2 Literature review

§ 2.1 **Introduction to creativity and effective parameters correlated with creativity in architectural design**

A pivotal target of this thesis is 'how to enhance creativity'. This chapter reviews effective parameters correlated with creativity in architectural design. The Chapter starts with the definition of creativity and investigates where creative ideas come from. Further on, it also elaborates upon types of creativity and touches upon the relationship between tolerance of ambiguity and creativity.

To narrow down the widespread topic of creativity and focus on creativity in architecture, the research ignores aspects of creativity which focus on personality and behavior of creative people, their mood, their state and their temper, intelligence vs. creativity, motivation and so forth. Instead, the research focuses on cognitive aspects such as thinking patterns, conceptual blending, idea expansion and tolerance of ambiguity.

These aspects are elaborated in the first journal article: "Creativity in architecture -A review on effective parameters correlated with creativity in architectural design" in the Journal of civil engineering and architecture, ISSN 1934-7359, USA, Nov. 2014, Volume 8, No. 11 (Serial No. 84), pp. 1371-1379.

§ 2.2 Creativity in architecture - A review on effective parameters correlated with creativity in architectural design[*]

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Abstract. Human civilization can be ameliorated by human creativity. Innovation and progress of human civilization results from a change in our thinking patterns, thus, potentially transforming the present into a creative future. Accentuating the role of creativity in design even more than other disciplines pushes one to underpin the understanding of creativity as a key role player in Architecture. Furthermore by identifying the basic principles of our ingenuity/creativity, researchers might be able to enhance this ability in the future. A key point in "creativity" is the role of previously gained experiences, which cause expanding the inventory of experiences. According to accepted definition in different disciplines, creativity is no more than new combinations of previous ideas. The paper explores different effectual parameters correlated with creativity in architectural design including notion of conceptual blending, improbabilist and impossibilist creativity, tolerance of ambiguity and its correlation with creativity and creativity aided tools and interfaces. At the end we will suggest necessary experiments to obtain empirical results for some speculations that are discussed in the paper. Also practical approaches will be suggested to apply the results in pedagogy of architecture.

Keywords. Virtual Environment, Experience, Creativity, Conceptual blending, Tolerance of ambiguity

§ 2.2.1 Introduction

The human civilization is spearheaded by human's creative potential. In fact, progress at every sphere of our lives crucially depends on our creativity. Accentuating the role of creativity in design even more than other disciplines pushes one to underpin the understanding of creativity as a key role player in Architecture. Furthermore by identifying the basic principles of our ingenuity/creativity, researchers might be able to enhance these abilities in future.

But how can we define creativity? Though creativity is the hallmark of human cognition, and therefore a topic of enormous scientific importance, yet not a single definition of creativity exists that is universally accepted by creativity researchers, and the scenario hasn't changed much in the last fifty years (Runco, 2004; I. A. Taylor, 1959). Nevertheless, any creative output (be it an idea, product, or performance) should have, at least, three characteristics: novelty (it is original), usefulness (it is functional and adaptive), and surprising (it is non-obvious, therefore eliciting an aesthetical or affective response)(Simonton, 1999).

Many architects confess that, very gradually and unconsciously they stock in some conventional design approaches, because slowly confinements in construction and conventional stereotypes and rules of the physical world impose on them, dominate them and prevent them from thinking innovatively. In this paper, after reviewing the related literature on creativity in design, methods will be proposed to boost creativity and reverse the process of losing it.

§ 2.2.2 What Is Creativity?

Creativity is typically defined as the process of bringing into being something that is both novel and useful (Amabile, 1996; Sawyer, 2012; Sternberg & O'HARA, 1999). The creative process is often a mysterious phenomenon, with sudden insights seeming to work at an unconscious and inaccessible level (Schooler & Melcher, 1995). The magical "aha" moment of discovery, the point at which an idea leaps into consciousness, is part of what makes creativity seem sudden, without logic, and elusive (Leung, Maddux, Galinsky, & Chiu, 2008).

Because of its apparent unpredictability and elusiveness, creativity may seem difficult to study scientifically and systematically. However, psychology based literature now can provide a wealth of evidence depicting the psychological factors that facilitate creativity; elements of personality, affect, cognition, and motivation can either

facilitate or impair creativity (Amabile, 1996; Csikszentmihalyi, 2009; Sawyer, 2012). For example, personality studies have demonstrated that creative people tend to be nonconforming, independent, intrinsically motivated, open to new experiences, and risk seeking (Simonton, 1999). Large-scale studies and meta-analyses have found that intelligence, tolerance of ambiguity, self-confidence, and cognitive flexibility also tend to be found in creative people (Feist, 1998; MacKinnon, 1978). Now, it seems logical that if we consider an approach from the other side of the spectrum - we push designers to encounter new experiences - we can enhance their thresholds of ambiguity, self-confidence, cognitive flexibility, etc. It has been proven that a number of contextual factors related to motivation, cognition and affect facilitate creativity. Individuals who pursue tasks for intrinsic rather than extrinsic purposes show enhanced creativity (Amabile, 1985, 1996; Amabile, Hennessey, & Grossman, 1986; Hennessey & Amabile, 1998). Especially in design we consider it largely intrinsic rather than extrinsic. A distant future focus, compared to a near future focus, has been shown to lead to more creative negotiation outcomes (Okhuysen, Galinsky, & Uptigrove, 2003) and to enhanced creative insight (Förster, Friedman, & Liberman, 2004). Focusing on potential gains rather than losses increases the accessibility of unconventional ideas and thus enhances fluency in generating creative ideas (Friedman & Förster, 2001; LAM & CHIU, 2002). Finally, creativity seems to flourish when people are in positive or neutral affective states rather than negative affective states (Amabile, Barsade, Mueller, & Staw, 2005; Fredrickson, 2001).

To narrow down the scope of this research to creativity in architecture, we will ignore all other aspects of creativity including personality and behavior of creative people, mood, state and temper of them, intelligence vs. creativity, motivation and so forth and instead we will focus on cognitive aspects including thinking patterns, conceptual blending, idea expansion and tolerance of ambiguity.

§ 2.2.3   **Where do creative ideas come from?**

How can we get new ideas? In his book "The AHA! Moment" David Jones (Jones, 2012) takes a bold stance by claiming that we cannot have a truly new idea, the best we can do is to make combinations of different ideas already known to us. Therefore one needs a vast subconscious mass of remembered data in order to increase the likelihood of combination of ideas.
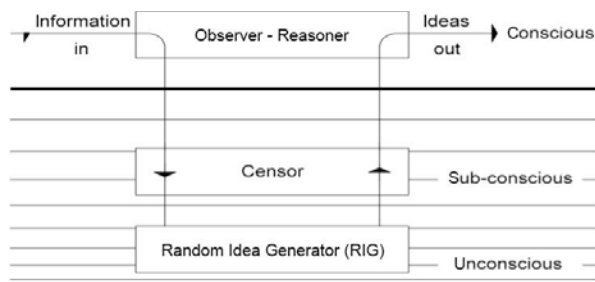
FIGURE 2.1 The model of human mental structure after Jones (2012).

Jones' theory of creativity is based on a three-tiered model of human mental structure (Figure 1). The top level is the Observer-Reasoner, the conscious part of our mind that is involved with planning, execution and action. It is also involved with reasoning, argument and conscious deliberation. The mid-level is the Censor, the subconscious part that houses our implicit knowledge (e.g., procedural skills, linguistic skills). It allows rapid access of stored knowledge or information, and also protects the Observer-Reasoner from constant perturbations. The lowermost level is the unconscious mind, the creative part of it is termed as the Random-Idea-Generator (RIG) that combines randomly, without any rule/supervision, ideas or information stored in the unconscious and preconscious mind. Due to the inherent randomness in the combinatorial process, most of the RIG ideas are wrong or not functionally useful and therefore blocked by the Censor before it could reach the uppermost conscious level, the Reason-Observer. If a creative RIG idea manages to pass the Censor and finally reaches the conscious level, it is likely to be perceived as a flash of sudden insight, known as Aha!.

This model, though quite appealing due to its inherent simplicity, does not provide much insight into how the ideas are combined. Even for a random combination to occur by the RIG, there has to be a mapping procedure by which ideas or concepts belonging to different domains or disciplines are allowed to merge with each other. The theory of 'conceptual blending' provides such a mechanism (Turner, 1998). In his book "The Literary Mind" Mark Turner states: "Conceptual blending is a fundamental instrument of the everyday mind, used in our basic construal of all our realities, from the social to the scientific." The theory posits that elements and vital relations from diverse scenarios are "blended" into a subconscious process known as Conceptual Blending, which is assumed to be ubiquitous to everyday thought and language. If two concepts are similar, simpler strategy is used to combine them and the resultant concept is less novel and offers limited surprise. However, for very different or remote concepts, complex strategies of structural mapping are required to fuse them and this results in most novel, innovative concepts. The more mutually remote the concepts are, the more surprising and creative the blended concept is. Indeed one of the classic laboratory tests on creativity is termed as remote associate test, which is based on this very idea that creativity involves remote associations between concepts (Mednick, 1962).

Insights obtained from these blends constitute the products of creative thinking. Arthur Koestler, demonstrate this idea in his 1967 book The Act of Creation and identified a common pattern in creative achievements in art, science and humor, which he called "bisociation"(Koestler, 1964). After analyzing and comparing varied instances of inventions and discoveries he concluded that fusing two unrelated elements coming from two different ideas/categories can be seen in an evolving matrix of meaning by way of a process applying analogies, comparisons, abstraction and metaphors. Indeed throughout history there are many examples of creative individuals who possessed expertise in multiple professions, thereby allowing the successful combination and cross-fertilization between different disciplines.

Good bodies of literatures consolidate and extend the above notion. Being in varied or diverse environments can train individuals to encode information in multiple ways, building a myriad of associations between concepts. For instance, bilinguals, who have been exposed to two languages, are more creative than monolinguals (Leung et al., 2008; Simonton, 1999). Creativity is found at relatively high rates for individuals who are first or second generation immigrants and for individuals who are ethnically diverse or ethnically marginalized (Lambert, Tucker, & d'Anglejan, 1973). At the group level, creativity is facilitated within collaborative groups that contain diverse members (Guimerà, Uzzi, Spiro, & Amaral, 2005; Levine & Moreland, 2004) and in groups in which heterogeneous opinions are expressed (Nemeth & Wachtler, 1983). Even at the societal level, creativity increases after civilizations open themselves to outside influences and when geographic areas are politically fragmented and relatively diverse (Simonton, 1997).

The current study also accentuates 'experience', its way of operation and points out its existence and relevance in creativity. Experiences indirectly affect creativity. The larger the inventory of experiences, the more and better combination of ideas is possible. Further, the more diverse and unusual the experiences, the higher the likelihood of creativity. For example, recent research suggests a link between multicultural experiences (e.g., learning a new language, multicultural exposure) and creative thinking (Leung et al., 2008). The exposure to and engagement with unusual experiences and/or situations may lead to a better cognitive flexibility by breaking the fixed cognitive patterns, a source of functional fixedness, and thereby, promoting creative associations between distant ideas. In fact, a recent research shows that after actively experiencing unusual virtual scenarios participants score higher on unusual uses task, a widely applied measure of creativity leading the authors to suggest a causal role of unusual and unexpected experiences in creativity (Guilford, 1967; Ritter et al., 2012). In this paper we attempt to extrapolate and connect this concept of "variety and extensiveness of experiences" to discipline of architecture.

§ 2.2.4   Types of creativity

Boden (M. A. Boden, 2003) has suggested two broad types of creativity: improbabilist and impossibilist. The improbabilist creativity involves new or unlikely, therefore improbable in nature, combinations of existing ideas, which is similar to the earlier concept discussed by David Jones. This is also the current working definition of creativity in architecture. Though this is not a universally accepted definition of creativity, however, informally this is the usual creative process, which architects follow. On the other hand, the impossibilist creativity is a deeper type involving the mapping, exploration and transformation of conceptual spaces. Therefore the two types differ in the mode of the creative thinking.(M. A. Boden, 2003). Improbabilist creativity specifies thinking in the associative mode, while respecting the logics, (physical) rules, and boundaries and constraints (Fauconnier & Turner, 1998).

If we extrapolate this definition to architecture, obeying conventional rules and the role of confinements in architecture in terms of material, technology, even perception of new spaces become clear. Impossibilist creativity is subject to the bisociative mode, in which the conceptual space is transformed, possibly at the expense of existing rules and disciplinary boundaries, and therefore affords higher autonomy in the procedure (Koestler, 1964). It is literally presumed that a product of impossibilist creativity needs mutation and transformation of the corresponding conceptual spaces (M. Boden, 1995). The first step relevant for creativity in design will be an enhancement of the perception of spaces. Since our visual perception is overly used to (and therefore constrained by) the environment around us in term of scale, depth, dimension, etc., changing the characteristics of the conventional environment around us might pave the way towards transformation of the corresponding conceptual spaces (Bubic, Von Cramon, & Schubotz, 2010).

§ 2.2.5   Shifting to Impossibilist conceptual blending in architecture

In the same logical vein as above, we expect to find similar outcome in the architecture discipline in design processes. The question here is how we transform improbabilist creativity to impossibilist creativity in architecture. Since the information feed of the brain is limited to what has been provided by the senses (e.g., hearing, seeing, tactile) and the experiences that can be accumulated from experiencing the physical world too are limited or constrained by the environment around us, in terms of its scale, depth, dimension, etc (Bubic et al., 2010). Transformation of the corresponding conceptual space needs mutation that seems farfetched with the available information feed.

Therefore changing the characteristics of the conventional environment around us may provide an alternative route for transformation of the corresponding conceptual space.

Digital era allows for new possibilities of architectural experience. It is assumed that new designs in virtual environments can be created that go beyond the mere accommodation of literal functions, and that affect human experiences. Detaching from the real one in sense of time and matter, enables the designers to cross the borderline between reality and fiction and expand their inventory. This new kind of architecture can create emotionally rich architectural experiences through the dynamic and precise manipulation of abstract visual forms in virtual space (Hakak, Biloria, & Rahimi, 2012). In this stage the inventory of experiences is expanding and we can expect that by blending new data with the old ones, mutations are bound to happen. From a cognitive point of view extensiveness of experience gained by surfing in unconventional virtual environments can positively be related to both creative performance (enhance interactivity, lateral thinking, idea generation, etc) and creativity-supporting cognitive processes (retrieval of unconventional knowledge, recruitment of ideas from unconfined virtual environment for creative idea expansion). Eventually with new languages and forms we can stimulate our creativity (Bartle, 2004; Castronova, 2008; Cherbakov, Brunner, Smart, & Lu, 2009; Novak, 2004).

§ 2.2.6   **The Relationship between Tolerance of Ambiguity and Creativity**

A large number of literature studies suggest a possible link between tolerance of ambiguity and creativity. A creative individual should have the ability, will and desire to deal with ambiguous and open-ended situations and suspend his/her immediate judgments to allow various possibilities to emerge; in fact, Taylor (C. W. Taylor & Barron, 1963) listed a liking for abstraction with considerable tolerance of (cognitive) ambiguity as one of the key traits of a creative scientist. Amabile (Amabile, 1996) too, illustrates the judgment suspension as "keeping response option open as long as possible" as well as tendency to break down the conventional rules/methods whenever necessary. Intrinsic motivation is also connected to creative achievements (Amabile, 1985, 1996; Hennessey & Amabile, 1998). We argue here that tolerance of ambiguity is related to creativity because it "empowers the intrinsically motivated exploration of novel, unusual, or complex stimuli". Zanasni and Barron (Barron & Harrington, 1981; Zenasni, Besan√ßon, & Lubart, 2008) show that creative achievers tend to be attracted towards complexity. Dacey (Dacey, 1989) describes: "The first characteristic of the creative person is tolerance of incongruity, which could be called tolerance of ambiguity. Its opposite could be called fear of the unknown or unfamiliar." Eysenck (Eysenck, 1993) illustrates that highly creative individuals, "can live with doubt and uncertainty, even enjoying risks and seeking out instabilities in the world."

Amabile (Amabile, 1996) also emphasizes the ability of divergent thinking and using wide and flexible categories. Individuals, who cannot tolerate ambiguity, tend to seek the solution through available options and rigid categories and tend to close the situation prematurely (Kenny & Ginsberg, 1958). However one should not confuse creativity with intelligence, as Kenny and Ginsberg (Kenny & Ginsberg, 1958) found that individuals with high levels of intelligence but low levels of creativity tended to be "intolerant of unlikely, unconventional types of hypothesizing about the world."

These literatures altogether conspicuously suggest a positive association between creativity and tolerance of ambiguity (Amabile, 1985, 1996; Sternberg, 1985; Sternberg & O'HARA, 1999; C. W. Taylor & Barron, 1963; Zenasni et al., 2008).

§ 2.2.7   **The Creative Cognition Approach**
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Recently, a scientific approach to studying creativity—the creative cognition approach—was proposed for understanding and specifying the cognitive processes that produce creative ideas (Amabile, 1996; Bink & Marsh, 2000; Finke, Ward, & Smith, 1992; Runco & Chand, 1995; Wan & CHIU, 2002). The central argument of this approach is that creative processes are not much different from those cognitive processes that produce our everyday mundane activities.

Every person has the potential to become creative as long as he or she effectively utilizes ordinary cognitive processes to produce extraordinary creative outcomes (Finke et al., 1992; Thomas B Ward, Smith, & Vaid, 1997; Weisberg, 1993). Specifically, the creative cognition approach identifies two kinds of cognitive processes implicated in creative thinking—generative processes and exploratory processes (Finke et al., 1992). First, people actively retrieve or seek out relevant information to generate candidate ideas with differing creative potential (the generative processes). Next, they survey these candidate ideas to determine which ones should receive further processing, such as modification, elaboration, and transformation (the explorative processes) (Leung et al., 2008). One strategy that makes effective use of generative processes is conceptual expansion, which takes place when attributes of seemingly irrelevant concepts are added to an existing concept to extend its conceptual boundary (Hampton, 1987; T.B. Ward, Patterson, Sifonis, Dodds, & Saunders, 2002; Thomas B Ward et al., 1997).

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Unconventional Virtual Environments (UVEs) can be designed in a way that variety of spatially intriguing concepts such as: Ambiguity, Multiple dimensions, Dematerialization, Infinite depth, Continuous change, multiple scales etc. can be experimented with. These concepts and their visualization can render cognition and perception a new meaning owing to the fact that the brain has not experienced and comprehended such concepts before and is thus not pre-conditioned to interpret them (Figure 2.2,2.3).
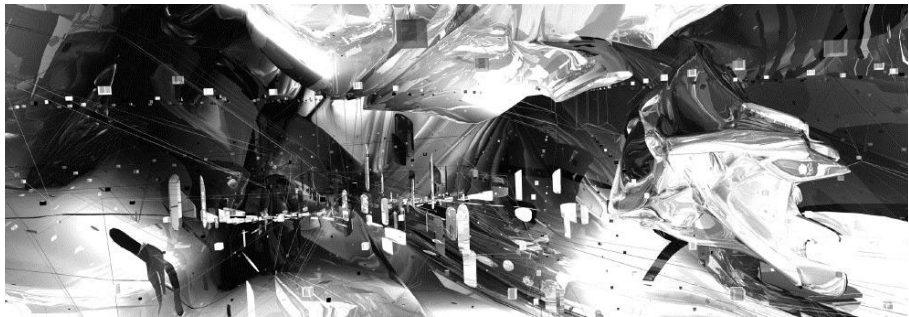

FIGURE 2.2   V4D_Visio4D by Marcos Novak-Used with permission

FIGURE 2.3   V4D_Visio4D by Marcos Novak-Used with permission

Although this shock has its dark side, once the initial, difficult adaptation stages have passed, it can also provide a great opportunity for acquiring new perspectives to approaching various tasks and learning new ways of thinking. Whereas old, conventional design approaches may constrain creativity, the experience of virtual environments may foster the creative expansion of ideas. Thus, we hypothesize that virtual environment experiences can contribute to creative expansion in at least four ways:

(1) Architects learn new ideas and concepts from exploring and designing in these environments. Through these experiences, people are also exposed to a range of behavioral and cognitive scripts for situations and problems. These new ideas, concepts, and scripts can be the inputs for the creative expansion processes because the more new ideas people have, the more likely they are to come up with novel combinations (Weisberg, 1993).

(2) Although architectural pedagogy established conceptions and conventions provide the architect with structured and routine responses to design, these cognitive structures may be destabilized as people to acquire alternative conceptions through their experiences in another environment, in terms of new perception and cognition and interaction with it, particularly as people adapt their own thoughts and behaviors to the new environment. Immersing in multiple virtual environments may even lead individuals to access unconventional knowledge when back in the physical world (Figure 2.4, 2.5).
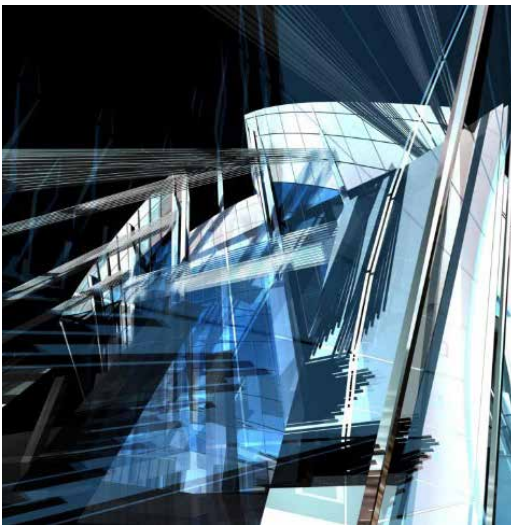

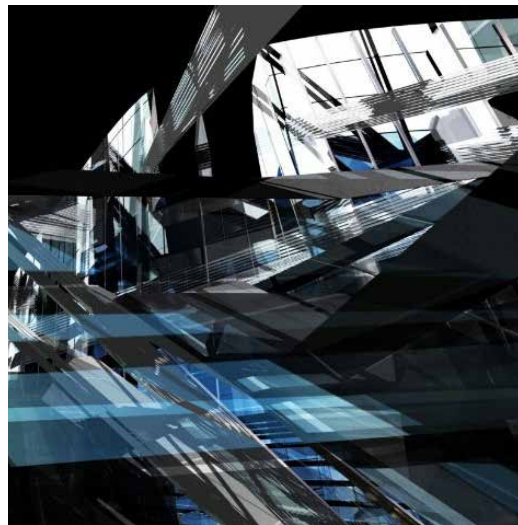FIGURE 2.4 Screenshot (authors) – new cognitive perception of virtual environments

FIGURE 2.5 Screenshot (authors) – new cognitive perception of virtual environments

(3) Having acquired and successfully applied incongruent ideas from these new experiences, designers may show an increase in psychological readiness to recruit and seek out ideas from diverse sources and use them as inputs in the creative process, allowing for continued exposure to a wide range of new ideas, norms, and practices.

(4) It is obvious that implementing formal shapes, characteristics, etc., directly in the physical world is not the purpose, however, incongruent concepts provoke exploration into their interrelations, the process of implementing incongruent ideas may lead to greater cognitive complexity, this challenge finally helps them to think out of the box. In short, the experience of virtual environments may foster creativity by:

a. Providing direct access to novel ideas and concepts in (unconventional) virtual environments.

b. Creating the ability to see multiple underlying functions behind the same form.

c. Destabilizing conventional knowledge structures (design approach), thereby increasing the accessibility of normally inaccessible knowledge

d. Creating a psychological readiness to recruit ideas from unfamiliar sources and places.

e. Supporting synthesis of seemingly incompatible ideas from another environment.

Suggested future research will focus on empirically proving that applying UVEs would enhance creativity. Recording the brain waves by EEG (electroencephalography) would be an appropriate measuring tool. While the participant is navigating in UVE, the brain waves will be recorded to see whether there is a correlation between activated parts of the brain with the activated parts on previous standard creativity experiments. The similarities between patterns of thinking will help in understanding the procedure and enhancing the creativity. In case of finding empirical evidence, the following questions may emerge and will need to be answered:

a. What types of virtual environments are needed for enhancing creative performance?

b. How does exploring a virtual environment benefit creativity?

c. How does the brain perceive such immersive environments? (Does it use a reductionist point of view or is it an emergent phenomenon?)

§ 2.2.9 Conclusion

The review demonstrates that virtual environment experiences predict both creative outcomes and creative processes. Virtual environment experiences are positively related to the conceptual boundary in design that requires insight into producing creative ideas without being confined to the widely known. It also predicts creativity supporting processes such as the tendency to access unconventional knowledge from memory and to recruit ideas from new experiences for creative idea expansion. Dealing with the ambiguity of the UVEs helps to enhance tolerance of these environments that positively correlates with creativity. Moreover, it is conspicuous that the relationship between virtual environment experience and creativity is stronger when people adapt and are open to these new experiences. Also, shifting from improbabilist creativity to impossibilist creativity is possible when navigating in UVEs.

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