

# Mild Place Illusion: A Virtual Reality Factor to Spark Creativity in Writing

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## ABSTRACT

Developments in Virtual Reality (VR) technology have modified the creative potential of each individual. We introduce a new concept, called "mild place illusion", as a new paradigm for designing VR-based user interfaces targeted at stimulating creativity. We show that for creative tasks - such as creative writing, new product ideation, and brainstorming - a "just-enough" amount of place illusion leads to a greater self-perception of creativity, as opposed to a "full-level" place illusion. This is a somewhat unexpected result since one would suppose, *a priori*, to have the full-level place illusion as the optimal setup for stimulating creativity. We considered that the methodology in this work was fairly complex, but our results show – through a data triangulation approach – that we were able to identify more consistent and personal creative experiences. Therefore, the main contribution of this paper is a new paradigm for designing VR user interfaces targeted at stimulating creativity by showing that a “one-illusion interspace” leads to a greater self-perception of creativity.

## CCS CONCEPTS

• **Human-centered computing - User centered design**

## KEYWORDS

Creative Writing tools; Human Computer Interaction; Creativity Support Tools; User Interface Design; User Experience Design.

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## 1 INTRODUCTION

Creativity is a complex and multifaceted phenomenon [1], an inspiration, and is not a purely intellectual process. Includes discovery or invention of a significant idea, pattern, method, or device that gains recognition from accepted leaders in a field [2]. It can be defined as the “*process of having original ideas that have value*” [2], involving our imagination. It is one of the most frequently cited 21st century skills [3] [4] [5]. As Carroll et al. argue [6], there is no single theory or definition that can fully account for the phenomenon of creativity. Creativity often knocks into areas of consciousness that are not regulated by conscious thought. It may draw on all areas of human consciousness, such as feelings, intuitions, imagination, as well as knowledge and practical skills [3] [7]. Researchers reinforce a lot of effort in developing numerous methods for supporting creativity, such as triangulating several temporal metrics, including self-report scales, external judgments and physiological measurements [6] [8] [9]. And some researchers also consider that it is appropriate to adopt a variety of methods to investigate it from a multitude of perspectives [1] [10]. Creative writing often displays imagination or invention. It goes outside the bounds of normal professional or technical forms of literature and can be found in journalism, science fiction, etc. and typically identified through different forms such as prose, poetry and many assorted ways [11]. Writers tend to write using different techniques and they take their creativity from anything. The creative writing process can be divided into six different stages: pre-writing, drafting, revising, editing, evaluating and publishing [12]. Successful writers write regularly and develop a routine. Amateur writers struggle with this [13]. Most of the work of successful writers (up to 90% of their work) does not make it to the final version [14]. However, regular writing strengthens their voice and their levels of motivation. Some of the currently available writing tools attempt to initiate the process [15], providing story prompts, while others focus on creating a distraction-free user interface where writers can focus solely on

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their craft [16]. Creative writing is a field that will continue to develop itself, because it is not just related to human creativity and to the significance of words as tools of human communications, but because it celebrates individuals as well as cultures [12]. It has also been reported to be among the most demanding creative tasks [17] [18]. Certainly, well-designed creative writing tools can help users in generating multiple levels of “flow” [19] or generating the sense of “being there” [20] combined with their creativity during the process of writing and tracking their creativity choices. Slater [20] states that place illusion – “It is the strong illusion of being in a place in spite of the sure knowledge that you are not there.” In this paper, we present a new experimental method based on virtual reality for studying place illusion in a writing context, along with the correlation of the degree of creativity. More specifically, we study three different creative writing environments (*No PI*; *“Mild” PI*; *“Full” PI*) and how they can affect the writer’s self-perception of creativity. We evaluate the participants’ experiences and proficiency with data from different sources during a creative writing task. In the experiment, we observed that participants felt more creative in the “Mild” PI condition, i.e. a “just-enough” amount of place illusion leads to a greater self-perception of creativity, as opposed to a “Full-level” PI or No PI. The remainder of this paper is organized as follows: in the next section, we review the background that supports our work based on illusion as a factor that sparks creativity. We also reviewed creative writing and creativity support tools. We then present a section describing our methodology, detailing the participants, procedures and methods used. Thereafter we present the results of a study with both qualitative and quantitative data. We wrap up with a discussion that includes some reflections on the entire experiment, as well as the overall conclusions.

## 2 BACKGROUND

New technological developments, such as those in the field of Virtual Reality, facilitate new forms of creative work. It is a two-way process, the interaction with technology provides fresh possibilities to use it in creative ways, while also leading to the evolution and sometimes transformation of technologies. Emerging computer-based tools can develop better and more creative solutions to the problems they face whether it’s in decision support systems [21] or in simple software systems. Over the last decades of creativity research there is still no consensus on how to evaluate how well a Creativity Support Tool (CST) supports the creativity of its users [22]. Hedge et al. [23], considers that success during software development, depends on the creativity of software engineers, despite being a conceptually complex, knowledge-intensive activity. We can give cheers for science and engineering, but there is still a paradox about this technology that helps us to be more productive, perform our work more rapidly and effectively. Therefore, there is an effort for developing creativity support tools, which enable us to explore, discover, imagine, innovate, compose and collaborate [24]. Joy et al. [25] suggest that people who generate multiple possible solutions are more likely to produce solutions which are less common. Also, they argue that some people are more capable than others of *braking free* from the mental set established by their initial

ideas, therefore they are more flexible, from a cognitive point of view. Selker [26] considers that creativity and motivation enhancement can easily be aligned with the design of high-quality human-computer interaction and also that creativity might be viewed as any process which results in a novel and useful product. Shneiderman [27] argues that it is a challenge to construct information technologies that support creativity and the goal of developing new CST can be obtained by building upon an adequate understanding of creative process.

### 2.1. The Illusion as a factor to spark creativity

Illusions have historically been of great use to psychology for what they can reveal about perceptual processes [28]. Slater [20] argues that when users experience place illusion (PI) - *the qualia of having a sensation of being in a real place, “being there”, often called “presence” – and the illusion that the scenario that has been depicted is actually occurring - Plausibility Illusion (Psi)*, participants in both PI and Psi know for sure that they are not “there” and that the virtual events are not occurring. That is, when both PI and Psi occur, participants will respond realistically to the virtual reality.

Waterworth et al. [29], suggests that virtual and mixed reality environments can produce vivid experiences and generate powerful emotions. Their view of creativity rests on the idea of collaboration between consciousness and the unconscious, between the virtual and real as well as between presence and absence. The authors also explored ways in which perceptually-seductive technology (PST) can be a tool to enhancing both memory skills and creativity. By presenting information in different perceptually-seductive and emotionally-stimulating ways, they suggest that PST can provoke creative ideas, robust learning and possibly also more engagement in the learning process [29] [30]. The relation of the individual to the technology, and with the world through the technology, is also considered in PST. It is suggested that in order to stimulate and support the creative process, IT environments should encourage both presence (perceptual or experiential mental activity) and absence (conceptual or reflective mental activity) which are seen as the end points of a continuum comprising the Focus dimension of PST [30]. The other two dimensions are Locus (whether attention is directed towards the virtual or the physical world) and Sensus – which is the level of attentional arousal, on a continuum from completely unconscious to fully conscious [29].

## 3 USER STUDY

We conducted a within-subject experiment to investigate the influence of the PI amount on the users’ self-perceived creativity. We selected creative writing because it is a popular activity [17], which made it feasible for us to properly recruit participants [18]. All data taken from the experiment was made completely anonymous. This experiment was conducted throughout six months.

### 3.1. Conditions

The creative activity in this experiment included writing in three creative writing environments (Fig. 1): no place illusion; mild place

illusion and full place illusion. To control for carry-over effects, the order of the conditions was randomly counterbalanced between participants.

**Control condition - No PI.** Our baseline is a text processor (Microsoft Word) that allows users an easy and near-instant input. It has a large variety of formatting options, including a variety of color choices, the ability to change font-weight.

**"Mild" Place Illusion - ("Mild" PI).** In this condition we used Haven [15] which is a clean and lightweight tool text processor, with audio soundtracks to provide inspiration, a full screen mode and a virtual reality landscape with subtle animations.

**"Full-level" Place Illusion - ("Full" PI).** In this condition, we simulate a virtual reality-based creative writing environment within the Haven tool.

The conditions were defined like this so that we could correctly address our research question in a focused manner: to assess the influence of the PI amount on the users' self-perceived creativity.



**Figure 1 - Creative writing conditions in the experiment (from left to right): No PI; "Mild" PI; "Full" PI.**

### 3.2. Task

Participants were required to write in the three different writing environments. We had to define three different fairytales of a similar degree of complexity that participants were equally familiar with. In each condition, participants received a fairytale to read. After that, they had to brainstorm ideas in a white paper with different-color pen or pencils (we gave them pen or pencils from different colors so that they could feel free to write using their preferred color). In every condition, they initiated their writing based on their ideas obtained during the brainstorming stage. No time limit was given.

### 3.3. Participants

We recruited only persons who had already taken creative writing courses, reportedly enjoyed writing or were actual writers. They were recruited through a university-wide mailing list. Nineteen people enrolled in this study, but we dismissed the collaboration of three people because they didn't show up on the appointed day. Others changed the agreed date, and scheduled another date because they did not feel in the mood to write on the appointed day.

Sixteen subjects participated in this study, 8 male and 8 female, ages between 21 and 56 years old ( $M=29.25$ ;  $SD=9.46$ ). All had normal or corrected normal vision; three wear glasses or contact lenses. All subjects were naïve to the experimental conditions. We lead one session per person.

## 3.4. Measurement approach

### 3.4.1. Creative Behavior Inventory

Among the many problems associated with the identification of creative talent is the problem of selecting appropriate criteria of creativity [31]. We should agree that measuring creativity is hard, because measuring "a thing" that is atypical, novel, innovative or unusual, be they products, ideas or people [32] it is difficult to generalize and to rank. Hocevar [31] developed the Creative Behavior Inventory (CBI) that tests how divergent thinking and creative attitude measurements can predict future creative behaviors by examining past creative behaviors. The CBI is a 77-item inventory for assessing creative accomplishments and activities in past behaviors. We used thirty items from the original CBI, particularly the specific examples of creative activities from literature, miscellaneous, performing arts, science and music [32]. We used the CBI as a psychometric tool to ask about past creative behavior and activities, and as a way to categorize how creative the participants were. An item score was based on response category: zero points for never, one point for once; two points for twice, three points for 3-4 times, four points to 5-6 times and five points for more than 6 times [31]. We classified subjects that had less than 30 points on the CBI as being *less creative*, and participants that had more than 30 points on the CBI as *highly creative* [22].

### 3.4.2. Flow Theory dimensions and Perceptual Effects

Human psychology, our desires, emotions and motivations are changing over the time. People are easily distracted, but when we are involved in certain activities, sometimes nothing else seems to matter. Csikszentmihalyi [19] argues that when we are "in the flow" we feel strong, alert, in effortless control, unselfconscious, and at the peak of our abilities. As the author argues, we all experience flow from time to time and we recognize its characteristics. In this paper, we were particularly interested in the following of Flow Theory dimensions: concentration, sense of control, losing track of time, and loss of self-consciousness. Since PI is a *qualia* and there is no way to directly measure it, as suggested by Slater [20], we used these dimensions based on questionnaire as an indirect assessment. After each condition, the participants were asked to fill out a Likert scale survey about how the experience made them feel based on the Flow Theory dimensions [19] ("I felt very concentrated during this task"; "I was able to solve this task without any problem"; "I lost my attention during this task"; "I lost track of time during this task"), and also about Perceptual Effects ("It felt as if the writing was drifting towards a very good way"; "I sometimes felt as if I was actually writing at the environment's location"; "Sometimes I felt that the environment was providing me inspiration"; "At some moment I felt that the virtual environment was influencing my thoughts"; "It sometimes seemed as if the creativity I was feeling came from somewhere between my mind and the virtual environment"; "It sometimes seemed as if I was feeling more creative than ever"; "The flow of my writing was caused by the virtual environment" based on [28] [33]. They ranked a seven-point Likert with the evidence scale for 1 (totally disagree) and 7 for (totally agree).

### 3.4.3. Self-assessments and Post-experiment interviews

An interview was conducted to collect qualitative data about the experience with questions such as "*Did you enjoy to write in this environment and why?*"; "*In this environment did you feel more creative and why?*" to know the participant's opinion about the whole experience, and we asked participants to rank the creativity of their written data (a self-assessment) [32] in a Likert scale (one to seven). One month after the experience was over, users received the written texts, without knowing what condition the texts belonged to. They had to read the texts and carry out the rating of their creativity, again in a Likert scale (one to seven).

### 3.4.4. External judging

The main focus of the Torrance Tests of Creative Thinking (TTCT) was understanding and nurturing qualities which help people express their creativity [34]. These metrics are widely used to assess creative potential and have been subjected to a number of validity studies [35]. Using this psychometric approach, we used a group of external judges to rate the person's creative product – the writing challenge. Amabile [36] argues that creativity can be regarded as the quality of products or responds judges to be creative by appropriate observers, and it can also be regarded as the process by which something judged is produced. Christiaans [37] performed an analysis to determine whether human judgment of creativity is a reliable and valid method using design evaluations and selections. Comparing human judgments from experts, no experts, and people with an intermediate level of expertise, his results show that as long as no absolute criterion of creativity exists, the assessment of creativity remains dependent on subjective judgment. We didn't provide a definition of creativity to the judges as suggested by Amabile [8], in order to allow people to use their own definition and make them more consistent. In order to assess if there were any differences between the results from participants and each condition, we recruited three experts in Creative Writing, Arts and Psychology to rate the creativity of all written data per writing challenge. They were not involved in the sessions in any way and rated individually the written data without knowing which tool the users had used. We asked them to for a score ranked in a 7-point Likert with the evidence scale for 1 (not creative) and 7 (very much creative) taking into account the three creative abilities per answer: Flexibility (production of different ideational categories), Originality (production of unusual ideas) and Elaboration (persistency on introducing details to products) from the Torrance Test of Creative Thinking (TTCT), [38].

## 3.5. Procedure

A preliminary evaluation was conducted with four participants in order to examine the feasibility and accuracy of all the creative writing environments. Participants were asked to write a very short story during ten minutes about one of these topics: nature, food, trips and holidays. Subsequently, participants were asked whether any of the conditions disturbed them during the writing task. Since all participants reported not being disturbed, we considered that the study could be conducted according to the procedure.

Participants were brought in individually to the research laboratory, previously prepared for the experiment. For the No PI and "Mild" PI conditions, we used one portable computer with screen size 13.3', display resolution 1920 x 1080 pixels. In the Full PI condition, we used a large white wall (5.2m x 2.20m) and a projector with a full HD resolution, 3D-sound columns and a wireless keyboard. After participants filled in the inventory (CBI), the writing task was explained. During the writing task, users were interrupted to pinpoint the state of flow regarding how they were feeling about the creative writing environment and the writing task. They were interrupted 10 minutes after they started writing. A researcher (the first author) made the record, through observation, of the whole process in terms of writing fluency, completion time for each task, and all qualitative elements that could be useful in the experiment. When users finished the writing task, they were asked to fill a survey about Flow Theory dimensions and a questionnaire about Perceptual Effects. Finally, they were interviewed and ranked their creativity in each condition. The total time per subject including pre-questionnaire, instructions, training, experiment, breaks and debriefing took over two hours. Subjects were allowed to take breaks (10 minutes) between each experimental condition.

## 4 FINDINGS AND DISCUSSION

### *Were the participants creative?*

Regarding reliability, our 30-item CBI inventory exhibited a Cronbach's alpha value of .72. We found that six males ( $M=46.83$ ,  $SD=17.66$ ) and six females ( $M=45.0$ ,  $SD=8.87$ ) were highly creative (more than 30 points in CBI) when compared to the other of its kind, two males ( $M=26.0$ ,  $SD=4.0$ ) and two females ( $M=19.5$ ,  $SD=8.5$ ). We compared the gender of the subjects with their creative level of the self-report scale in CBI to see if there were any differences between genders. On average, male participants experienced greater creativity in past activities ( $M=41.62$ ;  $SD=11.12$ ) than to female participants in past activities ( $M=38.62$ ;  $SD=15.08$ ). This difference was not significant ( $t(14) = 0.45$ ,  $p>0.05$ ); however, it did represent a small-sized effect  $r=.12$ . Results of the self-report scale, suggest that our sample was likely "homogeneous" in terms of past creative actions.

### *Did the creative writing environments lead to increased levels of "flow"?*

The polarity of the scale was taken into account in Flow Theory dimensions survey. Results show that the average inter-correlation among the items and the number of test items can be considered good, consistent, in the scale used by the questionnaire on seven-point Likert scales: Flow Theory dimensions ( $\alpha=.81$ ). As a first step, we used repeated measures Friedman's ANOVA approach to testing differences between each environments.

Results were substantially significant regarding the Flow dimension *Loss of Self-Consciousness* ( $F(2) = 6.05$ ,  $p<.05$ ). Therefore, the non-parametric Wilcoxon tests, were used to assess if there were any differences for each pair of creative writing environments using the *No PI* to compare as a baseline. A correction was applied and so all effects are reported at a .025 level of correction.

Regarding the dimension *Loss of Self-Consciousness*, the statistical analyses showed that participants using *No PI* when compared with *"Mild" PI*, ( $T=2$ ,  $z=-2.07$ ,  $p<.025$ ,  $r=-.36$ ), were not statistically significant, the same for participants using *No PI* when compared to *"Full" PI* ( $T=2$ ,  $z=-2.23$ ,  $p<.025$ ,  $r=-.39$ ). We applied the effect size that gives us the magnitude of the effect investigated, by performing a post hoc analysis, identifying a medium effect size.

These results may be due to the fact that participants were interrupted during the task to mark its psychological state of flow [5]. Fig. 2, 3 and 4, show that the overall distribution of the psychological states of the participants when interrupted during the creative writing challenge was different for each environment. In the *"Mild" PI* condition, we can see that most participants went into flow, control and relaxation states, and experienced a better balance between skills and challenge. In contrast, in *No PI* session results shows low levels of flow state. However, it is interesting to see that in the *No PI* session a high number of participants were in the state of boredom, apathy and worry. In *"Full" PI*, we can see a low balance between skills and challenge when compared to *"Mild" PI*.

Triangulating the results with the statements in the interviews and from the observations after the interruption, when participants were interrupted to pinpoint their state of flow (regarding how they were feeling about the creative writing environment and their writing task), the results show that most of participants in the *"No PI"* condition did not want to continue with the writing activity (43.75%) contrasting with the 12.5% in the *"Mild PI"* condition and *"Full PI"* condition (12.5%). Thus, participants in *"Mild" PI* session after interrupted continued immersive and focused on writing (75%) contrasting with the 56.21% in *"Full" PI* session (56.25%) and *No PI* session (43.75%). Also, we observed that after being interrupted, 12.5% of the participants completed the writing challenge in *"Mild" PI* session.

In contrast, most of participants in the *No PI* session ended the writing task (43.75%), compared to 12.5% in the *"Full" PI* session. 31.25% of the participants in the *"Full" PI* session stopped to think and restarted writing, while only 12.5% in *No PI* session did so and 12.5% in *"Mild" PI* session.

When participants were interviewed as they had felt at the interruption in the challenge, most expressed that had no effect on the continued writing task, e.g., "...I returned to back on track because I was with the ideas on my mind" – [P1]; "...did not break the reasoning" – [P9]; "...I did not lost all the ideas that I had" – [P15].

Others assume that in *No PI* session they had more difficult to regain focus, e.g., "I stopped writing in no illusion session, because I found it difficult to return to resume the story" - [P14]; "I didn't lose the ideas on writing in haven" - [P12]; "I just start writing with no difficulty in mild session, but in the other, the full-level session, I was more distracted with the environment and because of that I stopped writing" – [P11]; "I just had a block in no illusion session, and I stopped" - [P10].

Following from what is known about creativity, concentration is an important ingredient to engage participants in an activity with high involvement, enjoyment and intrinsic motivation [19].

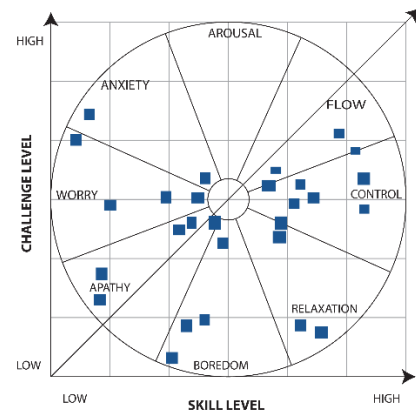


Figure 2 - No PI Session

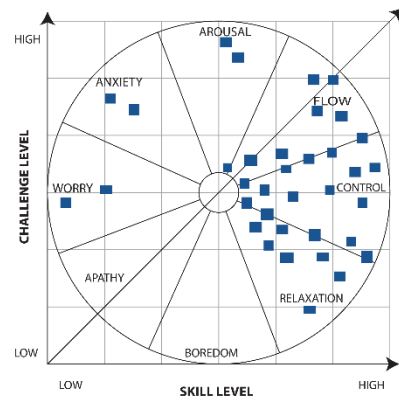


Figure 3 - "Mild" PI Session

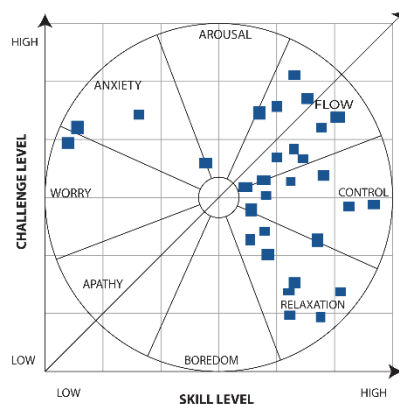


Figure 4 - "Full" PI session

Once they were interrupted they were no longer in flow of their fleeting state, but from results we could notice a small number of participants had finished writing after the interruption in the *"Mild"*

PI environment in contrast to other two environments. We can assume that the conditions available in this environment allowed participants to return to the flow state.

### **Did the creative writing environments lead to increased perceptual effects?**

Through Cronbach's alpha, the survey based on perceptual effects [28] [34] was found to be reliable ( $\alpha = .84$ ). Results on questions "I sometimes felt as if I was actually writing at the environment's location" ( $Fr(2) = 8.27, p < .05$ ), "Sometimes I felt that the environment was providing me inspiration" ( $Fr(2) = 14.53, p < .05$ ), "At some moment I felt that the environment were influencing my thoughts" ( $Fr(2) = 7.56, p < .05$ ), "It sometimes seemed as if the creativity I was feeling came from somewhere between my mind and the environment" ( $Fr(2) = 8.35, p < .05$ ), "It sometimes seemed as if I was feeling more creative than ever" ( $Fr(2) = 11.61, p < .05$ ) and "The flow of my writing was caused by environment" ( $Fr(2) = 7.14, p < .05$ ) results were substantial significant. Correcting the 5% level of significance ( $p < .025$ ), and using *No PI* to compare as a baseline, Wilcoxon tests were used to display if there were any differences for each pair of environments.

#### **Pair 1: No PI versus Mild Place of Illusion**

Regarding the questions "I sometimes felt as if I was actually writing at environment location" ( $T=3, z=-2.54, p < .011, r=-.45$ ), "Sometimes I felt that the environment was providing me inspiration" ( $T=1, z=-3.19, p < .001, r=-.56$ ), "At some moment I felt that the environment was influencing my thoughts" ( $T=2, z=-2.85, p < .004, r=-.50$ ), "It sometimes seemed as if the creativity I was feeling came from somewhere between my mind and the environment" ( $T=2, z=-2.29, p < .022, r=-.40$ ), "It sometimes seemed as if I was feeling more creative than ever" ( $T=2, z=-2.84, p < .004, r=-.50$ ), results were statistically significant. The results from the question "The flow of my writing was caused by environment" ( $T=2, z=-2.11, p < .035, r=-.37$ ), were not statistically significant.

#### **Pair 2: No PI versus Full-level of Place of Illusion**

Regarding the questions, "I sometimes felt as if I was actually writing at environment location" ( $T=3, z=-2.59, p < .009, r=-.46$ ), "Sometimes I felt that the environment was providing me inspiration" ( $T=2, z=-2.55, p < .011, r=-.45$ ), "At some moment I felt that the environment was influencing my thoughts" ( $T=3, z=-2.34, p < .020, r=-.41$ ), "It sometimes seemed as if I was feeling more creative than ever" ( $T=2, z=-2.67, p < .008, r=-.47$ ), results were statistically significant. In questions, "It sometimes seemed as if the creativity I was feeling came from somewhere between my mind and the environment" ( $T=3, z=-1.91, p < .056, r=-.34$ ) and "The flow of my writing was caused by environment" ( $T=2, z=-2.14, p < .032, r=-.38$ ), results were not statistically significant. Taking into account the results, in both environments – "Mild" PI and "Full" PI when compared to *No PI* – participants felt that the environment was not a direct factor in the flow of their writing.

#### **"Mild" PI versus Full-level of Place of Illusion**

When we compared the "Mild" PI condition with "Full" PI condition, using an ANOVA with repeated measures with a Greenhouse-Geisser correction, the perceptual effects for participants were not

statistically significantly different ( $F(1.000,15.000)=0.23, p > 0.005$ ). When we asked them if there were any features they really liked and if those features influenced the ideas to write, some of them expressed genuine interest in the relation to the background environment, clean view and audio soundtrack (present in "Mild" PI and "Full" PI conditions) and they commented, e.g., "...I felt somewhat empowered and creative during this session(mild PI) given the sounds and clean background"-[P4]; "...the music helps to inspire and seems like the text is flowing a little"- [P3]; "...sound helped to keep me writing with a clear mind"-[P5]; "I was feeling pressured by the environment...I wanted to give another direction to the story that I was writing, but the environment influenced to have other purpose...and also I changed the music during the writing task because it's was giving bad feelings "- [P7]; "...changing the environment to write is a very good thing, because we can adapt the background and that can help us to write more... that was what I did"- [P12]; "...I used the sound of the rain in my story...and also the feeling that you are writing (from the sound of keyboard-another feature) and listening to the constant noise, makes you want to continue to write, "- [P2]. Only two users assumed that the sound was very distracting, "...I just turned off the sound...it was distracting me"- [P13]; "I got lost in my thoughts and did not write much, I was more attentive to the sound"- [P16].

## **5 DISCUSSION AND CONCLUSION**

Place illusion is defined as "the qualia of having a sensation of being in a different place" [20] and is constrained by the sensorimotor contingencies afforded by a virtual reality system. Creative professionals – such as writers – often report they feel more creative when they are working at a special place or location or setup that increases their creativity [12]. In this paper we presented a new approach called "Mild Place Illusion", as a new paradigm for designing virtual reality user interfaces specifically targeted at stimulating creativity. We showed that for creative tasks such as creative writing, new product ideation, and brainstorming, a "just-enough" amount of place illusion leads to a greater self-perception of creativity, as opposed to a "full-level" of place illusion. In general, the analyses in this paper confirm that a "Mild" Place Illusion environment is capable of providing higher levels of creativity and can lead to better results. We considered that the methodology in this work was fairly complex, but our results show – through a data triangulation approach – that we were able to identify more consistent and personal creative experiences. As suggested by Hewett et al. [39], within the limits of human working memory, the greater the variety of concepts that one considers, the greater is the probability that creative ideas will occur. As Carroll et al. [6] suggest, we empower users to harness and embrace their creativity through the use of creativity support tools. Technology is only capable of turning on or turning off human creativity. Creativity Support Tools can enhance the intellectual resources and improve collaboration among users through more rapid discovery processes. They can also promote,

accelerate and facilitate creativity [2]. We tried to balance a creativity focus on the individual (CBI and Self-Assessments) and their flow state while carrying out the writing task and their previously acquired skills. Bonnardel and Zenaschi [40] suggest that the development of new technologies should be dependent on the individuals' cognitive processes. More precisely, they argue that technology developments should be adapted to the individuals' cognitive processes instead of requiring users to adapt themselves to new technologies. It was clear that most of our subjects felt somewhat empowered and creative during the experiment, especially when they were in the Mild PI condition. LeBoutillier and Marks [41] suggest that a particular procedural context, is multifarious, with styles, forms, contents and contexts of imaging, which can account for the role of mental imagery in the creative process. Our quantitative and qualitative results have been promising: *a*) With an emphasis in everyday creative activities in the past work of each participant such as literature, miscellaneous, performing arts, science and music actions we could reduce bias with self-assessments results from the CBI and results showed that our sample was likely "homogeneous" in terms of past creative actions; *b*) Results from the Flow Dimension Loss of Self-Consciousness were substantially significant but when comparing each pair of environments, they were not statistically significant. These results suggest that in the future we will not interrupt participants during the task to mark their psychological state of flow. However, it was interesting to see that the participants in the No PI condition were feeling more apathy, boredom and worriedness during the execution of the task; *c*) When comparing each environment with the state of Perceptual Effects, only the results about the question "*It felt as if the writing was drifting towards a very good way*" were not significant. Triangulating the quantitative results with the qualitative data that we collected from the interviews, we can assume that participants were feeling more immersive, more concentrated and more creative in "Mild" PI session. We could also observe that most participants were really thoughtful and engaged in the activity during Mild PI, rather than during full level of PI; *d*) Generating multiple possible solutions by reading the text to trigger their creativity and afterwards using the brainstorming technique to generate ideas was a good way to ensure that we would not be restricting the creativity of participants, giving them freedom to write through their own (previously-generated) ideas. Results show that participants in "Mild" PI wrote more words than No PI or "Full" PI, without spending a lot of time. Triangulating these results with interviews, we can assume that they were more focused on the task itself and felt more creative; *e*) Self-assessments are also as complex as creativity itself. Despite the fact that we could not establish differences with sound confidence in order to assess the relationship between self-assessments of creativity and ratings of external judges, results suggest that users in Mild PI were more creative, during the writing task.

The contribution of this paper is a new paradigm for designing VR user interfaces targeted at stimulating creativity by showing

that a "one-illusion interspace" leads to a greater self-perception of creativity. The study reported in this paper has some limitations, because we did not sample all creative domains and have been focused on a limited sample population. Like any habit, creativity can either be encouraged or discouraged [42]. Moreover, it can be perceived differently by each person. Although our findings are consistent with "Mild PI", the present study is unable to rule out the alternative interpretation that either general "presence", intelligence or spatial ability is the common factor underlying both creativity itself and creative thinking. Overall, it seems plausible that the common factor underlying was the creative writing task that could lead and trigger a different creative process for each participant. Sanchez-Vives and Slater [43] suggest that the concept of "presence" refers to the phenomenon of behaving and feeling as if we are in the virtual environment and can break the deep, everyday connection between where our senses tell us we are where we are actually located. In contrast Turner et al. [44] conclude in their work that recreating real places as a distinct from virtual spaces or environments raises a series of significant challenges.

Finally, and despite the limitation that we did not consider the long-term usage of each environment, the present study did find empirical support for what has previously been a large debate about measuring creativity. Also, our study can be replicated in different domains combining several approaches that have the common goal of better supporting peoples' creativity. Today, there is ample potential in VR technology to further advance these efforts. One of the most important long-term prospects of this study resides in the assessment of different VR qualities (e.g. Place Illusion) and its impact on user's creativity. Studying these qualities will enable VR designers to come up with more engaging environments to support creative activities. VR has been employed in so many domains (health, entertainment, military) and there is ample room for improvement of current creativity support tools using VR. However, this improvement should be properly informed by focused studies such as the one we presented, especially because emotion, flow and mood play an important role in human creativity, and they can be negatively impacted by improper VR settings.

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