Being Yourself to be Creative: How Self-Similar Avatars can Support the Generation of Original Ideas in Virtual Environments

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ABSTRACT

Creative idea generation, the generation of original yet effective ideas, can be supported in virtual environments when interactions are facilitated via avatars with an appearance similar to their user, i.e. self-similar avatars. However, it is not known how self-similar avatars support creative idea generation. We propose that self-similarity supports the generation of original ideas, because it (i) increases the identification a user has with its avatar, which (ii) increases positive affect, and (iii) influences the positive affect-original idea generation link. To test this conjecture, an experiment was conducted where people composed their own avatar to be either self-similar or non-self-similar, which they then used to engage in two idea generation tasks presented within a custom virtual environment. The results suggest that using a self-similar rather than a non-self-similar avatar positively influences the generation of original ideas; and that this depends on the influence of self-similarity on the link between identification and positive affect. Thus, this paper contributes a mechanism that explains how self-similar avatars support the generation of original ideas.

Author Keywords

Affect; Avatars; Creativity; Idea Generation; Identification; Originality; Self-Similarity; Virtual Environments.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

Creative idea generation, the generation of ideas that are both original and effective, enables innovation in science, art, and technology [26]. Previous research has shown that creativity can be supported within and by digital representations of physical spaces, i.e. virtual environments, [29], in which people interact via a digital representation of themselves or something else, i.e. avatars [34]. Therefore, virtual environments present new opportunities for developing tools that support creative idea generation. Examples of such opportunities include games that require creative problem solving, and virtual environments

specifically designed for collaborative creative work [7, 16]. The design of avatars with the aim of influencing creativity in particular, so called *avatar-mediated brainstorming* tools, is an emerging type of creativity support tool [7, 16].

Recent studies suggest that the *Proteus effect*, the phenomenon where the way that users think and act is influenced by the visual appearance of the avatar [34], can be used to support creative idea generation. One such study, for example, showed that when engineering students used an inventor avatar, they produced more ideas during a brainstorm than when they used a non-inventor avatar, or no avatar at all [15]. Although the Proteus effect can be used in different ways to enable creativity support tools [7, 16], there is also another way in which avatars can be designed to support creativity [12].

Virtual environments increasingly enable their users to compose their own avatars, enabling the design of avatars that have a high degree of similarity in appearance to their user, i.e. *self-similar avatars* [32]. Users report that they identify more with self-similar, than with non-self-similar avatars, attributing an identity, goals, and perspectives to avatars similar to themselves [30]. This in turn increases the positive affect that is experienced when using the avatar; with positive consequences for a range of factors with relevance to task performance [5]. Suggesting that for some tasks it is better to be represented as yourself, rather than as someone or as something else.

Interestingly, preliminary evidence exists that suggests that using self-similar avatars can also have a positive effect on *creative idea generation* [12]. Suggesting that this may be a novel form of avatar-mediated brainstorming. However, this finding has not yet been replicated in a dedicated study. Moreover, studies have yet to be done on how self-similar avatars can support creative idea generation. There is, however, precedent for such a study. That is, creativity studies show that positive affect positively predicts the generation of original ideas [3]. So if we assume that using self-similar avatars (i) influences identification, which (ii) increases positive affect experienced toward the avatar [5], this may (iii) influence the link between positive affect and the generation of original ideas [3]. As such, these

conjectures may point to how self-similar avatars can support the generation of creative, or more specifically, original ideas in virtual environments.

The present study therefore experimentally investigates the following research question (RQ): *How do self-similar avatars support the generation of original ideas?*

THEORETICAL BACKGROUND

Avatar-mediated brainstorming tools constitute a novel type of creativity support tools [7, 16]. Research on this topic aims to study how to best design the visual appearance of avatars used in virtual environments to support creative idea generation.

The Proteus effect

One approach that has been developed aims to leverage the Proteus effect [34]. That is, the phenomenon that the visual appearance of an avatar prime's the way its user thinks and acts within a virtual environment. For example, studies showed that using a child-like avatar led people to estimate objects in the environment as larger than they really were, whereas adult-like avatars led to appropriate estimates [4]; using an attractive avatar to interact with another led users to disclose more information about themselves and decrease interpersonal distance more so than when using an unattractive avatar [34]; and using an avatar with the visual appearance of a Ku Klux Klan member influenced the negativity of stories written by the avatar's users [24]. Thus, the avatar's visual appearance influences the way the user thinks and acts within a virtual environment.

The Proteus effect can also be leveraged to support creativity, by designing avatars which visual appearance primes a way of thinking and acting that facilitates creativity [7, 16]. For example, the results of a recent study suggested that engineering students typically associate creativity with inventor stereotypes [17]. When engineering students used an avatar that looked like an inventor, within a virtual environment, to brainstorm in a group, they generated more ideas then when they used a non-inventor avatar, or no avatar at all [15]. The visual appearance of the avatar also appears to prime the mental model, or perspective, through which problems are addressed. When asked to generate problem solutions for public transport issues, users with avatars that looked like daily commuters generated more solutions that addressed user needs, while users with avatars that looked like inventors generated more technical solutions [6]. Moreover, avatars can be used to foster group coherence, which helps to mitigate negative effects of social loafing, the phenomenon that people contribute less to group work than they would on their own, in electronic brainstorming systems. By letting avatars wear social badges group belonging was manipulated, which led to groups of users producing more ideas than when they did not wear such social badges, mitigating at least to some extent the negative consequences of social loafing [18]. As

such, avatars can be designed to leverage the Proteus effect in different ways to support creative idea generation.

Potentially, there is also another way in which avatars can be designed to support creative idea generation [12].

Self-similarity

Avatars can be designed to represent the user, i.e. a *self-similar avatar*; or to represent something or someone else, i.e. non-self-similar avatar [34]. Preliminary findings suggested that self-similar avatars could be an alternative to, or complement, the use of the Proteus effect for the development of creativity support tools [12]. That is, a study by [12] explored the moderating effect of self-similarity and perceived embodiment on the Proteus effect during an idea generation task. Users were assigned an avatar that looked like an artist, an office worker, or themselves (as a control); and were asked to generate ideas within a virtual environment. Surprisingly, the results showed that the ideas generated by users that controlled avatars that looked like themselves led to ideas that were rated as more creative than ideas generated by users that were controlling an artist or office worker avatar, going against the study's prediction that the artist avatar would lead to higher ratings of creativity. Further analysis indicated that self-similarity positively correlated with creativity, but only within the group of users that controlled the avatars that were designed to look like themselves.

This preliminary finding suggests that, next to using the Proteus effect, self-similarity could also be used to support creative idea generation. However, the preliminary nature of that study calls for replication of this effect in a dedicated study, and for further investigation into how self-similar avatars may influence creative idea generation.

How self-similar avatars may influence creative ideation

Based on literature about the effects of self-similar avatars in domains other than creativity support tools, it can be conjectured that a relationship between identification with the avatar and positive affect may explain in part its effects on creative idea generation via the relationship between positive affect and the generation of original ideas.

Identification here can be defined as the process in which the identity, goals, and perspective of the avatar appear to match with those of its user [9]. Identification can be manipulated via an avatar's visual appearance [5]. For example, [30] showed that people who customized their avatar such that it looked like themselves, experienced more identification with their avatar during game play. Note however, that in [30], this effect was not only due to the visual appearance of the avatar. For example, identification with an avatar is also higher if it supports the user's personal aspirations and helps to achieve the expected outcome of the virtual experience [30]. The degree to which a user identifies with its avatar associates with the degree of *positive affect* that is experienced by using the avatar [5].

That is, increases in visual similarity between the avatar and its user predicts enjoyment of using the avatar, but in a manner that is conditional upon the effect of self-similarity on identification [30]. Complementarily, the similarity between traits attributed to an avatar and a user's personality influences enjoyment [14]. Similarly, users experience a more positive attitude toward self-similar avatars (including higher affection, connection, and passion) [28]. Using a self-similar rather than a non-self-similar avatar therefore increases positive affect because of its effects on identification.

The relationship between identification and positive affect may provide clues about how self-similar avatars may support creative idea generation. That is, idea generation typically forms part of a larger creative or design process in which ideas are generated to develop original and effective problem solutions [22]. The likelihood of generating original ideas depends in part on the ability to switch attention between different concepts, and to keep these concepts in working memory, i.e. *cognitive flexibility* [3]. Increases in cognitive flexibility predict an increase of the likelihood that one switches between concepts during idea generation [10]. The more diverse concepts are available in working memory, the more likely it is that integrating these concepts into an idea, leads to an idea that is original [3]. Indeed, positive affect associates with the ability to generate *original ideas* [3, 11]. The mechanism underlying the link between positive affect and creative idea generation lies in the effects of positive affect on cognitive flexibility [10]. That is, positive affect has been shown to increase the likelihood that a person switches between concepts and tasks by loosening the constraints on gating new (task-irrelevant) information into working memory [13]. Thus, increases in positive affect often correlate with the generation of original ideas [3]. This link between positive affect and the generation of original ideas has been demonstrated in different contexts, including during psychometric tasks [3], creative workshops and training programs [8], and on the work floor [1].

Thus, the relationship between identification and positive affect, and the relationship between positive affect and the generation of original ideas, could explain how self-similar avatars may influence the generation of original ideas.

The present study
Based on the reviewed literature it is proposed that using avatars that vary in the degree to which they are visually similar to its user, to interact within a virtual environment, can influence the ability of users to generate original ideas. Until now, one existing study has supported this conjecture [12]. Self-similarity can therefore be an alternative to, or complement, the use of the Proteus effect to support creative idea generation. As such, it can be seen as a novel form of avatar-mediated brainstorming [7, 16]. The preliminary nature of the existing evidence for a relationship between avatar self-similarity and creative idea generation [12], however, calls for a replication in a dedicated study; and an explanation for how using self-similar avatars may influence creative idea generation.

The present study will therefore test how avatar self-similarity influences the generation of original ideas in a dedicated study. Based on the reviewed literature it is conjectured that: i) self-similarity positively influences identification with the avatar, which in turn increases the likelihood that people experience positive affect; and ii) due to the influence of positive affect on cognitive flexibility, the likelihood increases that diverse concepts enter working memory [13], which diversity influences the likelihood the ideas that users generate are original [3] (Figure 1).

In the present study, these conjectures are investigated experimentally by testing the following two hypotheses.

H1. Using a self-similar avatar increases positive affect because of its effects on identification.
H2. Using a self-similar avatar increases the originality of generated ideas due to its effects on the link between identification and positive affect.
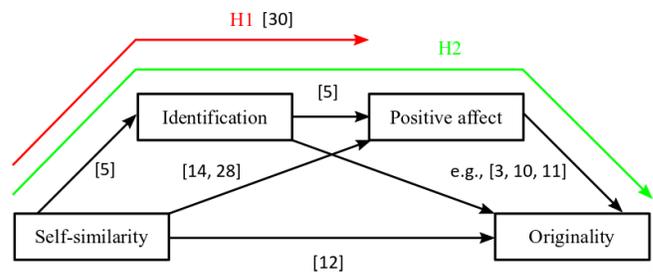

Figure 1 Conceptual model that underlies the conjectured hypotheses (H1 and H2), and references to previous research that support the relationships within the conceptual model.

METHOD
To test the hypotheses an experiment was conducted with a between-subject design. In the experiment, participants engaged in an idea generation task while using a self-similar or a non-self-similar avatar in a virtual environment.

Participants
Fifty-seven people participated in our study (M_{age}=22.02, SD_{age}=4.58, $Range_{age}$=18-40, 33 Females, 24 Males). Participants rated themselves as moderately creative (M_{crea}=3.18, SD_{crea}=.86, $Range_{crea}$=2-5). Participants were assigned randomly to the experimental conditions. No significant difference was found between the experimental conditions for gender $\chi^2(57)$=1.41, p=.236; age, $F(1, 56)$=.01, p=.909; and self-reported creativity, $F(1, 56)$=.03, p=.855. Participants were recruited via the participant recruitment system of the Department of Communication and Cognition of Tilburg University. All participants were taking part in a higher education program. Results of one participant were not used in the analysis due to faulty execution of the idea generation task. Participants received course credit for their participation.

Generating self-similar and non-self-similar avatars

Participants were asked to compose an avatar that either visually resembled themselves (self-similar avatar) or did not resemble themselves (non-self-similar avatar). To compose these avatars they used Autodesk's Character Generator. This online tool enables people to compose avatars by selecting facial, upper, and lower body features (Figure 2). For the self-similar condition participants were asked to compose an avatar that resembled themselves as much as possible. For the non-self-similar condition participants were asked to compose an avatar that resembled their own skin, eye, and hair colour, and was of the same gender – but did not resemble themselves for other facial, lower, and upper body features (e.g. other posture, length, nose, or mouth). The latter was asked to prevent confounding factors, e.g. a male user of a female avatar, which may affect the validity of the results in unexpected ways. After finishing the avatar it was exported by the researcher for use in the idea generation task. Composing the avatar was done on a laptop.
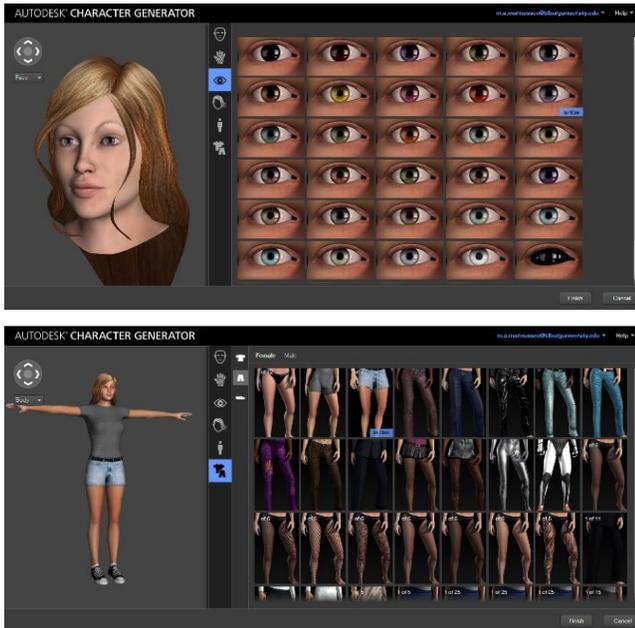

Figure 2 Screenshots van de Autodesk Character Generator, which was used by the participants to compose either a self-similar or a non-self-similar avatar.

Idea generation task

Participants did a psychometric task to test their ability to generate original ideas (Figure 3), the *instances task* [27], in a custom made virtual environment. The instances task and similar tasks are commonly used as a proxy for measuring the ability to generate (original) ideas; and such tasks are regularly used in the creativity research cited in the present paper. To enable this task in a virtual environment, participants used their avatars to navigate and be guided through a virtual maze until they came across a geometric shape (a sphere or a cube) that was presented in front of a large mirror. The mirror was there to ensure participants could regularly see their self-similar or non-self-similar avatar. This follows the method developed by [2]. When participants came across one of the two shapes they executed the instances task. That is, they were instructed to generate as many instances of that shape as they could within one minute (e.g. a planet when encountering the sphere). The order in which participants were guided one or the other object first was counterbalanced to prevent order effects. Participants were instructed to say their instances out loud, which results were recorded by the researcher present. The virtual environment in which the idea generation task took place was implemented in the Unity game engine [26] and presented with a head mounted display, the HTC Vive [17].
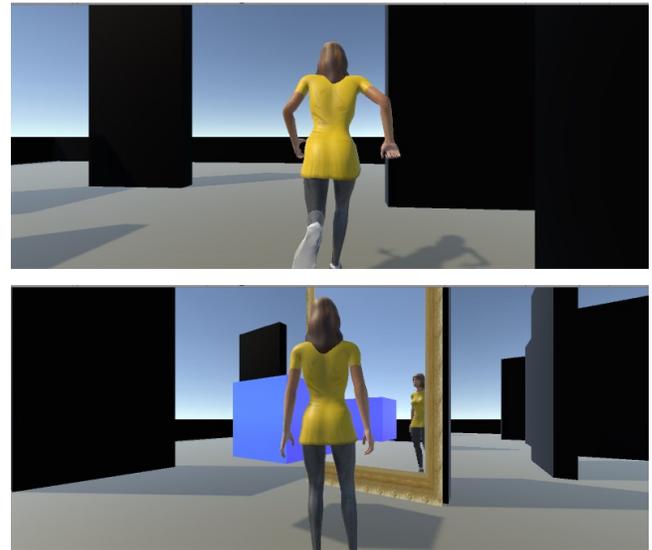

Figure 3 Screenshots of the virtual environment. The user navigates a maze with its avatar, when it encounters a geometric shape placed in front of a mirror the user is instructed to generate original instances of that shape, while seeing its avatar's back (via the camera view) and front (via the mirror).

Assessing originality

To assess the originality of the instances generated during the idea generation task we counted the unique instances generated by each participant, given the instances generated by all participants, for the each geometric shape. We divided the amount of instances by the amount of unique instances to obtain the likelihood that a user generates a unique instance. The latter provides a better metric of originality compared to the also often used counting of unique instances, as it corrects to some degree for the confounding effects of the overall amount of instances generated on originality [25]. This approach is a common assessment technique in studies about creative idea generation [25].

Assessing identification

The degree of identification the user experiences with its avatar was assessed with three Likert scales (1=Completely disagree, 7=Completely agree), i.e. "I resemble my avatar",

"It feels like I am my avatar", and "I identify myself with my avatar", based on scales from [32]. This previously used scale captured identification reliably in previous research. Indeed, also in this study Cronbach alpha suggested sufficient reliability, i.e., $\alpha = 0.87$. Ratings were averaged for use in further analysis.

Assessing positive affect

The degree of positive affect the user experiences because of using its avatar was also assessed with three Likert scales (1=Completely disagree, 7=Completely agree), and was conceptualized as liking and wanting to use the avatar, i.e. "I like my avatar", "I'd rather use this avatar for other purposes", and "I'd rather use another avatar". The latter two were recoded to achieve the same polarity. The positive affect rating was explicitly chosen to refer to the effects of using the avatar to ensure that identification and positive affect were attributed to the same object (the avatar); and to some extent prevent confounds from other influences on affect, such as baseline mood levels that are not attributed to an object or emotions attributed to other objects. Cronbach alpha suggested sufficient reliability, $\alpha = 0.84$. Here also, ratings were averaged for use in further analysis.

Procedure

Upon arrival participants were instructed about the procedure of the study, signed informed consent, and filled in a brief questionnaire about their socio-demographics. At this stage any information that could reveal the purposes of the study was withheld. Thereafter participants were assigned to one of the two experimental conditions. They were instructed on how to use Autodesk's Character Generator and, depending on the experimental condition they were assigned to, used this software to compose a self-similar or non-self-similar avatar. The researcher then exported the avatar and placed it within the developed virtual environment. During this time the participant was given instruction about how to use the head mounted display, i.e. how a controller should be used to navigate the virtual environment. Thereafter, participants were instructed to navigate toward an assigned geometric shape first, and search for another second; upon which encounter they would attempt to generate as many instances of that shape as they could within one minute. After finishing the idea generation task they removed the head mounted display and filled in a questionnaire about the identification and positive affect they experienced while using their avatar within the virtual environment. Participants were then debriefed and sent on their way.

Analysis

The hypotheses tested involve conditional effects. That is, the effects of self-similarity on positive affect depend on the effects of self-similarity on identification (H1); and the effects of self-similarity on originality depends on its effects on the relationship between identification and positive affect (H2). This requires a mediation analysis. The analytical strategy used for this is recommended in [19], which suggests that testing correlations between dependent variables and mediators (Pearson correlations), and testing of the statistical differences between independent variables for the mediators and dependent variables must precede tests for mediation (ANOVAs). Subsequently, the hypotheses were tested using Hayes' PROCESS SPSS module for mediation analysis [19]. Further details about the analytical strategy used are provided in the results section.

RESULTS

To gain insight into the relationships between identification, positive affect, and the likelihood that users generate original ideas a Pearson correlation was calculated between each of these variables. The scatterplots are presented in Figure 4. The results show that there are significant positive correlations between identification and positive affect, $r(57)=.526$, $p<.001$, identification and originality, $r(57)=.326$, $p=.014$, and positive affect and originality, $r(57)=.341$, $p=.010$. These findings justify further testing of hypotheses H1 and H2.
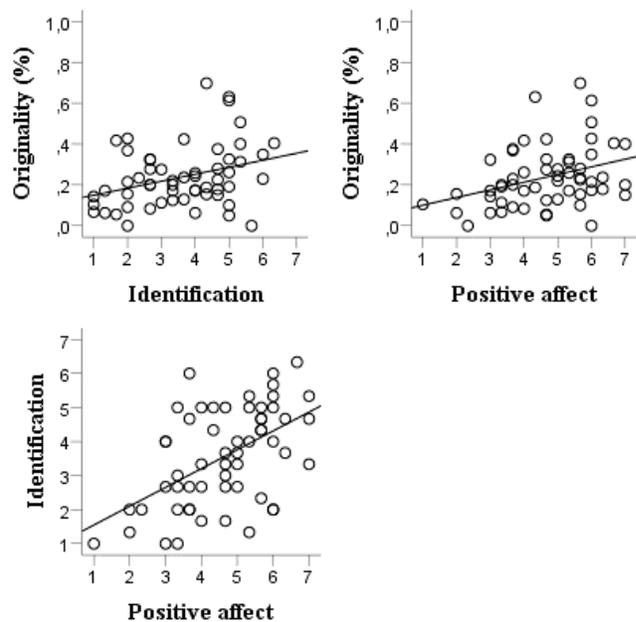

Figure 4. Scatter plots of the dependent variables identification, positive affect, and originality (%).

To test whether there were direct effects of using the self-similar avatars on identification, positive affect, and the generation of original ideas, we submitted these as dependent variables to a one-way ANOVA, with using the self-similar and non-self-similar avatars as the independent variable. The descriptive statistics are presented in Figure 5.

The results show that using a self-similar avatar rather than a non-self-similar avatar has a significant effect on the degree to which the user identifies with its avatar, $F(1, 56)=15.20$, $p<.001$, $\eta_p^2=.220$. Using a self-similar avatar (M=4.26, SD=1.20) led its users to self-report more identification with their avatar than those who used a non-self-similar avatar (M=2.92, SD=1.37). These findings
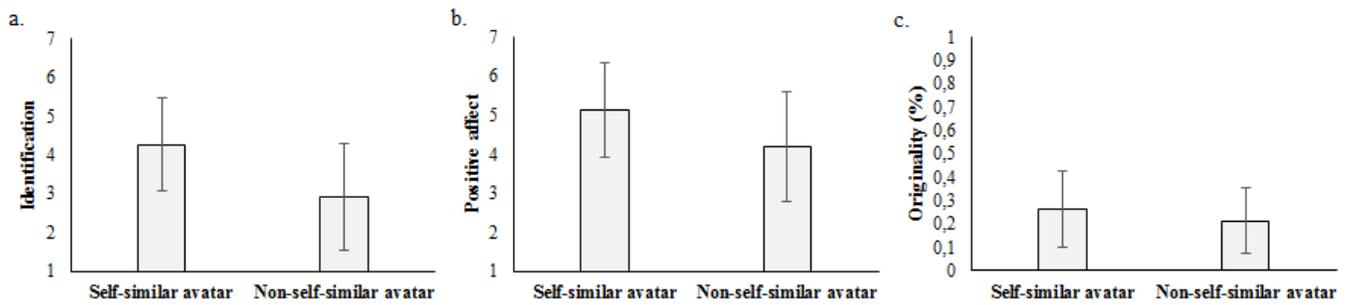
Figure 5 Means and standard deviations above and below the mean (error bars) of a) identification, b) positive affect, and c) originality (%) resulting from the participants using either a self-similar avatar or the non-self-similar avatar.

suggest that using a self-similar avatar positively affects the degree to which users identify with their avatar.

Using a self-similar rather than a non-self-similar avatar also had a significant positive effect on the degree of positive affect a user experiences due to using its avatar, $F(1, 56)= 6.62$, $p=.013$, $\eta_p^2=.109$. Using a self-similar avatar (M=5.12, SD=1.21) led its users to self-report more positive affect towards their avatar than those who used a non-self-similar avatar (M=4.21, SD=1.41). These findings suggest that using a self-similar avatar positively influences the user's affect.

However, no significant effect of using a self-similar avatar on the originality on the ideas that the users generated was found, $F(1, 56)=1.45$, $p=.234$, $\eta_p^2=.026$. Using a self-similar avatar (M=.262, SD=.164) made it on average slightly more likely to generate original ideas than those who used a non-self-similar avatar (M=.214, SD=.138). These findings suggest that using a self-similar avatar has no direct effect on the likelihood that its user generates original ideas. Further testing with a mediation model is necessary to explore whether there is indeed no direct effect, or no effect at all. That is, also not mediated effect.

Overall, these findings justify further testing of hypotheses H1 and H2.
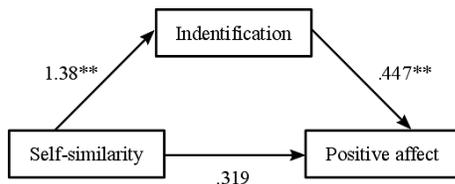

Figure 6. Mediation model for the effects of using self-similar avatars on positive affect, mediated by identification. Data are unstandardized coefficients. ** p<.001.

To test whether the effects of using self-similar avatars on positive affect depend on the degree to which a user identifies with its avatar (hypothesis H1), we conducted a mediation analysis using Hayes' [19] bootstrapping method, with the avatar as the independent variable, identification as the mediator, and positive affect as the dependent variable. The results show a significant indirect effect of using a self-similar rather than a non-self-similar

avatar on positive affect that is conditional upon its effects on the degree to which the user identifies with its avatar, $b=.616$, 95% CI[.244 1.192], i.e. the lower and upper bounds of the confidence interval does not cross zero. However, no signification direct effect was found, $b=.319$, 95% CI[-.335 .973], i.e. the lower and upper bounds of the confidence interval cross zero. These findings suggest that the effect of using self-similar avatars on positive affect is conditional upon the effects of the avatars on the degree of identification the user experiences (Figure 6). The findings support hypothesis H1.
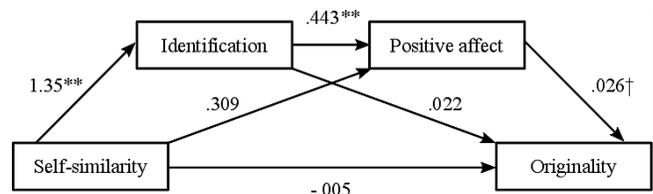

Figure 7. Sequential mediation model for the effects of using self-similar avatars on originality, mediated by the link between identification and positive affect. Data are unstandardized coefficients. † p <.10, ** p<.001.

To test whether there is an effect of using self-similar avatars on the ability of users to generate original ideas that depends on the effects of the avatar on the link between identification and positive affect (hypothesis H2), we conducted a sequential mediation analysis using Hayes' [19] bootstrapping method, with the avatar used as the independent variable, identification and positive affect as mediator 1 and 2, and originality as the dependent variable. The results show that there is a significant indirect effect of using a self-similar rather than a non-self-similar avatar on the originality of the participant's ideas that is conditional upon the effect of the avatar on the link between identification and positive affect, $b=.016$, 95% CI[.002 .048]. The indirect effects of using the self-similar avatar on originality that are conditional *solely* upon identification, $b=.030$, 95% CI[.-.009 .090], or on positive affect, $b=.008$, 95% CI[-.006 .038], are not significant; whereas the total indirect effect was significant, $b=.053$, 95% CI[.012 .116]. Furthermore, no significant direct effect was found, b=-.005, 95% CI[-.095 .086]. These findings suggest that the effect of using self-similar avatars on the likelihood that a user generates original ideas, is conditional upon the effects

of the avatar use on the link between identification and positive affect (Figure 7). These findings support hypothesis H2.

DISCUSSION

The present study investigated how self-similar avatars can be used to support the generation of original ideas in virtual environments (RQ).

The results showed that using a self-similar, compared to a non-self-similar avatar, increased positive affect because of its positive effects on identification (H1); and that using a self-similar avatar, compared to a non-self-similar avatar, positively influenced the originality of the ideas that were generated during the instances task, due to its effects on the relationship between identification and positive affect (H2). This suggests that self-similar avatars can be used as a novel form of avatar-mediated brainstorming.

The contribution of the presented study is therefore as follows. First, the results provide a much needed confirmation of [12] in a dedicated study, that avatar self-similarity indeed influences creativity, and specifically the generation of original ideas. Second, the preliminary nature of previous research in [12] also called for an explanation of how self-similar avatars may influence the generation of creative ideas. The results of the present study showed, for the first time, how self-similar avatars can be used to support the generation of ideas that are original. Specifically, the results confirm previous research that formed the basis of the present study's conjectures. That is, the results confirmed the effects avatar self-similarity on the link between identification and positive affect found in previous studies [5, 28, 30]; and showed that the effects of avatar self-similarity on this identification-positive affect link influenced the relationship between positive affect and the generation of original ideas, cf. [3, 10, 11].

Of course, there are also limitations to this study, some of which affect the validity of the results, and some that point to possible alternative explanations of the results.

First, there is uncertainty about the function of composing versus the function of using self-similar avatars. That is, composing may in itself be needed to enable identification, and thereby positive affect later during the ideation task. As we did not apply pre and post identification measures, we cannot know whether composing the avatar is an essential component of the mechanism uncovered, or whether using self-similar avatars obtained without the user composing it itself, can achieve the same effects. In addition, time spent on creating the avatars may have also led to differences in identification with the avatars. As this was also not measured, possible confounds by the time spent on composing the avatars can also not be ruled out. This leaves open the possibility for alternative explanations of the effects of avatar self-similarity on identification.

Second, there is uncertainty about the effectiveness of using self-similar avatars as a way to support creativity. That is,

no direct effect of using a self-similar avatar on the originality of the generated ideas was found. Instead, effects were only found in the mediation test. Possibly, using self-similar avatars did not always evoke the links between identification, positive affect, and the generation of original ideas. Alternatively, high identification may have also been elicited in the non-self-similar avatar group. That is, increased identification can, next to self-similarity, also be the result of composing an avatar that supports the user's personal aspirations and helps to achieve the expected outcome of the virtual experience [30]. Since the latter was not assessed, it cannot be ruled out as an alternative explanation for this null finding, and can thus help explain why no direct, but only mediated, effects were found of avatar self-similarity on the generation of original ideas.

Third, there are limitations to the possible inferences that can be made about the exact influence, or even ability to enhance, the generation of original ideas; which limits speculation about practical applications. That is, on the basis of the used experimental design, we cannot rule out the possibility that using a self-similar avatar has no influence, whereas a non-self-similar avatar has a negative influence on the generation of original ideas; nor confirm whether, as assumed in the present paper, cf. [12], using self-similar avatars positively influences the generation of original ideas. This is in part because there was no reference group, e.g. by using an in-between (non)-self-similar avatar. Moreover, the used experimental design also limits speculation about whether using a self-similar avatar can enhance the generation of original ideas, which would have required comparison to a control group where people do not use an avatar and not use a virtual environment. We recommend that these limitations are taken into account when interpreting and building further upon the results of this study.

Future studies should address the discussed limitations to confirm the mechanisms uncovered in this study, and enable practical application.

First, a possible direction for future work is studying the relevance of composing the avatar itself. Composing an avatar might play a crucial role in enabling identification [5], and is a common feature of many virtual environments [32]. However, it may also be that the effects of using a self-similar avatar on the generation of original ideas do not need composition, and only require using an avatar with a degree of self-similarity. For example, in the study by [12] a body scanner was used to generate a self-similar avatar, and therefore the user did not compose its own avatar, but nevertheless self-similarity positively correlated with the reported creativity of the generated ideas. Future work should investigate whether composing the avatar is a necessary, or at least a useful step, in enabling the positive effects of avatar self-similarity on the generation of original ideas.

Second, and relatedly, if the act of composing is a necessary or useful step in enabling identification, we propose to develop a tool that enables one to compose a self-similar avatar in a manner that emphasizes identification. One way to approach this is by enabling the selection of facial and body features not only by self-similarity, but also with poses and facial expressions, clustered by associations between appearance and a person's identity, goals, and perspective, cf. [14]. Developing tools that enable composing an avatar in a manner that emphasizes identification can possibly make more effective use of the uncovered links between identification, positive affect, and the generation of original ideas.

To summarise, when it comes to using avatars in virtual environments, it may be best to be represented as yourself if your goal is to be creative.

ACKNOWLEDGEMENTS

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