Homo creativus: an overview of research on creativity

Homo creativus: *uma visão geral da pesquisa em criatividade*

Homo creativus: *una visión general de la investigación sobre la creatividad*

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Summary

Creativity – the ability to generate productions that are both original and relevant to the context in which they occur – is examined here. In the introduction, a psychological conception of creativity is presented with an overview of scientific work on creativity, organized according to a conception in 7 "C"s: the characteristics of the creative person, the creative process, creative collaboration, the context conducive to creativity, the nature of creative productions, the adoption or consumption of creative works, and the curriculum favoring the development of creativity. In a second part, illustrations of research concerning the different "C"s will be described. Directions for future work on creativity are specified.

Keywords: Creativity evaluation; Creativity research; Creativity development.

Resumo

Criatividade - a capacidade de gerar produções originais e relevantes para o contexto em que ocorrem - é examinada aqui. Na introdução, uma concepção psicológica de criatividade é apresentada com uma visão geral do trabalho científico sobre criatividade, organizado de acordo com uma concepção em 7 "C" S: as características da pessoa criativa, o processo criativo, a colaboração criativa, o contexto propício para Criatividade, a natureza das produções criativas, a adoção ou consumo de obras criativas e o currículo favorecendo o desenvolvimento da criatividade. Em uma segunda parte, as ilustrações de pesquisa sobre os diferentes "C" s serão descritas. Orientações para trabalhos futuros em criatividade serão especificadas.

Palavras-chave: Avaliação criatividade; Pesquisa criatividade; Desenvolvimento criatividade.

Resumen

Creatividad - la capacidad de generar producciones que son originales y relevantes para el contexto en el que ocurren-se examina aquí. En la introducción, se presenta una concepción psicológica de la creatividad con una visión general del trabajo científico sobre la creatividad, organizada de acuerdo con una concepción en 7 "C" s: las características de la persona creativa, el proceso creativo, la colaboración creativa, el contexto que conduce La creatividad, la naturaleza de las producciones creativas, la adopción o consumo de obras creativas y el plan de estudios que favorece el desarrollo de la creatividad. En una segunda parte, se describirán ilustraciones de la investigación sobre las diferentes "C". Se especifican los caminos para el trabajo futuro sobre la creatividad.

Palabras clave: Evaluación creatividad; Investigación creatividad; Desarrollo creatividad.

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Homo creativus: An overview of research on creativity

The creative capacity, an essential human attribute, has been a source of societal growth since the emergence of Homo sapiens, and our more distant ancestors such as *Homo Neanderthalis* or *Homo habilis*. Indeed, the earliest hunting tools, from the Stone Age, provide evidence of prehistoric creativity. The creations of housing, cooking, clothing, rock art, agricultural techniques, as well as the inventions of rites, customs, festivals, games, and oral and written languages form the basis of our contemporary society. Today, creativity is recognized as a 21st century skill, part of a foundation of four soft skills (creativity, critical thinking, collaboration, communication) considered as vital skills for personal and professional success by the Organization for Economic Development Cooperation (OECD) and the World Economic Forum.

Creativity refers to an ability to generate productions that are both original and adapted to the context in which they occur (Runco & Jaeger, 2012; Paulus & Nijstad, 2003; Lubart et al., 2015). These productions can be an idea, an artistic work, a novel, a technological invention, an advertising message, a new way of managing a crisis, or many other types of work. An original production differs from what has already been done in the past. This originality can be estimated, on the one hand in relation to the previous productions of the author him or herself, and on the other hand in relation to his or her entourage (the disciplinary field). In terms of appropriate quality, the new contribution must meet the requirements and constraints imposed. The new idea must have contextual value. We thus distinguish a creative idea from a bizarre idea, which is off topic.

Although it is a term that appeared relatively recently, humanity has always tried to understand what could be the basis of genius. During Antiquity, we find many common points between creativity and a "gift" provided by the gods, as for example among the muses of Greek mythology, coming to inspire artists (Mason, 2017). Examples linking inspirational genius to creativity can be found in many artists over the centuries. For example, for Beethoven, when he was in the middle of writing one of his pieces, he was under the influence of a "spirit" dictating his music to him, or the author Rudyard Kipling spoke of a "familiar demon" taking control of his pen (Lubart et al., 2015).

These first considerations on the mystical source of creativity have, over the centuries, given way to a perspective more centered on individuals and their characteristics (intelligence and personality) as well as other elements (environment, context) that interact together. The early years of the study of creativity set the stage for the current study of creativity. Consider some examples of early work.

Francis Galton proposed that elementary mental capacities, such as association ability, are important in creativity (Galton, 1879, 1883). This research was later developed by many authors and led to the discovery of a set of characteristics common to "creative" individuals. Charles Spearman sees at the origin of creative individuals an ability to make links (correlates) between concepts coming from different places, backgrounds and domains (Spearman, 1931). It is this ability to find correspondences and similarities between more or less different concepts that allows creative individuals to carry out their various tasks quite easily. In a biographical study of three hundred individuals famous for their creative work, Cox (1926) finds that several elements bring these individuals together. First of all, they are all much smarter than average (average IQ of 154), combined with motivation and certain character traits that allow creativity to flow. These first decades of research on creativity made it possible to trace increasingly precise contours on the components of creativity, what it is, and what it represents.

During the second half of the twentieth century, Guilford (1950), and numerous other authors developed a more cognitive approach to creativity seeking all the mechanisms allowing creativity to manifest itself in an individual. For this author, creativity requires several different elements relating to our intellectual capacities, namely the ability to detect problems, an analytical capacity as well as evaluation and synthetic capacities. Guilford (1967) elaborated his factorial theory of intelligence which is composed of five basic blocks: Cognition, Memory, Divergent Thinking, Convergent Thinking and Evaluation. Two of these five

elements are particularly important in the study of creativity, namely: divergent thinking (the ability to come up with a large number of ideas from a single stimulus, open question or problem) and convergent thinking (the ability to choose a single answer, a single solution that is most relevant to pursue). Although Guilford's model for interpreting cognitive skills is outdated, it led a whole branch of creativity assessment to emerge.

Torrance, from 1950, was be interested in the tests proposed by Guilford and refined them in terms of scientific qualities and applicability at the level of a population of children, or adults. He proposed his own battery of creativity tests known as the "Torrance *Tests of Creative Thinking*" (TTCT). This series of tests based primarily on divergent thinking tests is still one of the best known today in the approach it uses to assess skills related to creativity.

These same years also led to many methods, or training programs related to developing creativity. We can, for example, cite Osborn's *brainstorming method,* or the "*Creative Problem Solving"* (CPS) method which appeared in the 1960s based on work by Parnes and his collaborators.

Thanks to the appearance of standardized assessments of creative skills as well as a common vocabulary around creativity, research could be carried out during the years that followed, focusing both on its links with intelligence, but also to those with personality. Thanks to a comprehensive review of the 900 scientific articles from the *Journal of Creative Behavior* (JCB) during the fiftieth anniversary (1967-2017), we have highlighted seven themes, representing the entire field of creativity (Lubart, 2017). These components are known as the " *7 C's of Creativity* ", reminiscent of the Seven Seas, that can be used to represent the world's oceans. The "7 C's" correspond to: Creators, Create, Collaboration, Contexts, Creations, Consumption and finally Curriculum.

Here is what each of the C's represents in detail:

Creators: The characteristics of individuals, such as their motivation, their personality, their emotional states are key factors here. Creators can be defined here as individuals or groups. In this component, for example, we find elements that constitute creativity as such: the "level" of creativity and the internal components allowing this creativity to express itself (Lubart et al, 2015).

Creating: This corresponds to the process that the individual or team follows in producing a production of a project considered to be creative. It is here that we can find divergent-exploratory thinking and convergent-integrative thinking.

Collaboration: This corresponds to the important interactions that other people will have during the realization of a creative project. We see more and more "collective creators" appearing which are recognized and appreciated by virtue of their "groups" of membership than of individuals alone (Wuchty et al., 2007).

Contexts: In this component, we are interested in elements external to the person that will influence creativity. This includes "physical" elements such as a work environment that encourages the appearance of creativity as well as "social" elements.

Creations: Once an object has been created and the creative process has been completed, we can mainly focus on how we are going to "evaluate" the object in question. The fact remains that finding the right criteria, depending on the various situations in which creativity can manifest itself, remains a complex exercise, both when an object is created, but also in the future when this object will take maybe a different and more suitable use.

Consumption: In this dimension, we examine the adoption of a production considered to be creative. The creations (an object, an idea, a process) indeed depend enormously on the contexts of the market, that is to say on the desirability of a good, and on the transition to a new product. It then becomes interesting to better understand the adoption and uptake of creative productions.

Curriculum: This component of creativity is concerned with finding the best ways to be able to transmit knowledge and develop creativity in individuals or groups. Both formal education and extracurricular learning experiences are relevant.

This set of elements that make up the field of creativity in its entirety are related to each other at different levels. In the second part of this article, we highlight examples of research on creativity. These

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studies carried out over the past decades at the Institute of Psychology at the University Paris Cité (formerly University of Paris V, Paris Descartes) are the result of collaborative work within our laboratory (Laboratory of Psychology and Applied Ergonomics, LaPEA).

Creating: the creative process

As part of the standard definition of creativity, the creative process is defined as a succession of thoughts and actions that leads to original and adapted creations (Lubart, 2000-2001; Lubart et al., 2015). Despite various studies on the creative process, few researchers agree on the number of steps, their nature or their sequence. This lack of consensus for a model could, in part, explain why the historical model of Wallas (1926) remains the best known and the most cited by researchers in creativity. In this model, Wallas (1926) proposes four stages: preparation (gathering of information), incubation (unconscious association of ideas), illumination (emerges from an idea consciousness) and verification (confirmation of the idea). As part of a multiyear project on the creative process in various professional fields, several studies have been carried out.

The creative process of professional artists

To illustrate the creative process in the field of art, we conducted interviews with 27 professional artists (Botella et al., 2013; Botella, 2018). The qualitative analysis made it possible to extract the stages of the process from the discourse. The activity of artistic creation could be described in terms of six stages: (1) an *idea* or a general " *vision* " arising after a period of emptiness, (2) *documentation* and *reflection* for gathering more information about materials and technologies, (3) the *first sketches* to give a material form to the project, (4) a more or less long period of *testing*, (5) *provisional objects* , and (6) it also often happens that a first object is followed by a *series of follow-up productions* .

This description of the artistic creation process has the advantage of taking into account the real experience of professional artists as described in their own words and linking it with the material and social world that surrounds it. Between the six phases of labor there are many feedback loops and a "back and forth" movement that can best be captured by longitudinal observations.

The creative process of art students

By interviewing 28 second-year art school students (*M* = 20.9 years old, *SD* = 1.7, 19 to 24 years old; Botella, Zenasni & Lubart, 2018), we then identified 17 stages of the creative process, much more than in previous models. Then, in 2019, by examining models of dynamic processes in the field and outside the field of creativity, we proposed a definition of the term "dynamic" for the creative process (Botella & Lubart, 2019): the creative process is dynamic in terms of its components themselves, their organization, their combination, the successive interactions they maintain with the environment, the unfolding of the nature of a phenomenon over time and its cyclicity. Thus, a dynamic creative process is contrasted with a static and linear process. Linearity implies going from one step to another without any other possible way whereas a dynamic description implies many interactions between the steps.

In another study, we observed in detail the creative process and the emotions of art students responding to an external command (Botella et al., 2011a). A first group of 21 art students had 5 days to create a poster for a congress; and a second group of 28 art students had 3 days to create a poster from a children's book. The results of these two groups indicate that the creative process is not sequential. For example, students in group 2 frequently report *concentration* and *production together*. *Production* is mentioned from day one in both groups. Additionally, students in group 2 report more steps on the first day than those in group 1, suggesting that students can tailor their process to the time they have.

Regarding emotions, the results indicate that each step in the process involves a specific emotional state (for example, *preparation* and *ideation* are described by negative emotions, and *planning* by positive emotions), and that emotions can be at both positive and negative (Cacioppo & Berntson, 1994). Moreover, like Feist (1994), we observed a trend of increasing positive affect and decreasing negative affect during the process. This result is particularly interesting because it suggests that the creative process could have a beneficial effect on emotions. We also found differences in stages and emotions felt between more and less creative students. For example, Group 1 students with low performance report significantly more *ideation* than those with higher performance.

The creative process for screenwriters

"Writing a screenplay is telling a story in images, in sounds, in silences, in dialogues. It's creating a sequence of actions that evokes a thought and engages the characters towards a destiny that they have not yet measured. It's associating events, big and small, to give them meaning. It's making a spectator vibrate to communicate to him an original vision of the world. [9]" Like the novel, the screenplay consists of using language to convey emotions and tell a story. Eventually, the screenplay will become a film if it resonates with a director and a producer.

The creative process of screenwriting was examined in partnership with a research team specializing in the study of the genesis of texts [10](Bourgeois-Bougrine et al., 2014). The exploration of the creative processes of 22 experienced screenwriters aimed to study the approaches naturally adopted by very creative people to solve problems, manage constraints, make decisions, etc. The study was based on interviews using the critical incidents method and on the qualitative and quantitative analysis of the verbatim. Our analysis made it possible to trace the resources involved, the emotional experience and the stages of the cognitive journey from the request to the realization of a work, passing through the definition and understanding of the problem, the planning of the action, the imagining and evaluating ideas and solutions, choosing and implementing the most appropriate solution, etc.

This allowed us to develop a model of the cognitive processes, conative and environmental factors involved in the writing of fictional screenplays (see figure 2). The model comprises three phases: impregnation, structuring or planning and finally the writing/rewriting phase. The impregnation phase is associated with a phase of procrastination that fiction writers associate with intense mental work that will be decisive for the creative process during the development of scenes and dialogues (writing – rewriting). Writers take the time "to do nothing, to go around in circles", to read, document themselves, to dream, to imagine situations, to think about what they want to tell, putting off writing until later. They talk about connections being made and images being formed and so emphasize allowing the mind to roam freely, to think, to imagine, to dream before they start writing.

In order to understand the psychological processes involved during procrastination which characterizes the impregnation phase, we refer to brain imaging studies (functional MRI) and to a theoretical framework called "Construal Level Theory" (CLT) (McCrea et al. 2008). Studies by Andreasen (2011) examining the brains of very creative people (who have won prizes including the Nobel Prize) using functional MRI, suggest that periods of daydreaming would activate the associative areas of the brain involved in memory, memory, introspection and imagination of several alternatives. This activation is more intense in highly creative individuals compared to those who are weakly creative. Other research (Buckner et al., 2008; Buckner, 2012) has shown that the activation of these areas would serve to build dynamic mental simulations based on personal past experiences, to think about the future, to imagine alternatives and scenarios. In addition, the "Construal Level Theory", which establishes a bidirectional link between the

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[9]Jacques Akchoti; https://www.femis.fr/formationcontinue/scenario/presentation.pdf
[10]Institute of Modern Texts and Manuscripts, ITEM ENS-CNRS, UMR 8132.

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psychological distance (temporal) and the level of abstraction of the reflection of individuals (abstract vs concrete) suggests that events distant in time are considered in a abstract, global and exploratory contributing both to procrastination and to the emergence of creative solutions (Förster & Dannenberg, 2010; Steidle & Werth, 2013).

Based on the analyzed verbatim, we compared the writing-rewriting phase to crossing a labyrinth whose path is strewn with decision points, dead ends and false tracks. This crossing takes place at times in an intuitive way in automatic mode and sometimes becomes laborious requiring backtracking, a revision of the initial plans, the consideration of new alternatives, etc. Problem solving requires taking a step back and mental flexibility to circumvent the impasse, change the terms of the problem and update the mental representation of the narrative. The expertise developed would then make it possible to get out of the maze with ease thanks to a better perception and integration of information. This phase is rich in insights or illuminations that open new perspectives that were not considered in the planning or structuring phase. The intuition that all writers talk about would have a cognitive component related to the automation of certain cognitive processes with the development of expertise and emotion when the writer "embodies" or puts him- or herself in the shoes of the character during writing.

To conclude, the creative process is a complex phenomenon both in its stages and in its sequence. We suggest that a dynamic approach to the creative process is needed to grasp the complex, idiosyncratic and seemingly unpredictable nature of this creative process and to develop potentially original and effective training to enhance it.

Context: Virtual environment and creativity

During the past decade, we have explored the impact of the work environment on the search for creative ideas. The originality of this research was to conduct the investigation in a virtual environment, now known as the "metaverse". In this environment, which potentially prefigures our hybrid workspaces with a "face-to-face" site and virtual places, we sought to understand the impact of a virtual environment on creative performance.

On a theoretical level, different digital representations can influence user behavior and, by extension, creative performance. The user immersed in a virtual environment can be influenced in particular by the appearance of his avatar, avatars embodied by other users (Guegan, Buisine & Collange, 2017), or by the characteristics of the environment as such. (Peña & Blackburn, 2013).

Influence of avatars on the creative process

Digital self-representations (ie avatars) can, under certain conditions, guide the behavior of users who embody them. This phenomenon, known as the *Proteus effect* (Yee & Bailenson, 2007), has been investigated concerning a diverse set of behaviors (eg helping others, aggression, behavior adopted during negotiation). Two theoretical explanations shed light on the Proteus effect. The specific appearance of the embodied avatar would induce (1) a modulation of the self-perception mechanism leading the user to confirm the implicit expectations associated with his virtual representation (Yee & Bailenson, 2007) and (2) a priming of concepts leading to a change in behavior by behavioral assimilation effect (Peña, Hancock, & Merola, 2009). Thus, for example, embodying a heroic character such as superman (cognitively associated with helping others and pro-social behaviors) can lead the individual to behave in a more benevolent way towards others. . Moreover, embodying an evil-looking character induces the opposite phenomenon (Yoon & Vargas, 2014).

Therefore, researchers have wondered about the potential influence of avatars on creative performance. In particular, it has been observed that engineers led to embody an avatar resembling an inventor (ie an appearance identified during a preliminary survey as being strongly linked to the

representation of the creative person according to the engineers) produced more ideas and ideas more original than when they embodied an avatar that did not look like an inventor (Guegan et al., 2016). Moreover, the use of these avatars - having no link with the representation of the creative person - did not produce a significant difference compared to a control condition in which no avatar was used (see Figure 1).
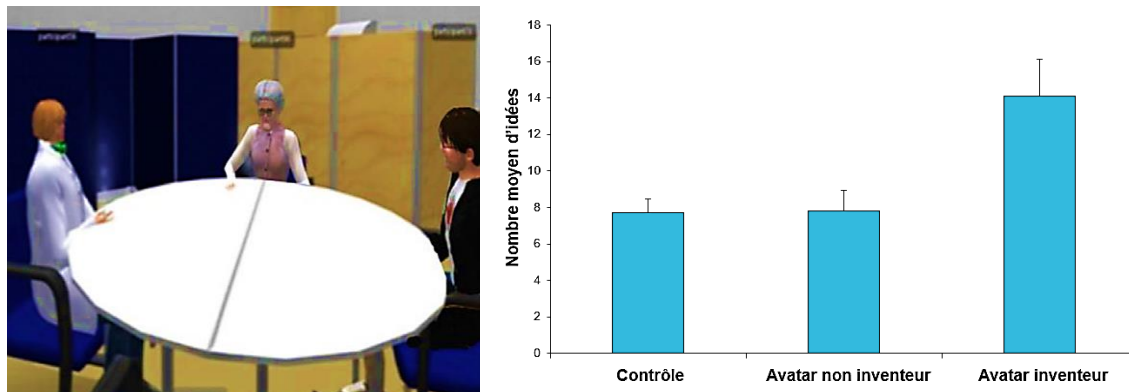

Figure 1. Brainstorming with avatars resembling inventors and mean fluency scores according to experimental conditions (excerpt from Guegan et al., 2016).

Furthermore, the use of avatars far from the representation of the creative person (e.g. an office worker) tends, on the contrary, to induce a decrease in creative performance (de Rooij, van der Land & van Erp, 2017). In another study (Buisine et al., 2016), two types of avatars were provided to participants during a creativity task aimed at identifying innovative uses for a new technology (i.e. a smart window that can be used in a train). Depending on the case, either the participants embodied an avatar resembling an inventor, or they embodied an avatar representing an end user of this new technology (e.g. a mother, a railway ticket agent). The results revealed that participants embodying avatars of inventors directed their ideas towards technical solutions whereas avatars representing users had the effect of directing ideas in the direction of user-centered needs. It has thus been observed that beyond the quantitative effects on the number of ideas produced, the avatars can also orient the content of the ideas, in coherence with the characteristics of the embodied avatar.

To induce this "creative Proteus effect", it appears essential that users can have relevant avatars, that is to say presenting a good match with their representation of the creative person and the nature of the task. For example, an avatar with the appearance of an inventor may be relevant for engineers, but not necessarily for all profiles of individuals. It is therefore appropriate that the target user population shares a common and stabilized representation of what a creative person should look like - in their eyes (Guegan, Lubart & Collange, 2019).

Influence of the virtual environment on the creative process

Beyond the influence of avatars, other works have investigated how virtual environments can influence creative performance. Indeed, the elements of virtual environments can constitute a set of contextual cues likely to automatically initiate concepts and, by extension, guide the creative process (Guegan, Nelson & Lubart 2017; Guegan, Brechet & Nelson, 2020; Nelson & Guégan, 2019). These considerations combine work on environmental priming (eg, Kay, Wheeler, Bargh & Ross, 2004) and theoretical developments highlighting the influence of immediate environmental demands on creativity (Amabile, 1988, 2011) .

Guegan, Nelson and Lubart (2017) designed a virtual environment containing a set of elements identified as characteristic of an environment conducive to creativity (eg vegetation, a bright space, books, art supplies) in a preliminary survey carried out among psychology students. It was found that participants (also psychology students) given a divergent thinking task in this environment produced more original ideas than in a real or virtual meeting room (see Figure 2).

Figure 2. Environment conducive to creativity, real and virtual meeting room (excerpt from Guegan, Nelson & Lubart, 2017).

Wang, Lu, Runco, and Hao (2018) also showed that participants generated more ideas, and more original ideas, after being exposed to a virtual environment involving the "destroy the wall" metaphor, commonly associated with creativity. In another study (Nelson & Guegan, 2019, study 1), participants performing a divergent thinking task while immersed in a forest (using a virtual reality headset) produced more ideas related to the trees and vegetation, and fewer ideas associated with water than participants performing the task at the bottom of a virtual ocean. These phenomena have also been observed in a population of children aged 7 to 11 (Guegan et al., 2020). Failing to use a virtual reality helmet, the exposure to the environments was done via a computer screen with regard to the age of the participants. In this study, children performed a divergent thinking task while walking through a virtual replica of their school principal's office (rule-associated environment), a playground (playful environment), or an imaginary, dreamlike environment. The results showed that the participants produced more original ideas in the dreamlike and playful environments than in the stricter environment of the director's office. In addition, the content of the environment guided the content of the ideas produced by leading the participants to produce ideas thematically related to the environment explored.

Taken together, this work therefore reveals that the characteristics of virtual environments can stimulate creative performance in terms of the number of ideas produced, but also direct the content of these ideas towards the generation of potentially original ideas.

Creations: The Subjective Assessment of Creativity

Whether it is a simple idea or a concrete realization, to what extent can a production be considered creative? How can we assess whether this production is both original and adapted to the field in which it is produced? In response to these questions, researchers have developed two types of approaches to assess creativity. The first is to use standardized scales (for example, the *Creative Product Semantic Scale* ; O'Quin & Besemer, 1989). But these scales have the disadvantage of offering an assessment that is based on a particular conception of creativity, the one defended by the researchers who developed it (Amabile, 1996; Kaufman et al., 2008). The second approach consists of obtaining a subjective evaluation of creativity from evaluators who are considered competent in the field. The consensus evaluation technique developed by Amabile (1982, 1996; Hennessey et al., 2011) has gradually established itself among researchers as a standard for the subjective evaluation of creativity (Carson, 2006). Kaufman et al. (2008) underlined the advantages of this technique: it is not based on any particular theoretical conception of creativity and it corresponds to the way in which creativity is evaluated concretely in everyday life. Our research on creativity has often used consensual evaluation techniques, involving various types of judges (novices, experts, coming from several fields of activity). This work has led us to a methodological analysis of the strengths and weaknesses of this type of evaluation.

The technique of consensual evaluation

According to Amabile (1996), the criteria for identifying creative productions can neither be defined nor measured objectively. This is why she proposed a definition that states that "a product or response is creative to the extent that appropriate observers independently agree that it is creative" (Amabile, 1996, p. 33). The technique of consensual evaluation corresponds to the operationalization of this definition. The principles on which it is based are well known to researchers (e.g. Amabile, 1982, 1996; Baer & Kaufman, 2019; Baer & McKool, 2009; Hennessey et al., 2011; Kaufman et al., 2008). Essentially, this consists of recruiting judges with sufficient experience, which will allow them to identify creative productions in their field of activity. These judges will have to independently evaluate the level of creativity of each production, in relation to each other and in accordance with their own conception of creativity. For researchers who use this technique, the supposed validity of the evaluations thus obtained rests on a logical reasoning stipulating that *if* the judges are sufficiently competent in their field and *if* their evaluations are sufficiently consistent, *then* what the experts agree on must be considered as the level of creativity of the evaluated productions. Concretely, if the evaluations of the various judges are sufficiently consistent, they are aggregated, and the resulting evaluation reflects the level of creativity of the productions. However, our psychometric work offers a critical analysis of two principles on which the consensual evaluation of creativity is based.

What type of judges should be called upon to assess creativity?

Researchers who use the technique of consensus evaluation consider that judges sufficiently familiar with a certain field should logically agree on the level of creativity they perceive in the productions (for example, Baer & McKool, 2009; Kaufman & Baer, 2012; Kaufman et al., 2008). But the question remains, what characteristics should relevant judges have? Kaufman and Baer (2012) proposed to distinguish three types of judges according to their level of expertise: experts with at least ten years of specific experience in the field and who are distinguished by exceptional achievements, quasi-experts who benefit with some experience but whose expertise is not recognized and novices who have no expertise in the field. Numerous authors have shown that the evaluations of creativity carried out by experts are consistent (for example, Baer, 1997, 2003; Baer et al., 2004, but see Gerrard et al., 1996; Hickey, 2001). More surprisingly, ratings obtained from novice judges, most often students, can also achieve an acceptable level of inter-rater

consistency (e.g., Baer, 1996; Chen et al., 2002, 2005; Joussemet & Koestner, 1999; Kasof et al., 2007; Niu & Sternberg, 2001). Some research has directly compared the quality of assessments performed by judges with different levels of expertise (e.g. Hickey, 2001; Kaufman et al., 2008; Kaufman et al., 2010). Contrary to the predictions of Kaufman and Baer (2012), results do not allow us to conclude that the evaluations carried out by novice judges would be systematically less consistent than those carried out by more experienced judges, and novice ratings correlate somewhat with expert ratings. Based on our own observations, in line with Galati (2015), it is entirely possible to ask novice judges to assess creativity in relatively simple situations; on the contrary, it is essential to call on real experts in the most complex evaluation situations.

What implicit conceptions of creativity guide judges' assessments?

As mentioned above, evaluating creativity using the technique of consensual evaluation presupposes that the judges are able to collectively and coherently evaluate the creativity in different productions. This amounts to postulating, most often implicitly, that there is a subjective conception of creativity which would be shared by different judges. Consequently, and insofar as the judges have enough experience in their field, they would be able to unanimously recognize this characteristic in each production evaluated (Amabile, 1996). Implicit conceptions therefore come into play, intentionally or not, when one seeks to assess certain characteristics or certain behaviors (Runco & Johnson, 2002). Only very rarely have we sought to verify whether such implicit conceptions of creativity really exist and to study their content (Katz & Giacommelli, 1982; Spiel & von Korff, 1998).

However, the subjective evaluation of creativity raises two questions. First, that of knowing whether the implicit conceptions of the judges correspond to the commonly accepted scientific definition which bases the evaluation of creativity on two criteria: the levels of originality and adaptation of the productions (Christensen et al., 2014). From a free association task, Spiel and von Korff (1998) find that the expression most often associated with the word "creativity" was "novelty", the second was "idea". Ramos and Puccio (2014), found that participants most often cited originality (New, Unusual, Different and Unique), however, no expression related to creativity refers directly or indirectly to the second scientific criterion of creativity, that of adaptation.

The second important question is whether what is perceived as creative reflects an implicit unitary conception; in other words, if the same implicit conception is more or less shared by the judges of the same category (expert, quasi-expert or novice). Admittedly, implicit theories of creativity have been studied with different types of judges separately. For example, several studies have been conducted respectively with students (Hass, 2014; Katz & Giacommelli, 1982; Ramos & Puccio, 2014; Runco & Bahleda, 1986), or teachers (Runco, 1989; Runco & Johnson, 2002 ; Runco et al., 1993; Sternberg, 1985). To our knowledge, little work has compared conceptions between various groups, such as teachers and children , parents and teachers.

Consumption: Users serving the design of products and services

Within a context of intensive innovation in industrial and commercial contexts, several research studies study the activity of design – in particular in its most recent forms, such as the contribution of user participation and design conditions. encouraging their contribution of ideas

Various techniques exist in the field of user-centered design (eg Maguire, 2001; ISO 2019) with the aim of collecting information on the characteristics of users, the contexts of use, needs and ideas concerning the use of technologies and services from a participatory design perspective. Among these, the "probe" type techniques (Gaver, Dunne & Pacenti, 1999; Kärnä-Behm, 2016) bring together a set of variants that share three characteristics: 1) self-documentation by the user (which can take different forms such as

filling in a diary, writing postcards or a diary, taking photographs, etc.); 2) immersion in the personal daily context of the user and 3) a generally long observation period. The advantage of this type of approach is that it actively involves the user, that information can be gleaned over long periods of time and in situations and environments that are normally difficult to access or even inaccessible. In the context of intensive innovation, the technique of the probe consists in providing a sample of targeted "potential" users with a simple artifact illustrating the emerging technology under consideration, so that the participants install it, use it or imagine possible uses from home, in their daily environment, for several days or even several weeks.

The interest of this technique in terms of facilitating the creative design process for and by users led us to examine its contribution by means of an experimental study (Decotter, Burkhardt & Lubart, 2019) taking as a control condition the standard situation of exploration of prototype by users within the framework of a laboratory user test. Beyond facilitating the collection of information on the context and the participants, a necessary contribution to any design process, our hypothesis was that through the technique of the probe, there is the simulation, the observation and the manipulation of the artifact by the participant in his or her daily physical and social environment, which will stimulate ideation and facilitate projection into possible uses among these users. The artifact that served as a probe was a plug and play pico-projector (iptek T30; see Figure 1) compatible with Iphones and any PC with S-Video, which could be used either with a tripod or the hand. We chose an artifact representative of emerging technologies, because it was little known to the public at the time of the study (spring 2013).

Figure 3. Plug and play iptek T30 pico-projector used in the study by Decotter, Burkhardt and Lubart (2019).

A sample of 140 participants from the Paris region (120 women and 120 men), regular users of a smartphone, was recruited through advertisements in various specialized forums (eg iphonesoft.fr) and social networks (Facebook and Twitter). The experimental plan compared two exposure conditions (home probe technique vs. user test) and two elicitation conditions (individual vs. group) in order to also study the effect of the group on the generation of ideas. creative. Regardless of the condition, all participants benefited from the same short presentation and explanation of how the micro projector works. Participants in the probe condition then returned home with the artifact to keep it for a week during which they were asked to place it in various locations and imagine possible uses. Participants in the "user test" condition were invited to use it freely and explore its functions and possible uses for a quarter of an hour. Following this first phase, the participants of the two conditions were invited to write down on cards as many ideas as possible for future services involving the pico-projector and the way in which these services could meet some of their needs. In the group elicitation condition, participants grouped in fours received the same instructions

as in the individual condition but were encouraged to discuss and share each idea. The distribution of the 1525 ideas produced by exposure and elicitation condition was analyzed quantitatively (fluency) and qualitatively in terms of degree of creativity with 12 experts on the basis of an adaptation of the method of judges in association (see Decotter , Burkhardt & Lubart, 2019; Decotter, 2013 for a detailed presentation and in particular the consistency check) and the 3-dimensional subscales of the semantic scale of creative products (O'Quin & Besemer, 1989): Novelty, Resolution, and Elaboration and Synthesis.

The results thus characterize the contribution of the probe technique to creative design. First, exposure through this technique is accompanied by significantly more ideas than in the user test condition; the individual elicitation condition also significantly engenders greater fluency without the two factors exhibiting any significant interaction. Second, ideas generated from the "probe" exposure condition were found to be significantly more creative than those generated in the laboratory condition. There was no significant main effect of elicitation condition but a significant two-way interaction between the two factors. This reveals that for the "probe" participants, the level of creativity of ideas is higher in the group elicitation condition than in the individual condition, while the opposite is observed for the "user test" group where the Individual elicitation spawned more creative ideas than the collective condition. Thus this study suggests that the probe technique is effective in supporting the creativity of users and helping them to imagine services and new needs that emerging technologies could satisfy.

A complementary research theme concerns the contributory dimensions of (future) users to the genesis of ideas in design, in order to assist them, in particular when it comes to innovation and the development of technologies that are still immature - and therefore not known to the intended future users. Among the questions addressed: 1) are (and in what way) the future users/users involved in the design? 2) what contribution(s) do they actually make to the design? 3) What are the most interesting conditions, techniques or design methods to promote the contribution and participation of future users in the creation of adapted solutions? The promotion of user participation in design projects has long been motivated by the idea that their participation leads to the development of products that better meet their needs, resulting in greater ease of use and better customer acceptance (Kujala, 2003). However, this user/user participation is actually observed in the field to varying degrees depending on the field of design; quite common in the fields of software design and consumer products, it appears less frequently implemented in other fields such as architecture, design of transport systems, etc.). In a study based on the analysis of 71 critical incidents reported by 23 design experts from several fields, Richard, Burkhardt and Lubart (2014) observed, for example, a difference in approach between the field of object design general public, where participation is essentially based on interviews and individual tests with a prototype, and the field of transport and mobility, where participation appears most often organized according to a collective modality, in the form of public consultation or creativity workshops. This same study also showed that the individual modality of user involvement (eg individual interview, diary, etc.) is associated with the collection of rich information on user needs, whereas their collective involvement (eg focus group, brainstorming, consultation meeting) seems to have an effect rather on the acceptability of the solutions designed. In addition, involving users in the final stages of development leads mainly to contributions on service improvement ideas, whereas users involved in the early stages of innovation come up with creative ideas, provided they are provided with support tools, for example to develop their projection skills. Other works have focused on the design process in online communities, and in particular on the factors explaining the success or failure of proposals from users (see for example Barcellini, Détienne & Burkhardt, 2014). This type of study is also important on the one hand in order to document the real practices and, on the other hand, to identify the factors at play in the field to explain the success, the difficulties and the failures of the design with the users. Altogether, these studies look at the contribution of users in the development of new products, and this is an integral part of the "consumption" topic in the field of creativity.

Curriculum: Development of creativity in formal and informal educational contexts

In this part, we will discuss creativity training. For example, to understand the development of creativity in the field of culinary creativity (Aron, Botella, & Lubart, 2019), Beghetto, Kaufman and Hatcher (2016) examined how Auguste Escoffier developed his culinary talent. Thus, it was the comments of his uncle with whom he was an apprentice that allowed him to move from the mini-c level (personal creativity) to the little-c level (local recognition). Then, it took a lot of practice, often estimated at 10 years of domain expertise, to reach the pro-c (professional recognition) level. The last passage, from the pro-C level to the big-C level (wide public recognition), is often very difficult to identify because the creators do not become legends overnight. This study highlights the importance of experience and the family environment.

So more broadly how can creativity be developed creativity? We believe that it is necessary to develop the necessary ingredients for creativity, that is to say the multivariate factors. According to the multivariate approach, creativity involves 4 types of factors (Lubart, 1999; Lubart et al. 2015; Sternberg & Lubart, 1991, 1995): cognitive (knowledge, intelligence), conative (personality, motivation), emotional (emotional traits and states) and environmental (physical, social environment, etc.). Different educational contexts, either the "formal" school framework or the extra-curricular contexts can favor the development of the ingredients of creativity or their implementation in a training of the creative process. Consider a few examples of studies on this topic.

Development of cognitive and environmental factors: flexibility and interactions

Based on interviews with professional artists (Botella et al., 2013) and observations of art students in real-life contexts (Botella, 2018; Botella et al., 2010, 2011; Botella & Zenasni, 2012), we chose two factors to develop exercises improving the creative process of art students: flexibility and social interactions (Botella & Lubart, 2016, 2021). Flexibility is a cognitive factor essential to creativity because it is the ability to analyze a problem from several angles (Scott, 1999; Thurston & Runco, 1999), "the ability to apprehend a single object, a single idea, from different angles, sensitivity to change as well as the ability to get away from an initial idea to explore new avenues" (Lubart et al., 2015, p. 37).

Thus, we then proposed to develop flexibility and social interactions in 25 engraving students (69% are women; Botella & Lubart, 2016). First, we measured their flexibility and social interactions. Then, depending on which area they had the most difficulty in, they were assigned to the "Flexibility" (n =11) or "Social" (n =14) group. In a second step, the students of the Flexibility group were invited to use different techniques, never used before or to try something new; whereas students from the Social group were invited to discuss their ideas and productions with other students. All the students also filled out a logbook concerning the stages of their process and the multivariate factors at each of the twelve sessions.

The results indicate that the exercises allowed the students in the Flexibility group to experiment more with their ideas and to develop their open-mindedness, whereas the students in the Social group reported that the exercises allowed them to interact more with others, to communicate their ideas better and show more work force than usual. In the end, the students of the Social group were more satisfied with their production.

Development of conative factors: serendipity formation

Dumouilla (2018) linked conative factors (risk-taking, perseverance, optimism, openness, flexibility and exploration) with serendipity, which is the act of taking advantage of chance. During a Serendipian creative process, an unforeseen event would occur, which could modify the initial problematic or the ideas to come. Thus defined, it may seem surprising to offer training in the unexpected because it is recognized after the fact and cannot be planned (Catellin, 2014). But it is possible to develop the skills allowing the

emergence of the serendipity necessary for the creative process (Darbellay, Moody, Seddoka, & Steffen, 2014), that is to say the conative factors favoring that people benefit from chance events.

This training was based on 4 modules developing risk-taking and perseverance, flexibility and optimism, exploration and openness and creativity (Dumouilla, 2018). Each module begins with a presentation of the objectives and important points of the theory, after there is a warm-up, then an experiential practical exercise and finally the module ends with a review and perspective taking. This training is therefore part of a mainly experiential pedagogy (Krathwohl, 2002) emphasizing curiosity, a sense of humor, pleasure and spontaneity (Guitard et al., 2006).

In an action-research study, 83 NEETs (*Neither in Employment nor Education and Training* – young people in a complicated or transitory situation) were trained (*M* = 23.19 years, *SD* = 2.08, 58% women). In the short term (immediately after training), training improved divergent thinking, exploration, well-being, satisfaction with life and self-esteem but training decreased optimism; in the long term (one month after), optimism was restored, self-esteem continues to increase, the beneficial effects on exploration and satisfaction with life are maintained, but those divergent thinking tends to return to their initial level. On the other hand, no beneficial effect was observed for risk taking and flexibility. Considering the difficulties in engaging in training NEETs, who are by definition disengaged, it was not possible to include a control group.

Development of emotional factors: training in creativity with emotions

In a pedagogical study to promote creativity through emotions (Capron Puozzo & Botella, 2018) we followed 16 pre-service teachers (6 women, 3 men, seven no response; *M* = 32.75 years, *SD* = 3.86 years, between 26 and 48 years old for the nine respondents). A mixed methodology was used (Fortin & Gagnon, 2015), combining qualitative and quantitative data, using a diary (Botella et al., 2017) completed during 12 sessions.

The quantitative results indicate that the first course, which serves to break the ice, mobilized the consideration of constraints, the fact of leaving things to chance, experimentation and achievement. In lesson 7, pre-service teachers had a high level of arousal when writing science fiction. For this session, they had to take more risks in their training. During lesson 8, they were stressed during the presentation of their fiction. Then, in sessions 9-10 (didactic transposition of learning) and 11 (implementation of exercises to promote creativity), the pre-service teachers collaborated more (dialogue with others, ask for an opinion, communicate, convince, and team working). Regarding emotions, those with negative valence (disappointment, exhaustion, frustration, stress) were on average quite weak throughout the sessions, whereas those with positive valence (satisfaction, pride) and activation emotions (awake, inspiration) were stronger. The semester ended with pride in setting up an experiential workshop.

The qualitative data indicate that all the multivariate factors emerge from this training in which the experience of creativity leads the learner to question him or herself about this process in the light of the theoretical tools learned. In addition, the rather negative emotions that are verbalized by the pre-service teachers were related to the environmental factor whereas the positive verbalized emotions were related to lived experiences. Finally, the results show that the benevolence of the trainer is fundamental as well as a climate favoring learning to avoid putting a learner in an emotional situation of anxiety which inhibits the desire to learn more than to stimulate it (Govaerts & Grégoire, 2014).

Multifactorial development through play

Outside of the traditional educational context, at school, play as an extracurricular activity can also support the development of creativity. From an early age, children engage in make-believe play, to imagine themselves in the role of someone else (Russ & Wallace, 2013). Playing thus requires a great deal of imagination, which is of course greatly beneficial to creativity. But playing also involves other skills,

such as perseverance (Granic et al., 2014). An important characteristic of games is the presence of a challenge, a challenge to be met. If you've ever played a board game or a video game in your life, you're surely aware of the bitter taste of defeat. Without perseverance, players give up quickly. Thus, this need to persevere despite failure is present in the vast majority of games. This can take the form of a platform game like Super Mario Bros, in which the player must chain precise movements, and which will punish the player in the event of errors. It can also be found in a first-person shooter, like Call of Duty or Fortnite, where players must explicitly eliminate their opponents. In this form of play, getting beaten by other players is an integral part of the gaming experience.

Similarly, creativity involves a great deal of perseverance and resilience (Grohman et al., 2017). Being creative is not easy, and we often find ourselves facing deadends. Failure and obstacles, just like in games, are an integral part of the creative process. This can take the form of the writers' blank page, or the lack of approval from others, be they clients, colleagues or superiors.

The game is therefore connected to creativity, and it also seems possible to use it to directly improve creativity. Playing a game engages us in a very interesting mode of operation in relation to creativity. Playing disinhibits us, as shown by their effectiveness as icebreakers, which opens our minds to more possibilities (Depping et al., 2016; Galois-Faurie & Lacroux, 2014). Certain games can put us in a positive mood, which greatly facilitates the ability to generate ideas (Davis, 2009). Other games may explicitly solicit imagination and creativity, and possibly directly improve it. Some studies are beginning to explore the potential of board games to develop creativity.

A quasi-experimental study conducted by Mercier & Lubart (2022) notably compared the effect of two types of board games (N = 55), based on the consensual definition of creativity. First, there were "creative" board games, which require the generation of original and adapted ideas to have a good performance. Second, there were "non-creative" games, which do not require a creative generation to obtain a good performance. The results showed that playing board games in general, for 30 minutes, significantly improves the idea generation of individuals who were initially below average, in terms of the number of ideas generated and their originality (Figure 4). These results are encouraging and seem to indicate that there would be an immediate general effect of the practice of board games on creativity, without being able to comment on the specific effect of creative games. A second experimental study (Mercier & Lubart, 2023) developed further these results (N = 239). The authors compared the effect of board games on divergent thinking, using three conditions: creative board game, non-creative board game, and control (no game) condition. After 30 minutes, results indicate a dramatic improvement in originality, specifically after playing a creative board game, d_{cohen} = 0.54. In other words, it is possible to obtain a substantial improvement in the originality of the ideas given by individuals, after only a short board game session.

The effects of video games on creativity are also beginning to be documented. Jackson et al. (2012) conducted a survey on a large sample of 12-year-old children (N = 491) and found significant and positive correlations between frequency of playing video games and divergent thinking. Two experimental studies seem to support this relationship. Yeh (2015) observed an improvement in participants' non-verbal divergent thinking (N = 31) after playing an action video game, compared to playing a "non-action" video game [11]. Moffat et al. (2017) also performed an experiment investigating the effects of three types of video games (a first-person shooter, a sandbox game, and a puzzle game [12]) on divergent thinking. Each participant (N = 21) completed a verbal divergent thinking task before and after playing only one of the three

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[11] The action game was *Light Heroes*, a shooter where the player must destroy enemies on a battlefield. The non-action game was *Clusterz*, where the player must destroy colored bubbles before they fill the playing space, by popping groups of three or more bubbles.

[12] The first-person shooter was *Serious Sam*, where the player fights waves of enemies in an open environment. The sandbox game was *Minecraft*, where the player can create, modify and destroy their environment. The puzzle game was *Portal 2*, where the player must solve puzzles by placing portals and teleporting through them.

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games. The results suggest a significant improvement in flexibility after playing puzzle-solving and first-person shooter games.

Games therefore prove to be effective tools for developing the creative potential of individuals. This method stands out in particular for the large number of people who can benefit from it. This of course includes children and adolescents, but also adults, who are very fond of games, as shown by the growing popularity of Serious Games in business (Galois-Faurie & Lacroux, 2014), and more generally the growth of the video game market. (Newzoo, 2020). This method is also distinguished by the relative ease of application to improve creativity. Some methods, although effective, require a lot of time and support, in terms of training or recruiting stakeholders, and implementing creativity techniques. Games can position themselves as a viable alternative, less costly timewise and financially, while maintaining considerable efficiency.
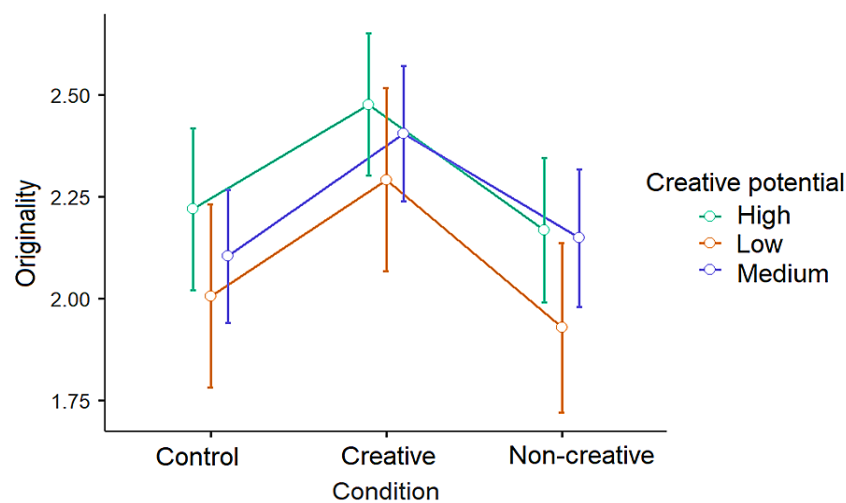

Figure 4. Variations of originality according to condition and creative potential (except from Mercier & Lubart, 2023).

Taken as a whole, we have seen that to develop creativity, we must develop its ingredients: multivariate factors (cognitive, conative, emotional, environmental). We have seen examples of training in these ingredients, in various educational contexts, with different populations, which underlines the great possibilities of training in creativity via the multivariate factors.

Discussion and Conclusion

Homo Creativus is the term we use to highlight one of the hallmarks of 21st century human beings – their creativity. The work presented in this article illustrates various results obtained concerning the creative process (Creating), the environment conducive to creativity (Context), creative productions (Creations), the involvement of users in the design of products and services (Consumption), and the development of creative capacity (Curricula).

It is useful to note that creativity unfolds both in professional contexts, in daily life outside work, as well as in the internal psychic life of each individual (for example, during personal reflection). Thanks to the different methods employed in the research presented (interviews with creative professionals, observations of students, experimental studies with users, learners and players), the scientific corpus of empirical observations, data modeling and theories makes it possible to observe scientific advances in creativity. Basic research, applied research and action research have been carried out. It is interesting to consider extensions of these explorations, which will surely benefit more from crossovers between the sub-

themes (the different "Cs"). For example, do the individual differences of creative people interact with the environmental context (Creator x Context)? Should creativity training be adapted according to the disciplinary field and the type of creative production targeted (Context x Creation)? Does the creative process unfold in a differential way according to the profile of the individual creator, the characteristics of his or her environment, and the training that the person received (Creator x Context x Curricula)? A multitude of questions arise and open perspectives for further work on *Homo Creativus*.

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