, Adlin T (2010a) The Persona lifecycle: keeping people in mind throughout product design. Morgan Kaufmann Publishers, San Francisco

Pruitt J, Adlin T (2010b) The essential Persona lifecycle: your guide to building and using Personas. Morgan Kaufmann Publishers, San Francisco

Pruitt J, Grudin J (2003) Personas: practice and theory. In: Proceedings of the conference on designing for user experiences, pp 1–15. San Francisco, USA

Ries E (2011) The Lean Startup: how today's entrepreneurs use continuous innovation to create radically successful businesses. Crown Business, New York

Rosenberg RS, Baughman SL, Bailenson J (2013) Virtual superheroes: using superpowers in virtual reality to encourage prosocial behavior. PloS One 8(1):e55003

Schmitt L, Buisine S, Chaboissier J, Aoussat A, Vernier F (2012) Dynamic tabletop interfaces for increasing creativity. Comput Hum Behav 28:1892–1901

Thalen JP, van der Voort MC (2014) Virtual personas: a case study on truck cabin design. In: DUXU 2014, design, user experience, and usability. Lecture notes in computer science, vol. 8519 (8519), Springer International Publishing, pp 357–368

Visser FS, van der Lugt R, Stappers PJ (2007) Sharing user experiences in the product innovation process: participatory design needs participatory communication. Creat Innov Manag 16:35–45

Von Hippel E (2005) Democratizing innovation. MIT Press, Cambridge

Vyas D, van der Veer G, Nijholt A (2013) Creative practices in the design studio culture: collaboration and communication. Cogn Technol Work 15:415–443

Yee N, Bailenson J (2007) The Proteus effect: the effect of transformed self-representation on behavior. Hum Commun Res 33:271–290

Yee N, Bailenson J (2009) The difference between being and seeing: the relative contribution of self-perception and priming to behavioral changes via digital self-representation. Media Psychol 12(2):195–209

Yee N, Bailenson J, Ducheneaut N (2009) The Proteus effect: implications of transformed digital self-representation on online and offline behavior. Commun Res 36(2):285–312

Yoon G, Vargas PT (2014) Know Thy Avatar: the unintended effect of virtual-self representation on behavior. Psychol Sci 25(4):1043–1045