The Creative Proteus Effect: How Self-Similarity, Embodiment, and Priming of Creative Stereotypes with Avatars Influences Creative Ideation

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ABSTRACT
Creative ideation can be enhanced in 3D virtual environments by manipulating the appearance of a user's avatar so that it primes a creative stereotype. However, not much is known about the factors that influence the effectiveness of using avatars to enhance creativity. In this study we investigate experimentally whether the degree to which users identify with their avatar moderates their actual ability to generate creative ideas. The results suggest that a non-creative avatar (office worker stereotype) diminishes creativity, but our creative avatar (artist stereotype) does not augment creativity. The similarity in appearance between the user and its avatar positively moderates, whereas its perceived embodiment with the avatar negatively moderates the ability to generate creative ideas. However, the study also suggests that self-similarity might be an even more effective way to support creative ideation than priming creative stereotypes. Therefore, this study (i) contributes that self-similarity and embodiment moderate the effectiveness of using an avatar to prime creative stereotypes to enhance creative ideation, and (ii) points toward a novel way to enhance creative ideation in virtual environments, by using avatars that look just like yourself.

Author Keywords
Avatars; Creative Stereotype Effect; Creativity Support Tools; Embodiment; Proteus Effect; Self-Similarity.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI); J.4 Social and behavioral sciences.

INTRODUCTION
Creative ideation, the ability to generate ideas that are original yet effective, plays an essential role in well-being, innovation, and culture [1]. Given that people spend a considerable amount of time in 3D virtual environments, i.e. digital environments that mimic physical spaces, and where people interact via avatars [2], it is of interest to investigate new ways in which creative ideation can be supported within such environments [3, 4]. Avatars, the virtual beings users control to interact within the virtual environment [5], may therefore pose such an opportunity.

Avatar studies suggest that an avatar's appearance can prime a user's actual behaviour [6]. Avatars designed based on creative stereotypes (e.g. an inventor), can prime creative behaviours that support creative ideation in virtual environments [3, 4]. However, not much is known about the factors that underlie the effectiveness of this approach. This may be due to the degree to which users identify with their avatar. The visual similarity between a user and its avatar, i.e. self-similarity, can positively impact task performance [7, 8], and the degree to which a user believes the avatar's body is its own, i.e. perceived embodiment, appears to moderate the effectiveness of the ability of an avatar to prime behavior [9, 10]. This suggests that self-similarity and embodiment moderate the effectiveness of avatars as support for creative ideation.

To investigate this, we experimentally test whether self-similar avatars designed based on creative stereotypes can be used to influence creative ideation; and the role of self-similarity and embodiment therein.

THEORETICAL BACKGROUND
Recent studies suggest that avatars can be used as a way to enhance creative ideation in virtual environments [3, 4]. The visual appearance of an avatar can prime the way people think and act [6]. For instance, using an avatar that looks like a Ku Klux Klan member leads to writing more negative stories [7]; while using an avatar that is taller and more attractive than its user can increase self-confidence [6], and enhances game performance [8]. Thus, these studies suggest that people can be primed by the appearance of their avatars. This is referred to as The Proteus effect [6].

Creative stereotypes can prime creative behaviours [11]. When asked to generate original uses for an object (e.g. a brick), taking the perspective of a rigid librarian led people to produce less original ideas, than when asked to take the perspective of an eccentric poet. Thus, priming creative stereotypes can be used to influence creative behaviour.

It follows that using an avatar designed based on creative stereotypes influences creative ideation [3, 4]. Indeed, recent work suggests that using an avatar that looks like an inventor, compared to a neutral looking avatar helps people to think of more, and more original ideas during a face-to-face brainstorming task [3]. Furthermore, avatars can also influence the type of ideas people generate. For instance, when asked to generate ideas for smart windows in public transportation, using an inventor avatar led to more technology focused ideas, whereas using a public transport user avatar led to ideas about improving practical needs [4]. Thus, using avatars designed based on creative stereotypes can influence actual creative ideation. We refer to this as *the creative Proteus effect*. This leads to hypothesis H1.

H1: Using a creative avatar augments creative ideation, whereas a non-creative avatar diminishes creative ideation.

Although *the creative Proteus effect* has been demonstrated in previous work, not much is known about the factors that influence or underlie its effectiveness [cf. 3, 4]. We propose that the degree to which a user identifies with its avatar moderates the effectiveness of the creative Proteus effect. In this study, we focus specifically on the role of *self-similarity* and *perceived embodiment*.

Self-similarity can influence task performance [7, 12]. For instance, computer game players perform better when they use an avatar that looks like, rather than not looks like themselves [7]; and teams represented by avatars similar to the team members enhances team performance [12]. This can be explained by a positive effect of self-similarity emotional involvement and positive affect experienced when using the avatar [8]. Although no studies on the link between self-similar avatars and creative ideation have been done; its positive effects on task performance [7, 8, 11]; and a link between positive affect, emotional involvement, and creative ideation [13]; suggest that self-similarity can influence creative ideation. This leads to hypothesis H2.

H2: The similarity of an avatar to the user itself moderates the effects of using an avatar designed based on creative stereotypes on creative ideation.

The (creative) Proteus effect also seems conditional upon the *perceived embodiment* of an avatar by its user [9, 10]. This depends on achieving a complex of factors involving a sense of self location, a sense of agency and a sense of body ownership [14]. For instance, when people view an avatar that is eating healthy or unhealthy food; their own tendency to imitate this behaviour depends on the degree to which they feel present themselves within the virtual environment [15]. If we assume that the Proteus effect is dependent on a particular degree of perceived embodiment, we can assume that the effectiveness of the creative Proteus effect is also dependent thereon. This leads to hypothesis H3.

H3: The perceived embodiment of an avatar moderates the effects of using an avatar designed based on creative stereotypes on creative ideation.

METHOD

To test our conjectures, we devised and executed an experiment with a between-subjects design.

Participants

In total, 61 people participated in our study (49 Female, 12 Male, M_{age}=23.62, SD_{age}=3.54, $Range_{age}$=18-32). Participants were recruited using convenience sampling at the communication and information sciences department, Tilburg University (NL), in exchange for course credit. Participants were assigned randomly to the experimental conditions, and the researchers were aware the assignments.

Materials and measurements

Creative ideation task

The instances task was used as a proxy to test creative ideation [16]. In this task participants are asked to generate creative instances of objects characterised by a particular feature (in our study things shaped like a circle or triangle) within three minutes. Participants were explicitly instructed to be creative. To assess creativity participants selected their top two most creative ideas after the creative ask; after which three independent raters scored these ideas for their creativity on a scale from 1-10 [16]. Raters were instructed to rate creativity as a composite of originality and effectiveness. The means of their ratings per participant were used in further analyses. Cronbach alpha was low, α=.47, a common reliability level for creativity ratings [17].

Creative avatars and virtual environment

To test our hypotheses participants performed the creative task using one of three *avatars* (Fig. 1): (i) *Creative avatar*, an avatar wearing a white painter's blouse with paint stains and paint brushes (n=19), and was chosen because artistic jobs are stereotypically associated with creative behaviour [18]; (ii) *Non-creative avatar*, an avatar wearing a grey office-like jacket with a necktie (n=19), and was chosen because office jobs are stereotypically associated with non-creative behaviour [19]; (iii) *Control avatar*, an avatar wearing the clothes the participant is actually wearing (n=23), and for which we expect no creative Proteus effect.

The avatar was used in a *virtual room* (Fig. 2): a minimally designed living room of medium size, with three couches, three plants, a door, and a window with a city street view. We assumed this would minimise any confounds that may arise from avatar-environment interactions (e.g. affect its stereotypical interpretation), and minimise the chance that the room itself would inspire any ideas during the task.

The avatars were generated using the body-scanning and auto-rigging software by [5]. During the body-scan, participants wore the clothes stereotypical of the described experimental conditions. The virtual room was presented using a head mounted display [20].

Self-similarity

Using body scanning to generate the avatars ensured similarity in visual appearance between the user and the avatar [5]. Self-similarity was assessed after the creative

task with a questionnaire that contained the first four questions used by [21], and the question used [22]. Cronbach's alpha showed acceptable reliability, α=.82.

Figure 1 Examples of the avatars used in the experimental conditions. The non-creative avatar (left), creative avatar (middle), control avatar, wearing their own clothes (right).

Figure 2 The virtual reality environment that was used in the three experimental conditions.

Embodiment

To stimulate perceived embodiment participants were asked to imagine they were the avatar, were looking in a mirror and saw themselves. The avatar's movement was animated to approximate the movements of their users, i.e. small arm, leg, and head movements. Embodiment was assessed after the experiment using the presence questionnaire by [15]. Cronbach alpha suggested acceptable reliability, α=.80.

Procedure

Participants were introduced to the study and signed informed consent. At this stage information about the actual purpose of the study was withheld. For the creative and non-creative avatar condition they put on selected clothing, were body-scanned (see [5]), and then removed the selected clothing again. Participants filled in a questionnaire about their demographics while the researcher animated the avatar and rendered the virtual environment. Participants were then asked to stand up and put on the head mounted display, were reminded of the task, and did the embodiment manipulation. Then, participants executed the creative task in virtual reality. After this, they selected their two most creative ideas, and filled in the self-similarity and embodiment questionnaires. Finally, they were debriefed.

RESULTS

To test our hypotheses we used four *linear mixed models*. The models and results are presented in Table 1. The descriptive statistics are presented in Table 2.

DV / IV	Creativity	Self-similarity	Embodiment
Creative avatar	5.37 (1.15)	3.93 (1.09)	5.03(.73)
Non-creative avatar	4.89 (1.19)	3.82 (1.10)	4.88(.76)
Control	5.87 (1.31)	3.61 (1.20)	4.61(.84)
All conditions	5.41 (1.27)	3.77 (1.12)	4.83(.79)

Table 2 Means and standard deviations (between parentheses).

Model 1: The results show a significant difference between the control and the non-creative (office) avatar, *B*=*-.97*, t(61)=-2.63, *p*=.011, but no significant difference between the control and the creative avatar, *B*=-.49, t(61)=-1.34, *p*=.186. Interestingly, using the control avatar associates with higher creative ideation that using the non-creative and, although not significantly, the creative avatar (Table 2). Thus, using our non-creative avatar diminishes creativity, but using *our* creative avatar does not influence creativity. This only partly supports H1.

Model 2: The results show that self-similarity is a

DV / IV	Creative ideation			
	Model 1	Model 2	Model 3	Model 4
Intercept	5.87 (2.70)*	6.91 (.96)*	8.10 (1.23)**	8.10 (1.22)**
C1: Creative avatar	-.49 (.38)		-2.12 (2.80)	-2.12 (2.81)
C2: Non-creative avatar	**-.97 (.37)***		**-3.58 (2.42)***	**-3.58 (2.04)***
C3: Control avatar	.[a]		.[a]	.[a]
Self-similarity		**.40 (.16)***	**.68 (.22)****	
Embodiment		**-.63 (.24)***	**-1.02 (.30)****	
C1 x self-similarity			-.78 (.50)	-.09 (.42)
C2 x self-similarity			-.27 (.40)	.41 (.34)
C3 x self-similarity			.[a]	**.68 (.22)***
C1 x embodiment			.97 (.74)	-.05 (.65)
C2 x embodiment			.77 (.61)	-.25 (.42)
C3 x embodiment			.[a]	**-1.02 (.31)***
Residual	1.42 (.21)	1.42 (.23)	1.19 (.21)	1.19 (.22)

Table 1 Estimates of fixed effects. Unstandardized coefficients and standard errors (between parentheses); Intercept and residual; [a] are conditions relative to the estimates for each block (and thereby redundant). * p<.05, **, p<.001

significant positive predictor, B=.40, t(61)=2.28, p=.012, whereas, embodiment is a significant but negative predictor of creativity, B=-.63, t(61)=-2.49, p=.014. Thus, increased self-similarity of an avatar augments creative ideation, while perceived embodiment, surprisingly, diminishes creativity. This supports H2, but inversely supports H3.

Model 3: The results replicate the findings in model 1 and model 2 (Table 1). In addition, there was no significant difference between the interaction of self-similarity with the control avatar, with the creative avatar, B=-78, t(61)=-1.82, p=.083, and with the non-creative avatar, B=,-.27 t(61)=-.73, p=.464. Similarly, there was no significant difference between the interaction of embodiment with the control avatar, B=.97, t(61)=1.55, p=.166, with the creative avatar, and with the non-creative avatar, B=.77, t(61)=1.45, p=.090. This suggests that self-similarity and embodiment moderate the effects of using an avatar designed based on creative stereotypes on creative ideation across the experimental conditions. This confirms our findings on H1, and further supports H2 and H3.

Model 4: The results replicate the findings from model 1 (Table 1), but add to the findings in model 2 and 3. Self-similarity did not significantly predict creative ideation for the creative, B=-.09, t(61)=-.27, p=.804, and not for the non-creative avatar, B=.41, t(61)=1.52, p=.197. Rather, self-similarity was a significant positive predictor of creative ideation for the control avatar, B=.68, t(61)=2.71, p=.001. Similarly, embodiment did not significantly predict creative ideation for the creative, B=-.05, t(61)=-.09, p=.948, and the non-creative avatar, B=-.25, t(61)=-.63, p=.499; but did significantly and negatively predict creative ideation for the control avatar, B=-1.02, t(61)=-2.83, p=.002. This suggests that self-similarity and embodiment may moderate creative ideation mostly when there is no creative Proteus effect manipulation. This again confirms H1, but sheds new light on H2 and H3.

DISCUSSION

This study shows that avatars designed based on creative stereotypes can influence actual creative ideation, and reveals two factors that influence its effectiveness. Using an avatar designed based on a creative stereotype (a visual artist), did not augment creativity, but using an avatar designed based on a non-creative stereotype (an office worker) did diminish creative ideation (H1). This replicates in part earlier work by [3, 4]. This study also shows, for the first time, that the similarity of an avatar to the user itself positively, and its perceived embodiment negatively moderates creative ideation (H2 and H3). Thus, self-similarity and embodiment appear to moderate the effectiveness of the *creative Proteus effect*.

Interestingly, using an avatar that looks like the user does at that moment (control avatar) led to more creative ideation than using the creative and the non-creative avatar; and upon further inspection, self-similarity and embodiment appeared to moderate creative ideation in particular for the control avatar. This suggests that self-similarity in itself might also be an effective way to support creativity. As such, these findings cast doubt on (i) the effectiveness of the creative Proteus effect, and possibly point to (ii) another, novel, way to support creative ideation using self-similar avatars, i.e. via a *"Being yourself" effect* [cf. 7, 8].

We would like to discuss two limitations in detail because they point to our intended future work. First, we only partly replicated earlier findings by [3, 4] that suggest that avatars can be used to prime creative behaviour. It appears that, despite earlier findings [18], our artist stereotype was not an effective prime [cf. 11]. Future work can therefore benefit from studies that test what creative stereotypes are effective primes. However, using highly self-similar avatars might also explain this replication issue. If there really exists a "Being yourself" effect, this introduces a confounding factor into the control avatar, which limits drawing conclusions about the effectiveness of the creative Proteus effect. This requires confirmation in a dedicated study.

Second, using body-scanned avatars may introduce confounds that limit the generalisation of self-similarity and embodiment as moderators of the creative Proteus effect. Likely, body-scanning introduces issues that associate with the uncanny valley (Figure 1), i.e. eeriness and revulsion elicited by avatars that almost, but just not, look human-like [23]. If so, self-similarity may positively predict creativity because it lifts the avatar's appearance out of the uncanny valley; decreasing negative affect. Perceived embodiment may be a particular issue when avatars are perceived as uncanny, intensifying negative affect, which diminishes creative ideation [cf. 13]. The findings can therefore only be generalised to the use of highly self-similar avatars, suggesting that also here further research is required.

Of course, there are several more limitations to the results and some with relevance for the result's generalisability. These include the notion that whether or not the used avatars are perceived as a creative stereotype can be dependent on for instance culture [24], gender [25], and (virtual) environment [26], which may moderate the intended effect of the stereotypes; Participants in two of the three conditions wore the stereotypes' clothes during scanning, which may have unduly contributed to the priming effects [26]; The scan quality might have influence across all conditions, e.g. higher quality scan methods may lead to different results [27]; and finally, the creativity measure itself is subjective and dependent on cultural factors, further limiting generalisability [1, 28], but see [16]. We would like to emphasise that these limitations need to be taken into account when interpreting and building upon our study and its results.

In summary, this study (i) contributes that self-similarity and embodiment moderate the effectiveness of using an avatar to prime creative stereotypes, and (ii) it points toward a novel way to enhance creative ideation in virtual environments, by using avatars that look just like yourself.

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