Creativity in the Twenty First Century

Todd Lubart · Marion Botella · Samira Bourgeois-Bougrine · Xavier Caroff · Jérôme Guegan · Christophe Mouchiroud · Julien Nelson · Franck Zenasni *Editors*

Homo Creativus

The 7 C's of Human Creativity

Springer

Creativity in the Twenty First Century

"Creativity in the Twenty-First Century Book Series" repositions "creativity" as a boundary-crossing discipline that is essential to learning and teaching, social-economic dialogues, academic discourses and cultural practices, as well as technological and digital communications. The series serves as a timely platform, bringing together like-minded scientists and researchers around the world to share their diverse perspectives on creativity and to engage in open and productive inquiries into promoting creativity for a more peaceful and harmonious world. Researchers and practitioners from all continents are invited to share their discipline-specific insights, research orientations and cultural practices, as well as to pose new questions on what creativity is, how to promote it, which directions to pursue, who should participate, and so on.

The book series is led by emerging eminent and senior scientists, researchers, and educators in the fields of creativity, psychology, the cultural sciences and education studies. They create networks of sharing and spread innovative publishing opportunities within the communities of practice. They invest considerable time and effort in deepening creativity expertise, structuring creativity programs, and organizing creativity activities for the communities of interest. The book series aims not only to "glue together" like-minded scientists (community of practice) to share benefits of creativity theorizing, research and practice, but also to encourage non-experts (community of interest) in all societies to become supporters and spokespersons of positive engagement in creative learning, teaching and dialogues.

Book proposals for this series may be submitted to the Publishing Editor: Natalie Rieborn Email: natalie.rieborn@springer.com

More information about this series at https://link.springer.com/bookseries/13859

Todd Lubart · Marion Botella ·
Samira Bourgeois-Bougrine · Xavier Caroff ·
Jérôme Guegan · Christophe Mouchiroud ·
Julien Nelson · Franck Zenasni
Editors

Homo Creativus

The 7 C's of Human Creativity

Springer

Editors
Todd Lubart
Université Paris Cité and Univ. Gustave Eiffel, LaPEA
Boulogne-Billancourt, France

Marion Botella
Université Paris Cité and Univ. Gustave Eiffel, LaPEA
Boulogne-Billancourt, France

Samira Bourgeois-Bougrine
Université Paris Cité and Univ. Gustave Eiffel, LaPEA
Boulogne-Billancourt, France

Xavier Caroff
Université Paris Cité and Univ. Gustave Eiffel, LaPEA
Boulogne-Billancourt, France

Jérôme Guegan
Université Paris Cité and Univ. Gustave Eiffel, LaPEA
Boulogne-Billancourt, France

Christophe Mouchiroud
Université Paris Cité and Univ. Gustave Eiffel, LaPEA
Boulogne-Billancourt, France

Julien Nelson
Université Paris Cité and Univ. Gustave Eiffel, LaPEA
Boulogne-Billancourt, France

Franck Zenasni
Université Paris Cité and Univ. Gustave Eiffel, LaPEA
Boulogne-Billancourt, France

ISSN 2364-6675 ISSN 2364-6683 (electronic)
Creativity in the Twenty First Century
ISBN 978-3-030-99672-7 ISBN 978-3-030-99674-1 (eBook)
https://doi.org/10.1007/978-3-030-99674-1

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Contents

Homo Creativus: Introduction

Todd Lubart

Keywords *Homo creativus* · Creativity · 7 Cs · Creators · Creating · Collaboration · Context · Creations · Consumption · Curricula

Millions of years ago, the ancestors of modern humans appeared on earth. Over time, evolutionary processes led to several early human species, including most recently *Homo neanderthalensis*, which disappeared approximately 30,000 years ago. Since more than 300,000 years, modern *Homo sapiens* developed, and coexisted with *Homo neanderthalensis.* Recent evidence suggests that these groups were in contact with each other. Today, contemporary humans, *Homo sapiens* compared to numerous other species including distant cousins like chimpanzees, are distinguished by their advanced cognitive capacities to process information and think in complex ways. All modern humans are classified into the species *Homo sapiens.* The latin term, *Homo sapiens,* was attributed by Carl Linnaeus, a Swedish botanist and zoologist in his 1735 work *Systema Naturae* (a later; more complete edition was published in 1758).

«Human» corresponds to *Homo* in Latin, based on the adjective form *humanus*, translated initially into the French word «humain». *Sapiens*, in Latin, is translated as «wise» or «knowledgeable». It is interesting to note that the hallmark of intelligence since the eighteenth century was knowing a lot combined with the ability to reason in complex ways. In general, «smart» people act in appropriate ways to achieve their goals efficiently. They tend to have a large corpus of knowledge about the world, and more specifically this concerns their professional domain. Expertise in a field refers to advanced knowledge and know-how, and this expertise often requires years of study. In a metaphorical way, computers that have information processing routines operating logically on large databases are the natural extension of what homo sapiens do best.

T. Lubart (✉)
Université Paris Cité and Univ. Gustave Eiffel, LaPEA, Boulogne-Billancourt F-92100, France
e-mail: Todd.lubart@u-paris.fr

T. Lubart et al. (eds.), *Homo Creativus*, Creativity in the Twenty First Century,
https://doi.org/10.1007/978-3-030-99674-1_1

Schooling, which has been developing for thousands of years, was often based on a traditional approach in which an expert conveys knowledge to disciples. In most countries, mandatory schooling for youth developed in the past century. School became the place where people acquire knowledge and information processing skills. The traditional measures of intelligence that are the most widely used today, such as the Wechsler tests (WPPSI, WISC, WAIS) were designed to assess capacities to reason, think, and solve problems using knowledge in an efficient way. The main goal in this approach is to get correct answers as quickly as possible. These tests predict school performance, which itself predicts career and life success. However, the traditional view of homo sapiens as a «smart» species compared to most others is only part of the story.

This book focuses on another hallmark of homo sapiens, the ability to think in *original*, *adaptive* ways. This means that humans generate new knowledge. This creative side of humankind has been important since the beginning of time, and we might even claim that it is thanks to creative thought and action that the sociocultural world in which we live came to be. A few examples are the initial invention of tools for hunting and building. The invention of man-made shelters, the invention of techniques to control fire, cooking techniques, the invention of pottery, the invention of graphic and verbal communication including language, and later writing. Of course, this initial list is just the beginning of a long chain of inventions and creations that have led to all the artifacts that populate our daily life. However, the creative mind has also led to immaterial inventions that form the basis of culture, traditions, social rites and festivals. Concepts such as liberty, peace, crime or summer vacation are also human creations.

In terms of macroeconomic development, the shift from hunter-gatherers to agriculture and more sedentary lifestyles was a major creative event, as new techniques and tools led to this first «revolution», which was followed by the industrial revolution, and most recently by the digital revolution. It is now recognized that economic growth is tied to creative thinking that finds its way into innovative products or procedures. In this regard, the Solow residual formalized by the economist Robert Solow, indicates that long-term economic growth is not attributable simply to additional people or machines to produce more of the same goods. The «residual» growth that has characterized human society since its onset is, to an important extent, due to innovation, the translation of creative ideas into valuable novelty that is available in the marketplace (Artige & Lubart, 2020).

There is a growing literature on creativity in ancient times (Gabora & Kaufman, 2010; Hodder, 2020; Mithen, 2005). Advances and continuing discoveries have led to more and more evidence of our ancestors creativity, including the first stone tools invented 2.5 million years ago, more advanced stone tool innovations from 1.7 million years ago (Homo habilis), zigzag motifs carved on shells (540,000 years ago, Homo erectus), proof of techniques developed to master the use of fire and, burial sites funerary practices (400,000 years ago), ceremonial sites (175,000 years ago, Bruniquel cave), jewelry (100,000 years ago), geometric designs (75,000 years ago), cave art, oil lamps and musical instruments (35,000 years ago). In depth studies of creativity have been conducted. For example, Sofaer (2015) examined the process

of making clay objects, the nature and design of these objects, and the introduction of novel innovations in clay objects which also reflect social creativity in cultural practices, such as new culinary practices and funeral rituals.

This leads us to suggest that humans have an inherently creative nature. To highlight this idea, we use the term «*homo creativus*» (Lubart, 2012) Homo creativus reflects and emphasizes original thinking compared to the term Homo sapiens which focuses on «knowledge». In recent educational trends, "twenty-first century competencies" have been identified as the key skills that education can promote in our current century to favor professional and life success. Although many competencies can be listed as important for the twenty-first century, there are four that are always present, namely creativity, critical thinking, collaboration and communication (see www.p21.org).

The concept of creativity as a psychological construct has a long history. Creativity was conceived by some early theorists to have a divine origin, and human creators were seen as receptacles for divine inspiration. In some cases, cultural creation stories which specify how the world came into being show parallels with the way that human creativity is viewed on the individual level. Creativity can be conceived in terms of a competency, an ability, a potentiality, but it can also be used with a process, or product focus. Indeed, the history of the concept of creativity and its' diverse definitions have been the subject of inquiry, and illustrate a concept (creativity in this case) that was invented and developed over time (Dacey, 1999; Runco & Jaeger, 2012). The different chapters in this edited book present a set of currently-used definitions of creativity which share the basic focus on novel, original thinking that is contextually relevant and meaningful. However, there are various nuances that each specific definition offers, as readers will discover across the chapters.

Given that creativity is a broad concept and has been examined extensively in the scientific literature for more than a century (see Glaveanu, 2019), it is worthwhile to have a framework to structure inquiry about it. In other words, what are the different facets of homo creativus? Is it possible to conceptualize the study of creativity in a systematic way that reflects the existing literature and offers opportunities to expand on this literature in the future? The objective is a multidisciplinary framework on creativity studies to capture the rich diversity of topics and approaches. Our goal is to explore the topic of creativity much like early adventurers explored the globe.

In ancient times, those who visited all the different parts of the globe were said to have sailed the seven seas. Perhaps the earliest reference to the seven seas dates to 2300 BC, used by Enheduanna, a Sumerian high priestess in a hymn to Inanna, goddess of love, fertility and warfare. For the ancient Greeks, the Aegean, Adriatic, Mediterranean, Black, Red, and Caspian seas, as well as Persian Gulf comprised the 7 seas. After European explorers discovered North America, the Seven Seas began to refer to the Atlantic, Indian, Pacific, Mediterranean, Caribbean and Arctic seas, together with the Gulf of Mexico.

The Mesopotamians recorded the movement of seven celestial bodies, namely the Moon, Mercury, Venus, the Sun, Mars, Jupiter, and Saturn. These seven astronomical entities became to be known as the Seven Heavens—and an association, at least metaphorically, was seen with the seven seas on earth. Indeed, when the seven

celestial bodies moved, there were some effects on ocean tides. In diverse religious and cultural groups, the seven heavenly objects were in some cases also related to a metaphysical vision of heaven, with seven levels or parts.

Upon the 50th anniversary of Guilford's seminal article, the *Journal of Creative Behavior*, which started in 1967 and is the longest running journal devoted to creativity studies, organized a special issue. An analysis of the articles in the JCB from its inception showed that seven main topics could be identified (Lubart, 2017). Each one was denoted by a word starting with C, given that the overall concept was creativity studies. These are: Creators, Creating, Collaboration, Context, Creations, Consumption, and Curricula. We call them the 7 Cs of Creativity.

Creators refers to the individuals who engage in the production of original, valuable work. These agents may be working alone or collectively. Research on Creators has often investigated their characteristics in terms of personality, cognition, or affect. Much of the research adopted an individual differences approach, measuring specific characteristics such as mental flexibility, or openness through questionnaires or tests. These scores on the "ingredients" of creativity can then be related to individuals' expressions of creative thinking. Some work has compared and contrasted creative individuals in various professional sectors, such as artists, scientists, or entrepreneurs, looking at typical profiles of creative people in each field.

Creating focuses on the process of initiating, developing and bringing to fruition an original, meaningful work. All the thoughts and actions, organized in a temporal sequence compose the act of creating. Research on Creating has traditionally sought to trace the process stages and examine the specific process features that favor originality. Some work examined traces of creative activity through artists and scientists notebooks, such as the well-known study of Charles Darwin's notes from his exploratory voyage on the Beagle on the creation of his theory of evolution (Gruber & Barrett, 1974). Other work traced the activity during a creative task, such as observations of the actions engaged by art students who make a still-life (see Getzels & Csikszentmihalyi, 1976). Yet other work relied on self-reports, or introspective accounts of creative process engagement (Lubart, 2018).

Collaboration concerns the interaction between people, in terms of dyads, or groups engaged in creative work. Creating in a social setting includes the interactions with significant others during the creative process, such as an author interacting with his or her editor, a designer interacting with a client, or a student interacting with classmates during project work. Research has examined the kind of interactions that occur between members of collaborative groups, focusing often on teams engaged in brainstorming or improvisational music groups (see for example, Sawyer, 2014).

Context is the term that refers to the physical and social environment in which creativity occurs. The context includes family, school, professional settings as well as societal, cultural dimensions. Context can support or hinder creativity, it can also orient the content of the work. Research on Context has examined both micro and macro factors that impact creative activity, in some cases over generations and centuries of creative activity in a field. There is research, for example, that uses questionnaires about environmental characteristics (in the family, school and workplace), examining the links between the presence or absence of specific features

(e.g., support, rules, etc.) and level of creative activity. In addition, research using historiometric procedures has looked at relationships between measures of societal environmental characteristics (such as years of war, proximity to cultural centers, presence of eminent creative role models) and indicators of societal creative performance and accomplishment, such as the number of patents per decade, number of literary works, or number of recognized musical compositions (see Simonton & Ting, 2010).

Creations denotes the outcomes or productions that result from the act of engaging creativity. Creations have been studied in terms of their features, the criteria with which they are evaluated and how these productions are integrated into a field of work. Once the production exists it can evolve over time, interacting with other productions in the marketplace of creative works. Research on creative products has examined, for example, judges' explicit and implicit criteria, as well as the inter-judge agreement on evaluations of productions. Some research has also developed objective scoring procedures that allow a production to be evaluated compared to others based on the presence or absence of features in the work itself.

Consumption refers to the adoption of these creations in the social marketplace of ideas, practices and goods. The characteristics of early adopters of creative productions, the market conditions that favor the adoption of creative work, be it new ideas, processes or products, are examples of topics that have been researched within this «C». There is also work examining how the act of consuming can lead to the further development of creative productions beyond their initial intention.

Curricula focuses attention on the development of creativity. This «C» includes formal educational programs that may be designed for school or professional training, to boost creativity. A large set of creativity techniques exist and can be learned to enhance the creative process and its outcomes. However, there is also the possibility of informal education for creative development through extracurricular activities, such as game play, hobbies or exposure to creative role models These different educational paths as well as others have been studied. For example, some research looked at the impact of exposure to certain pedagogical methods, programs focusing specifically on educating creativity, or indirect educational experiences that can contribute to creative development.

It should be noted that all types of research methodologies ranging from case studies, qualitative studies, quantitative studies using correlational or experimental designs, and simulation studies have been or could be used to explore each of the 7 Cs. Also, earlier conceptual frameworks to describe the field of creativity are compatible with the 7 Cs, but offer slightly different perspectives. For example, Rhode's (1961) four «P's»–person, process, press, and product–map directly onto the 7 Cs. Glaveanu's (2013) five A's—Actor, Action, Artifact, Audience, Affordance—also align with the 7 Cs.

The co-editors of this current book have been collaborating over the past 25 years on creativity research and this volume illustrates some of the work conducted but more widely offers examples of current work on each C from a larger set of scholars. Consider now some examples of research conducted by the co-editors of this book.

Concerning the C of Creators, numerous studies were conducted to measure cognitive, conative and affective characteristics of individuals related to indicators of creative potential and achievements. These studies examined, for example, mental flexibility, tolerance of ambiguity and affective traits like affect intensity (Lubart et al., 2015; Zenasni et al., 2008). A line of studies led to the development of measures of creative potential, notably the EPoC battery, to measure divergent-exploratory and convergent-integrative creative ability in several domains (Lubart, Barbot et al., 2019).

Creating, the creative process, was studied by several co-editors of this book in multiple domains, including visual arts, science and engineering, design, musical composition, and screenwriting (Botella et al., 2013, 2018; Bourgeois-Bougrine et al., 2014; Glaveanu et al., 2013). The methods included interviews with accomplished creators in these domains, who described their creative process, self-report and observational studies of people engaged in creating work. Although there are specificities in the creative process for each domain and each task, it is possible to observe systematic trends that allow the creative process involved in successful, original work to be distinguished from the process that leads to more mundane work (Lubart, 2018).

Collaboration was examined in the context of small team creativity. For example, in some studies, several individuals worked together in brainstorming tasks and the interactions and output were compared to control conditions in which individuals work independently and their productions are simply combined in a fictitious "group". The quality of the exchanges and discussion in dyads and small groups can be examined, and some measures of creative collaboration were developed.

Over the years, the co-editors of this book have examined several facets of the environment that support or inhibit creativity. Some work looked at the family context, in terms of rules that parents have, the rigidity or flexible use of parental rules and the link with children's creative thinking. Other work, in school settings, looked at support for creative thinking in terms of teachers' attitudes and beliefs. Workplace environment was studied in part using questionnaires related to workplace creativity and perception of organizational climate (see Caroff et al., 2018). Another line, proposed a set of virtualized work settings, to see which contexts would be most conducive to creative output (Bourgeois-Bougrine et al., 2020; Guegan et al., 2017). Finally, additional work examined the impact of culture, studied mainly through variation in national cultures, across country settings, on the nature and amount of creative activity (Lubart et al., 2019).

The C of Creations was the object of several empirical studies of judges' criteria. In some of these studies, judges rated a set of productions, such as advertisements, on a series of criteria, including novelty, utility and aesthetic value. Some studies used specially created productions that included variations in the composition of the presented works. This line of research led to insights about judges' criteria, the weights that they attribute to various facets of creative productions, and the similarities between scores provided by judges compared to more objective assessment systems, such as the relative frequency of an idea calculated statistically compared to the frequency of other ideas in a set of work (Caroff & Besançon, 2008; Lubart et al., 2010).

Consumption is another essential C of the 7 Cs because the focus has traditionally been on the production of creative work, but the uptake and transformation of ideas in the marketplace is part of the complete picture. Working together with behavioral economists, this theme was explored in a series of studies. For example, more or less original goods were presented to the public, and the value placed on these productions was estimated for these future "consumers' of creative goods. In some work, consumption habits and attitudes toward original products, or those involving some consumer customization and creative input were studied. Furthermore, some research looked at ways that consumers may actually contribute to product design, as collaborators in the value chain of new products and service development (Decotter et al., 2018).

The last C, Curricula, was examined in research that looked at three main topics. First, some studies examined the developmental impact, using semi-longitudinal methods, of pedagogical approaches, such as Montessori and Freinet pedagogies on children's creative thinking (Besançon & Lubart, 2008). A second line of work looked at the effects of specific programs to boost creativity, such as interventions to help students develop mental flexibility or other characteristics that support creative thinking (Barbot et al., 2015; Besançon & Lubart, 2015). Finally, a third line of work looked at extra scholastic activities that may contribute to creative development. In particular, studies of board game play have been conducted (Mercier & Lubart, 2021).

The research cited for each C illustrates diverse work conducted, but it is also possible to examine two or more Cs together. This approach may yield further insights. For example, in some studies of the impact of virtual environments with participants represented by avatars, the basic effect of a stimulating work environment on creativity (the C of context) was examined in conjunction with the C of creators. In this work, participants were exposed to various kinds of virtual work environments, versus traditional real-life settings, and measures of individual differences of their personality and abilities were made. The results showed that the benefits of the virtual environment were particularly present for individuals who were relatively high on risk taking, compared to those low on risk taking who showed no special effect of the virtual environment compared to the "real-life" traditional one (Bourgeois-Bougrine et al., 2020). This interactive effect enhances the understanding of creativity thanks to a combined Context-Creator, multiple C investigation.

A bibliographic analysis of recent work published in 2020 provides an overview of work on creativity. To provide a specific example, the PsycINFO search engine was used. This search engine focuses on literature in psychology, but a similar analysis could be conducted in other fields or in a multidisciplinary manner. Although there were numerous books, book chapters and Ph.D. dissertations about creativity, the analysis here will focus first on peer-reviewed journal articles. To conduct this analysis, the search term «creativity» as a keyword descriptor was used. The results are illustrative because other related keywords, such as divergent thinking, could also be used. In 2020, there were 661 articles with the keyword «creativity» that came from a range of journals.

Table 1 Psycinfo © number of records concerning creativity by decade

Time period	«Creativity»	Total database items	Percent for creativity
1951–1960	396	92,869	0.43
1961–1970	1823	155,434	1.17
1971–1980	2964	288,292	1.03
1981–1990	3743	483,783	0.77
1991–2000	4438	649,507	0.68
2001–2010	9412	1,220,931	0.77
2011–2020	11,634	1,848,528	0.63

These journals can be categorized into three sets. First, in the 2020 Psycinfo database, six journals focused directly on creativity. These were: the *Journal of Creative Behavior, Psychology of the Aesthetics, Creativity and the Arts, Creativity and Innovation Management, Thinking Skills and Creativity, Creativity Research Journal, Journal of Creativity in Mental Health.* Second, there were several general psychology journals that published articles on creativity: *Frontiers in Psychology, Current Psychology, Current Psychological Research and Reviews, Neuroimage, Plos One*. Finally, there were a large number of more specialized journals, often focused on a subdiscipline of psychology that published articles on creativity. Examples are *Personality and Individual Differences, Computers in Human Behavior, Psychoanalytic Dialogues, Organizational Behavior and Human Performance,* and *Education.*

It is interesting to note as well the overall trend in the psychology literature concerning articles on creativity. Here the generic search term «creativity» was used, without requiring that the term be a keyword. The number of items (peer-reviewed papers, books, chapters, dissertations) that had mentioned creativity in the title or abstract are indicated in Table 1, by 10-year periods, since Guilford's (1950) presidential address to APA. We can observe that there is an overall growth in the number of research items on creativity, ranging from 396 in the 1951–1960 period to 16,634 in the most recent decade, 2011–2020. This shows that there are 42 times more articles in the last ten years compared to the 1950–1960 period. However, it is important to note that the total number of entries in the Psycinfo database increased as well each decade, as the field of psychology has grown. The percentage of items concerning creativity compared to the total number of items remained relatively stable, ranging from 0.43 to 1.17% over the 70-year period examined. There is therefore more and more research on creativity, but it remains a relatively rare topic in psychology, representing less than one entry out of one hundred in the bibliographic database.

This book presents, therefore, a call to expand our knowledge of creativity, encompassing all 7 Cs of creativity. In this book, there are two chapters devoted to each C. For Creators, there is a chapter entitled "From Everyday Creativity to Eminent Cases of Creative Achievement in Professional Domain" by Dean Keith Simonton that addresses broad issues concerning creative people, eminent and non eminent. This chapter raises a series of fundamental questions that underlie current

debates in the literature today. The following chapter, entitled "Cognitive and Conative Profiles of Creative People" by Nils Myszkowski, Baptiste Barbot and Franck Zenasni, surveys the literature on creative individuals looking primarily at cognitive, conative and affective components that contribute to individual differences in creativity. A second section focuses on Creating. One chapter, entitled "The DA VINCI Model for the Creative Thinking Process" by Giovanni Emanuele Corazza and Sergio Agnoli presents a new theoretical model of the creative process and offers a synthesis of studies on the creative process. The other chapter in this section, entitled "Creative Processes in Five Domains: Art, Design, Scriptwriting, Music and Engineering" by Marion Botella, Franck Zenasni, Julien Nelson and Todd Lubart presents a series of results from empirical work on process tracing, to illustrate the sequence of thoughts and actions engaged in creative work. The third C is Collaboration. Here, Julien Nelson and Jérôme Guegan look at studies and models of "Creative Collaboration in Groups". Then, Vlad Glăveanu, in his chapter, "Creativity and Culture: Four (Mis)Understandings" offers a vision of culture as a collaborative setting in which all creative acts take place. Next, the C of Context is examined. First there is a chapter by Christophe Mouchiroud, Nils Myszkowski and Martin Storme, entitled "The Social Environment of Creativity" with special attention to family and several expanding layers of context. This is followed by the chapter "The Place to Be: Organizational Culture and Organizational Climate for Creativity" by Canan Ceylan and Jan Dul, which focuses specifically on concepts and research concerning work and professional environments. The C of Creations is examined in the following two chapters. Mark Runco in his chapter entitled "Types of Creativity", looks at a wide range of measures of creativity, with a focus on creative potential. Xavier Caroff and Justine Massu, in their contribution "The Black Box of the Consensual Assessment Technique: Some Questions and Doubts on the Subjective Rating of Creativity", examine questions related to the judgment of creativity, using the consensual assessment technique, applied to creative productions. The following section looks at the concept of consumption as related to creativity. A first contribution in this section, "Waste Creatively: The Intersection of Creativity and Consumerism" by Beth Hennessey, addresses broad societal issues of consumption of creative ideas and artifacts. The following chapter, "Creativity and Consumer Behavior: An Economic Analysis" by Louis Lévy-Garboua and Marco Gazel provides a behavioral economics perspective. The final section focuses on the C of curriculum. Here, an initial chapter by Katherine Cotter, Ronald Beghetto, and James Kaufman entitled "Creativity in the Classroom: Advice for Best Practices" looks at school and issues related to the development of creativity in educational settings. Then, the chapter by Gerard Puccio and Monika Modrzejewska-Świgulska entitled "Creative Problem Solving: From Evolutionary and Everyday Perspectives" examines the development of creativity through training focusing on creative problem-solving methods, including the acquisition of creative thinking techniques. This chapter situates the topic of curriculum in the historical work on the development of homo sapiens transitioning to Homo creativus. Finally, the concluding chapter by Samira Bourgeois-Bougrine brings together work and reflections of the combined 7 C's through an illustration of creativity in contemporary society. Taken together, the chapters in this edited book offer insights into

specific aspects of each C and illustrate the diversity of work that contributes to a scientific approach to creativity. Through the contributions in this volume, readers are invited to reflect on *Homo Creativus*, the human species denoted by its' creative nature.

References

Artige, L., & Lubart, T. (2020). Economic perspectives on creativity. In M. A. Runco & S. R. Pritzker (Eds.), *Encyclopedia of creativity*. Academic Press.

Barbot, B., Besançon, M., & Lubart, T. (2015). Creative potential in educational settings: Its nature, measure, and nurture. *Education 3–13*, *43*(4), 371–381.

Besançon, M., & Lubart, T. (2008). Differences in the development of creative competencies in children schooled in diverse learning environments. *Learning and Individual Differences, 18*(4), 381–389.

Besançon, M., & Lubart, T. (2015). *La créativité de l'enfant: évaluation et développement*. Mardaga.

Botella, M., Glaveanu, V., Zenasni, F., Storme, M., Myszkowski, N., Wolff, M., & Lubart, T. (2013). How artists create: Creative process and multivariate factors. *Learning and Individual Differences, 26*, 161–170.

Botella, M., Zenasni, F., & Lubart, T. (2018). What are the stages of the creative process? What visual art students are saying. *Frontiers in Psychology, 9*, 2266.

Bourgeois-Bougrine, S., Glaveanu, V., Botella, M., Guillou, K., De Biasi, P. M., & Lubart, T. (2014). The creativity maze: Exploring creativity in screenplay writing. *Psychology of Aesthetics, Creativity, and the Arts, 8*(4), 384.

Bourgeois-Bougrine, S., Richard, P., Burkhardt, J. M., Frantz, B., & Lubart, T. (2020). The expression of users' creative potential in virtual and real environments: An exploratory study. *Creativity Research Journal, 32*(1), 55–65.

Caroff, X., & Besançon, M. (2008). Variability of creativity judgments. *Learning and Individual Differences, 18*(4), 367–371.

Caroff, X., Massu, J., & Lubart, T. (2018). Measuring creativity at work. In *The Palgrave handbook of creativity at work* (pp. 3–22). Palgrave Macmillan.

Dacey, J. (1999). Concepts of creativity: A history. In M. A. Runco & S. R. Pritzker (Eds.), *Encyclopedia of creativity* (1st ed., pp. 309–322). Academic Press.

Decotter, D., Burkhardt, J. M., & Lubart, T. (2018, August). Evaluating users' creativity for service and needs identification in the field of emerging technologies: A comparison of two methods and two production conditions. In *Congress of the international ergonomics association* (pp. 983–989). Springer.

Gabora, L., & Kaufman, S. (2010). Evolutionary approaches to creativity. In J. C. Kaufman & R. J. Sternberg (Eds.) *Cambridge handbook of creativity* (pp. 279–300). Cambridge University Press.

Getzels, J. W., & Csikszentmihalyi, M. (1976). *The creative vision: A longitudinal study of problem finding in art.* Wiley.

Glăveanu, V. P. (2013). Rewriting the language of creativity: The Five A's framework. *Review of General Psychology, 17*(1), 69–81.

Glaveanu, V., Lubart, T., Bonnardel, N., Botella, M., De Biaisi, P. M., Desainte-Catherine, M., Georgsdottir, A., Guillou, K., Kurtag, G., Mouchiroud, C., Storme, M., Wojtczuk, A., & Zenasni, F. (2013). Creativity as action: Findings from five creative domains. *Frontiers in Psychology, 4*, 176.

Glaveanu, V. P. (Ed.). (2019). *The creativity reader*. Oxford University Press.

Gruber, H. E., & Barrett, P. H. (1974). *Darwin on man: A psychological study of scientific creativity*. EP Dutton.

Guegan, J., Nelson, J., & Lubart, T. (2017). The relationship between contextual cues in virtual environments and creative processes. *Cyberpsychology, Behavior, and Social Networking, 20*(3), 202–206.

Hodder, I. (Ed.). (2020). *Consciousness, creativity, and self at the dawn of settled life*. Cambridge University Press.

Lubart, T. (2012). Les ressorts psychologiques de la créativité. *Revue Économique et Sociale, 4*, 13–21.

Lubart, T. (2017). The 7 C's of creativity. *The Journal of Creative Behavior, 51*(4), 293–296.

Lubart, T. (Ed.). (2018). *The creative process: Perspectives from multiple domains*. Springer.

Lubart, T., Barbot, B., & Besançon, M. (2019). Creative potential: Assessment issues and the EPoC Battery/Potencial creativo: Temas de evaluación y batería EPoC. *Studies in Psychology, 40*(3), 540–562.

Lubart, T., Glaveanu, V. P., de Vries, H., Camargo, A., & Storme, M. (2019). Cultural perspectives on creativity. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge Handbook of creativity* (pp. 421–447). Cambridge University Press.

Lubart, T., Mouchiroud, C., Tordjman, S., & Zenasni, F. (2015). *Psychologie de la créativité-2e édition* [Psychology of creativity, 2nd ed.]. Armand Colin.

Lubart, T., Pacteau, C., Jacquet, A. Y., & Caroff, X. (2010). Children's creative potential: An empirical study of measurement issues. *Learning and Individual Differences, 20*(4), 388–392.

Mercier, M., & Lubart, T. (2021). The effects of board games on creative potential. *The Journal of Creative Behavior, 55*(3), 875–885.

Mithen, S. (Ed.). (2005). *Creativity in human evolution and prehistory*. Routledge.

Rhodes, M. (1961). An analysis of creativity. *The Phi Delta Kappan*, *42*(7), 305–310.

Runco, M. A., & Jaeger, G. J. (2012). The standard definition of creativity. *Creativity Research Journal, 24*(1), 92–96.

Sawyer, R. K. (2014). *Group creativity: Music, theater, collaboration*. Psychology Press.

Sofaer, J. (2015). *Clay in the Age of Bronze: Essays in the Archaeology of prehistoric creativity*. Cambridge University Press.

Simonton, D. K., & Ting, S. S. (2010). Creativity in Eastern and Western civilizations: The lessons of historiometry. *Management and Organization Review, 6*(3), 329–350.

Zenasni, F., Besançon, M., & Lubart, T. (2008). Creativity and tolerance of ambiguity: An empirical study. *The Journal of Creative Behavior, 42*(1), 61–73.

From Everyday Creativity to Eminent Cases of Creative Achievement in Professional Domains

Dean Keith Simonton

Keywords Genius · Creativity definition · Creative process · Development · Individual differences

Creativity is ubiquitous. It is apparent in everyday problem solving, such as creatively modifying a recipe for a favorite dish after discovering too late that a crucial ingredient is absent from the pantry. Creativity is also evident in the most monumental achievements of human civilization, such Albert Einstein's general theory of relativity or Pablo Picasso's *Guernica*. Everyday manifestations have been styled "little-c creativity" and genius-level achievements "Big-C Creativity" (Simonton, 2013b; cf. Kaufman & Beghetto, 2009). It is frequently assumed that little-c and Big-C creativity simply anchor the extreme ends of some continuous scale with many grades between. Or, more accurately, zero creativity anchors the low point, and then the scale proceeds from the smallest to the largest magnitudes of creativity.

To illustrate, consider the Creative Achievement Questionnaire (CAQ), a popular self-report measure of creativity (Carson et al., 2005; see also Silvia et al., 2011). The scale assesses creativity in a broad range of domains: visual arts, music, creative writing, dance, drama, architecture, humor, scientific discovery, invention, and culinary arts—with each domain having its own subscale. Every subscale has a zero representing the utter absence of creativity in the domain, and from that low point advances to the lowest levels of little-c creativity, such as self-perceived creative acts, before moving to the lower levels of Big-C creativity, such as achievements that earn national recognition. Although none of the scales progress to the highest grades of Big-C creativity, as would be indicated by the Nobel Prize and similar international

D. K. Simonton (✉)
Department of Psychology, University of California, Davis, CA, USA
e-mail: dksimonton@ucdavis.edu

T. Lubart et al. (eds.), *Homo Creativus*, Creativity in the Twenty First Century,
https://doi.org/10.1007/978-3-030-99674-1_2

awards, that omission is understandable given the extreme rarity of such recognition among the participants who most frequently fill out the questionnaire (to wit, college students). Moreover, assessments of posthumous fame are not surprisingly omitted as well, given that the CAQ relies on *self*-reports! Nevertheless, the main point remains: The instrument assumes that creativity can be measured along a quantitative scale that begins at zero and ends at the highest levels of at least national recognition.

This chapter will argue that everyday creators and creative geniuses who produce achievements of the highest order differ not in degree but in kind. Unlike contrasts in intelligence, which are founded on an underlying continuum, contrasts in creativity often betray one or more discontinuities. The chapter's argument begins with the very definition of creativity and from there discusses cognitive processes, developmental antecedents, and individual differences.

1 Defining Creativity

Creativity researchers have put forward a dizzying diversity of definitions (Plucker et al., 2004). Most researchers probably subscribe to the "standard definition" that imposes two criteria: (a) novelty or originality and (b) usefulness, value, or appropriateness (Runco & Jaeger, 2012). Nonetheless, a sizable minority have argued for the definitional superiority of a three-criterion definition, where the third criterion amounts to "surprise" or at least "nonobviousness," to use the standard imposed by the United States Patent Office (Boden, 2004; Simonton, 2012b). This additional criterion is implemented to rule out original and useful ideas that merely emerge from the straightforward application of domain-specific expertise (e.g., Amabile, 1996), or what the Patent Office calls "ordinary skill in the art" (as defined at http://www.uspto.gov/web/offices/pac/mpep/documents/2100_2141_03.htm). For the purposes of discussion in the current chapter, I will adopt the following three-criterion definition: *An idea is creative to the extent that it is jointly original, useful, and surprising* (Simonton, 2013a). The insertion of the qualifier "jointly" means that the definition is multiplicative rather than additive. An idea cannot possibly be creative if it is commonplace, useless, or obvious.

Too many researchers stop with the definition, not realizing that specifying the criteria only solves half of the problem (Simonton, 2013b). The issue is not really settled until we also address the following question: *Who* decides whether an idea is jointly original, useful, and surprising? The answer is critical. To appreciate this fact, let us consider two different responses: (a) the person who generates the idea decides on its creativity or (b) the idea's creativity is decided by a consensus of persons in the position to make that judgment.

1.1 Personal Creativity

In the proverbial "Eureka!" moment, the creative individual realizes that he or she has come up with an idea that is original, useful, and surprising. The idea is considered *original* because it had a low initial probably, sufficiently low that it required a prolonged incubation period before finally popping into the mind. The idea is personally judged as *useful* because it solves the problem at hand, the problem that stimulated the search for a solution. And the idea is subjectively assessed as *surprising* because it was not obviously derivable from any given domain-specific expertise.

Such acts of *personal* creativity are purely cognitive, involving a subjective assessment of an idea's claim to originality, usefulness, and surprise. Because the creator alone decides, the judgment requires no "second opinion." Creativity is thus a strictly psychological rather than social phenomenon. If the researcher's focus is on everyday creativity, this personal assessment suffices. For example, the concept of personal creativity is implicit or explicit in self-report measures that request the person to self-identify instances of creativity in their own lives (e.g., Richards et al., 1988). Even so, it certainly could happen that the creator's self-perceptions are very much deceived. The idea may lack one of the three essential qualities. Persons tripping on psychedelics who believe that they can fly will discover their error should they jump out the second-story window. Naturally, this objection is removed if the idea's creativity is independently validated by others. If those others reach a consensus on the creativity, then the idea can be considered *consensually* creative (e.g., Amabile, 1996).

1.2 Consensual Creativity

An idea's creativity can be consensually certified in many different ways. Two friends might be backpacking in the woods, chatting about the best place to stop for the night. One of them comes up with an original, surprising, but still useful suggestion, to which other responds "That's a great idea!" Another example of an interpersonal consensual validation is when some wit becomes the "life of the party," spontaneously making up one joke after another that keeps everybody in stitches throughout the evening. Here humor becomes assessed for its originality, usefulness (aptness), and surprise. However, consensual creativity does not even require that the evaluator be walking the same path or occupying the same room as the creator. Since the advent of YouTube, an idea's creativity might be assessed by the degree to which the posted video "goes viral," as determined by the number of viewings by anonymous web-surfers. Alternatively, the creativity of an amateur musical composition might be gauged by the number of downloads. These consensual measures do not necessarily require any special domain-specific expertise on the part of either creators or evaluators. Hence, ideas that satisfy this level of creativity might be said to stand at the cusp between little-c and Big-C creativity. Unlike genuine Big-C creativity, the

creative ideas are very often ephemeral, vanishing as quickly as they appeared. The party wit's jokes might seem less funny on retelling the next day, eliciting the lame "well, you needed to be there." The number of "cute little kitty" videos that have come and gone may be uncountable.

Far more interesting and important are those occasions in which consensual creativity demands domain-specific expertise on the part of both creators and their evaluators. That expertise is required because the creators aim at making a creative contribution to a specific domain in the arts or sciences. The creators actually identify themselves as artists or scientists. Most often the evaluators are themselves creators operating in the same domain and thus provide the basis for "peer review" (Csikszentmihalyi, 2014). This circumstance certainly holds for the sciences, where both grant proposals and journal submissions are judged by peers who, at least in theory, have the expertise needed to have written similar proposals or submissions. Similarly, art works submitted for exhibitions or festivals are often evaluated by juries consisting of creative peers. But other times the evaluations are made by persons who acquire status as "gatekeepers" by establishing a portfolio of good judgments—such as art gallery owners, theater impresarios, orchestra directors, film studio executives, and critics of all kinds. Sometimes more than one evaluation is involved before the consensual evaluation is complete. Thus, a new invention might first face judgment by a patent examiner to determine whether it meets the criteria for patent protection, but then encounter another up-down assessment by a venture capitalist before the invention can become a consumer product. If the invention's production is halted by a patent infringement law suit, creativity may later be determined by a judge. Although these assessments vary greatly in specific application, they can all be said to apply to the consensual evaluation in a *professional* domain where the creativity of an idea constitutes an essential criterion for deciding that the idea makes a bona fide contribution to that domain. Creators in these domains are authentic *professionals* (cf. Kaufman & Beghetto, 2009).

It should be emphasized that consensual creativity introduces numerous complexities not found in personal creativity. First and foremost, consensual creativity is no longer a purely psychological phenomenon but rather has acquired an interpersonal and even sociocultural aspect. As a consequence, the two assessments need not agree (Simonton, 2013b). Anyone who has had their creative masterpiece ripped to shreds in peer review has experienced firsthand how discrepant these two judgments can be! Second, unlike personal creativity, consensual creativity presumes a *consensus*, and such an agreement may not be forthcoming, especially in low-consensus domains like the arts and the social sciences (Simonton, 2009, 2014b). Again, anybody who has submitted a manuscript for publication only to receive peer evaluations that are all over the place—from "accept as is" to "reject outright" recommendations—knows how pathetic the supposed consensus can be. This absence of agreement becomes even more conspicuous in creative domains where the evaluators often apply divergent criteria. Cinematic creativity, for example, can be assessed by either professional critics (film reviews) or filmmaking professionals (awards), which seldom converge on identical judgments (Simonton, 2011b). The former are outsiders, the latter insiders.

Last but not least, unlike personal creativity, the evaluation of consensual creativity can prove unstable over time (Runco et al., 2010). Although creative persons might change how they view their own ideas over the course of their careers, such reassessments must definitely cease at their deaths. In contrast, posthumous reevaluations are rather frequent in the case of consensual creativity (Ginsburgh & Weyers, 2014; Whipple, 2004). In the extreme case, the result is the once "neglected genius" who has to wait for posthumous acclaim. Obvious examples include Gregor Mendel, Emily Dickinson, and Frida Kahlo. Even if consensual assessments eventually stabilize in the long run, the assessments can become unstable for the first few decades after the creator's death. This instability must obviously operate without any psychological correlates within the individual creator. After the latter dies, his or her psychology has become fixed in stone.

These posthumous consensual assessments can occur because professional creativity generates overt products that become part of the historical record. Mendel published his genetic experiments in a scientific journal, enabling his results to be rediscovered 35 years later; Dickinson's poems were collected for publication after her death, thus allowing posterity to appreciate what her contemporaries had overlooked; and Kahlo's paintings began to show up in the permanent collections of major art museums, starting with a prescient purchase by the Louvre. If nothing is preserved to permit these continuing reassessments, then the creative individual will slip into obscurity, becoming an unknown to history (Lang & Lang, 1988). Hence, the prerequisite for Big-C creativity is a surviving body of creative work (see also Simonton, 1991).

2 Cognitive Processes

The last section ended with the assertion that consensual creativity, unlike personal creativity, is somewhat decoupled from individual psychology. This point needs elaboration. So imagine the following two scenarios.

In the first, an amateur backpacker finds himself stranded in a remote wilderness because of an unexpected storm that closes all nearby trails and roads for weeks. Forced to survive in an inhospitable environment, he creates a number of ingenious techniques to obtain food and shelter, as well as to attract attention from possible search teams flying overhead. Finally, he is rescued, and he tells his story of survival, including the inventory of original, useful, and surprising tools and behaviors. The seasoned rescuers listen with amazement, advising the backpacker that he should write his ordeal up for a backpacking magazine. In their informed judgment, his solutions to an urgent problem were truly creative. The backpacker follows their advice and eventually expands the essay into a full-fledged survival manual that becomes a national bestseller.

The second scenario starts out exactly the same way, but ends very differently. The fortunate backpacker climbs into the helicopter and begins proudly to tell his tale of survival creativity. Only in this alternative universe, his rescuers just roll their eyes,

advising him that he could have saved himself a lot of trouble if he had taken along a bestselling survival manual. They then show him a well-worn copy containing every single technique that he thought he had invented. Unlike in the previous scenario, where his personal creativity was validated as consensual creativity, in the second scenario his personal creativity remained only personal. At the consensual level his ideas displayed no originality, usefulness, or surprise.

Yet despite the difference in outcome in these two scenarios, the backpacker's cognitive processes prior to the rescue were exactly equivalent. The personal creativity was identical in both cases notwithstanding the stark contrast in consensual endorsement.

Actually, this hypothetical example has interesting parallels in the real world of Big-C creativity. The history of science has many instances of independent discovery and invention, or what has been called "multiples" (Lamb & Easton, 1984). Two or more individuals may come up with the same creative idea in complete ignorance of the redundancy at the domain level. Well-known examples are the independent invention of calculus by Isaac Newton and Gottfried Wilhelm Leibniz, the theory of evolution by natural selection proposed by Charles Darwin and Alfred Wallace, and the telephone by Alexander Graham Bell and Elisha Gray, the two inventors seeking patent protection on the exact same day. Such multiples often lead to priority disputes that end up getting resolved with one person getting all of the credit—such as happened with the telephone. Hence, personal creativity in one person received consensual validation whereas the personal creativity in another person did not even when the resulting creative ideas are comparable. If Gray had been quicker on the patent application trigger, these endorsements would have been reversed, and the famous Bell Telephone Company would have become the Gray Telephone Company. Even so, the cognitive processes they each engaged in would have been unchanged. In a sense, little-c creativity is out of synchrony with Big-C creativity.

The foregoing discussion did not actually mention what these cognitive processes might be. It turns out that there is not a single "creative process" but rather a multitude of processes or procedures involved. These can be divided into two classes, namely, those are specific to a given domain of creativity and those that can be found in virtually all domains. I will refer to the former as "procedures," because they invariably represent that category, whereas the latter I will call "processes," because they mostly fall into that category, albeit some procedures can be domain general as well.

2.1 Domain-Specific Procedures

Problem solving in any established domain utilizes a set of techniques or procedures. These are sometimes referred as "strong" methods because they most often guarantee a solution to a given problem (e.g., Klahr, 2000). Often these strong methods might even be considered *algorithmic*, that is, they entail a step-by-step procedure for obtaining a solution. Want the roots of a quadratic equation? Then just plug the three constants into the quadratic formula and do the required multiplications, additions,

subtractions, square root, and divisions (in the right order). Indeed, persons who create in the mathematical sciences must possess a huge toolbox of methods for solving mathematical problems. The tools involve basic algebra, differential and integral calculus, differential equations, matrix algebra, vector geometry, and diverse areas of higher mathematics. Scientists who lack the necessary set of procedures must often take on a mathematical collaborator to do the calculations or derivations, just as Einstein was obliged to do when he got in over his head working on his general theory of relativity.

In any case, although mathematical procedures are used in all mathematical sciences, the contents of each toolkit will depend on the specific discipline. Techniques that are the bread and butter of one science may serve as no more than a condiment in another. Structural equation models are popular in quantitative psychology but not in theoretical physics. More importantly, each science contains a set of methods that are unique to that science. For example, a chemist must know how to balance equations representing chemical reactions, such as the elementary $2H_2 + O_2 = 2H_2O$. A chemist specializing in a particular branch of chemistry, such as electrochemistry, will master problem-solving strong methods unique to that branch.

Domain-specific procedures are also apparent in the arts. Leonardo da Vinci's *Treatise on Painting* is crammed full of various devices, such as detailed instructions of how to translate a three-dimensional space into a two-dimensional representation via linear perspective and other techniques. Likewise, classical composers could not create without first knowing a great deal about harmony, counterpoint, instrumentation, and a host of other strong methods. If a melody does not play well on a particular instrument, the composer must either revise the melody or else pick a different instrument to play it.

Whatever the particulars, these domain-specific procedures separate the experts from novices or amateurs. The methods set a Picasso apart from a typical "Sunday painter," a Thomas Edison from a "garage tinkerer." Even so, by themselves these techniques cannot guarantee ideas that are original, useful, and surprising. On the contrary, to the extent that problem solving is entirely driven by strong methods, the solution may not be creative at all. Instead, the result will merely represent "reproductive" or "routine" thinking (cf. Wertheimer, 1945/1982). Art schools and music conservatories are full of instructors who can teach every textbook technique that an artist or composer needs to know, and yet neither the teachers nor their straight-A students may produce anything beyond ordinary "academic" art or music. Something more is necessary to "think outside the box" defined by domain-specific procedures.

2.2 Domain-Generic Processes

Empirical research has identified a large number of processes and procedures that appear to facilitate bona fide "productive" thinking in a diversity of domains in both the arts and the sciences (Simonton & Damian, 2013). These Simonton (2015)

recently listed as "divergent thinking, remote association, cognitive disinhibition, conceptual reframing, analogy formation, tinkering, play, combinatorial procedures, and both systematic and heuristic searches" (p. 3), where heuristic searches can include such techniques as hill climbing, means-end analysis, working backwards, and trial-and-error (Simonton, 2012a). In contrast, Ness (2013) identified several "tools" used by Big-C creators: finding the right question, changing point of view, broadening perspective, reversal, observation, analogy, juggling induction and deduction, dissecting the problem, recombination and rearrangement, the power of groups, and frame shifting. These two lists only partially overlap. Yet taken together they still do not exhaust the possibilities. On the basis of more than three decades of empirical research, Rothenberg (2015) has put forward the Janusian, Homospatial, and Sep-Con Articulation processes. All told, some of these correspond to basic cognitive processes, such as remote association (spreading activation) and cognitive disinhibition (reduced latent inhibition), whereas others constitute overt procedures, such as conceptual reframing, means-end analysis, and Sept-Con Articulation. That is, the latter can be deliberately implemented by the creative person.

Unlike domain-specific strong methods, these weak methods cannot guarantee a solution to any given problem. The processes and procedures merely represent possible means for obtaining a creative idea. Sometimes they work, but most times not. Worse yet, because these methods are so weak, it is impossible to predict in advance which route to a creative solution will actually succeed. That is the very reason why highly creative individuals need such a large inventory of tools. If one doesn't work, then another tool can be taken out and tried. If that fails as well, then it's time to pull out yet another tool. Hence, the trial-and-error heuristic must be raised to the superordinate status of a "meta-heuristic" (Simonton, 2011a). Or, speaking more broadly still, the most generic creative process or procedure is what Donald Campbell (1960) called "blind variation and selective retention" or BVSR. Each tool produces possibilities that must then be tested for their usefulness. When a tool no longer manages to generate potential solutions, the creator will need to switch to another approach, and go through BVSR all over again. In other words, BVSR operates at two levels: first, the generators of possibilities and, second, the possibilities produced by each generator. At either level, the creator is "blind" regarding usefulness, thereby requiring the introduction of a selection phase.

What renders BVSR the prime candidate for a domain-generic creativity is that it makes the creative process comparable to what Campbell (1960) styled "other knowledge processes" (p. 380). These processes also operate according to "selectionist principles" (Cziko, 1995). Because the organism cannot know in advance whether a given "variation" had any utility, the only option is to subject that variation to a generate-and-test cycle, retaining that variation that best survives that test. Roughly parallel even if not isomorphic processes can be seen in biological evolution, neurological development, the emergence of antibodies, and operant conditioning (Dennett, 1995; Rosenbaum, 2014; Simonton, 1999). The latter connection is especially crucial because BVSR can be directly connected with the "personal creativity"

of any organism capable of adapting to its environment (Epstein, 1990). Indeed, the main contrast between operant conditioning and creative thought is that in the latter case, "thought trials" are very often tested against internal representations rather than the external world (Dennett, 1995; Simonton, 2011a).

3 Developmental Antecedents

What enables a person to make a creative contribution to a professional domain in the arts or sciences? One answer concerns developmental antecedents—experiences and circumstances in childhood, adolescence, and sometimes early adulthood that enhance creative potential. Consistent with what said in the previous section on cognitive processes, some of these antecedents will be domain specific and others much more domain general. I now turn to examples of each.

3.1 Expertise Acquisition

Researchers have long indicated the importance of the so-called "10-year rule" (Ericsson, 1996). World-class Big-C creativity requires that an ambitious individual devote a long apprenticeship to study and practice to move well beyond the limitations of the mere novice, no matter how talented (Ericsson, 2014). This extensive training enables individuals to acquire the domain-specific procedures mentioned earlier, such as the mathematics necessary in domains like physics, chemistry, and some subdisciplines of biology. Naturally, much more than just problem-solving techniques are acquired during this learning and apprenticeship period. The person must also attain competence in the accumulated knowledge of the domain. In the sciences, for example, this knowledge includes empirical findings and formal theories. This domain-specific knowledge should then enable the young person to become aware of what kinds of ideas would most likely be considered original, useful, and surprising by peers or gatekeepers for the domain.

One might conclude that the acquisition of domain-specific expertise would result in an equivalence between personal and consensual assessments of an idea's creativity. For instance, scientists would be socialized into knowing not just what ideas are publishable in the best journals but also what ideas are highly most likely to be cited. Yet as pointed out earlier, domains differ tremendously in their degree of consensus. Even in high-consensus domains such as the "hard" sciences, the agreement is always far from perfect (Simonton, 2004). A high-profile illustration is Einstein's relativity theory. Although some physicists accepted the new paradigm, many others were just as opposed. This opposition was strong enough to deny him the Nobel Prize for Physics through a whole decade of failed nominations. Even after his general relativity theory received a spectacular empirical confirmation in 1919, the Nobel selection committee could not reach a consensus. Finally, a compromise

was reached allowing Einstein to receive the Nobel in 1921, 11 years after his first nomination. The compromise? The prize citation would not explicitly mention relativity theory, but instead solely mentioned his 1905 work on the photoelectric effect. The omission of relativity was perceived as an insult to Einstein and his supporters! Of course, now the special and general relativity theories are considered among the cornerstones of modern physics and astronomy.

Einstein's long uphill climb to full professional acceptance was not unique. Max Planck experience with his new quantum theory led him to observe that "A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it" (Planck, 1949, pp. 33–34). Likewise, Charles Darwin noted with respect to his theory of evolution that he did not "expect to convince experienced naturalists whose minds are stocked with a multitude of facts all viewed, during a long course of years, from a point of view directly opposite to mine" but instead he looked "with confidence to the future, – to the young and rising naturalists, who will be able to view both sides of the question with impartiality" (Darwin, 1860/1952, p. 240).

Planck's comment is often paraphrased more humorously in the statement that "science advances one funeral at a time." Eventually, Planck and Darwin, like Einstein, were vindicated in their own lifetimes.

In discussing domain-specific expertise acquisition it is crucial to note that the "10-year rule" does not come anywhere close to representing a "rule," but rather only describes a rough statistical average subject to conspicuous individual differences (Simonton, 2000). Some creators can master the requisite expertise in less than half the time whereas others will take twice as long. This cross-sectional variance partly reflects substantial variation in innate talent, as defined by relevant cognitive and dispositional variables that accelerate or retard the acquisition process (Simonton, 2008b). Substantial talent thus enables a student or apprentice to "get better faster." Another exception to the rule is no less important, namely, the "more bang for the buck" effect (Simonton, 2014a). Two persons with the same expertise will differ greatly in the magnitude of creativity that they will generate from that expertise. For example, Einstein did not know more than the average theoretical physicist of his day, and arguably knew appreciably less, but he certainly managed to augment his knowledge with a creative imagination going far beyond that of his contemporaries. By relaxing certain constraints of classical physics—such as Newton's assumption of absolute space and time—Einstein was led to the relativity of space and time, and thus their linkage in four-dimensional space–time.

So what developmental antecedents might enable a creator to "think outside the box" defined by domain-specific expertise?

3.2 Diversifying Experiences

Sometime during early development creative talents will encounter "highly unusual and unexpected events or situations that are actively experienced and that push individuals outside the realm of 'normality'" (Ritter et al., 2012, p. 961). Such events or situations are called *diversifying experiences* (Damian & Simonton, 2014a). These experiences can adopt a variety of forms, provided they serve to disrupt conventional ways of thinking. Examples include (a) professional, ethnic, and geographic marginality as well as (b) developmental adversity, including parental loss at the family level and political instability at the societal level. Although the particular experiences will vary from one creative individual to another, their collective impact is to nurture the development of creative potential instead of producing an expert constrained by domain-specific expertise.

To be sure, diversifying experiences, particularly when they assume the form of extreme developmental adversity, can have repercussions more negative than positive (see, e.g., Damian & Simonton, 2014b). Hence arises the necessity of finding the "sweat spot" or optimum between too much and too little (Damian & Simonton, 2014a). Complicating matters yet further, the precise location of this optimal degree of diversifying experiences depends very much on the domain of creative achievement (Simonton, 2014b). In particular, diversifying experiences are much less important in the science than in the arts. For instance, highly eminent scientists tend to come from much more stable and culturally homogeneous home environments than do comparably eminent artists. This contrast can be seen in the different family backgrounds of Nobel laureates in the sciences versus the laureates in literature.

Although the bulk of the research relevant to this topic has been correlational rather than experimental, laboratory experiments also support a positive relation between diversifying experiences and creativity, at least in the short term (Damian & Simonton, 2014a). For example, creativity tends to be enhanced when participants are exposed to schema violating stimuli (e.g., Ritter et al., 2012). In the case of Big-C creators, naturally, these influences are just much bigger and longer termed, producing lifelong developmental consequences.

4 Individual Differences

It is customary to describe most individual-difference variables as exhibiting a "normal" or "Gaussian" distribution, as depicted by the iconic "bell-shaped curve" (Simonton, 2008a). Individual differences in intelligence offer a classic example (Herrnstein & Murray, 1994), a formal description that goes all the way back to Francis Galton (1869). Even if the cross-sectional distribution of little-c creativity might sometimes be described this way (cf. Nicholls, 1972), Big-C creativity cannot possibly have this distribution (e.g., Martindale, 1995). For instance, lifetime creative output is optimally described by the inverse power function known as Lotka's Law