Introduction

Why Constraint Theory?

Creativity seems to belong to the broad type of phenomena which, like emotions, have causes or conditions but which can take different roads or have different outcomes. This is the basic reason why constraint theory might be a good place to start. Creativity is neither total order, nor total chaos (Simonton, 2007), but something in between, order in or through chaos. But to clarify how constraint theory can help us identify the First principles of creativity science, we need to collect the relevant data. According to Aristotle, a general First principle for all scientific work is for the researcher to get "intimate" with the relevant data (Anagnostopoulos, 2009). With "data" or whatever word Aristotle used, he meant not only raw data observed or collected by the researcher, but also data which had already been collected and interpreted by other researchers (the distinction we today call primary and secondary data was not that important for him). Having compared many intellectual biographies of pioneers (P-creativity as H-creativity) in science, art and technology (S-creativity, A-creativity, T-creativity) with a special focus on the discovery of First principles anddisciplines in the making, I became convinced of the soundness of Aristotle's approach. The core problem when it comes to data, is not whether they are primary or secondary but if the intimate knowledge gained by such data clarifies the nature of the knowledge object or not (compare Montuschi, 2003).

Let us say we want to understand how fiction works. The writer of a novel has to keep the reader coming back to the novel again and again, because of the many hours of intermitted reading (Elster, 2000) it takes to read such a work of art from the beginning to the end. This is an example of physical constraints (I.1), comparable to the geographical constraints Columbus faced when trying to reach China by sailing west. But where do novelists learn the techniques for writing novels if not from reading other

novelists (prototypes, I.2)? In particular, first novels tend to have an easy identifiable role model. The way Jane Austen learned to write was to read and reread Richardson's novel *Pamela* which she knew by heart (see McKeon, 2010; Shields, 2002).

Physical constraints (I.1) also play a role when solving the problem of building musical instruments or how to reach an audience in a theatre. Physical constraints also constrain the aesthetic choices of architects. Building a house from straw or mud places different constraints on the architect than having bricks or carved stone at one's disposal. Greek architects mainly used carved stone for their monumental buildings. The fact that they had not yet discovered (knowledge constraint, I.3) the technology of making and using concrete (Kostof, 1985), might be the best explanation why they did not build arches and why Greek monumental buildings, only have columns and flat roofs (Hegel, 1970).

Greek, classical style (Le Corbusier, 1931/2017) also served as a prototype or development constraint (I.2) for other Greek architects. Building roofs in the shape of rounded arches the way the Romans did, was out of reach for the ancient Greeks because they did not know the building technique of using concrete to bind stones together (knowledge constraints, I.3). But this does not exclude the fact that Greek architects had intentions; they were designed by Greek architects, persons, and not merely by the Greek language as the "death of the author" theory would have us to believe. But there are other constraints as well such as rules (I.4).

Scientific theories basically aim at the falsification of previous theories, and this impersonal goal is the basic rule of science (I.4). But in order to gain social recognition for such an impersonal goal (struggle for priority, Merton, 1957), the scientific writer (Bazerman, 1988) must speak openly and take full personal responsibility for all the in principle impersonal claims made in the scientific work (scholarly article, academic book). The scientist cannot hide behind a fictive narrator or character (Booth, 1961/1983). Personal and impersonal elements are blended in both types of genres (Bahktin, 1986b), but in a complex and paradoxical manner.

Writers and artists in general basically investigate their own subjectively felt experiences (Cziksmenthalyi, 1996) but can easily hide the factual background by the impersonal techniques of fiction and/or art (compare Steffensen, 2017). Scientists or scholars play a game where one's own personal feelings are subordinated to the impersonal aim of falsification, but where the scholar is held personally responsible for the arguments or claims made by the author (as a rule one person when we are dealing with

pioneering work). In neither case (science, art) is the author "dead" in the sense of irrelevant for analytical or interpretative purposes.

Only when we have come so far, do different types of motivations (I.5) become interesting. There are in principle three main type of motivations: pleasure (I.5a), pressure (I.5b) and opportunity (I.5c). The psychology of creativity has tended to vacillate between pleasure and pressure (intrinsic versus extrinsic motivations (cf. Amabile's, 1989,, 1996, 1997) dilemma, a problem solved by Czikszentmihaly's, 1988, 1994, 1999, dual theory of flow and social recognition as equally important motivations). Sociologists seem to ignore the role of pleasure and tend to start with problems of pressure (struggle for recognition, Honneth, 1992, accumulation of "symbolic capital," Bourdieu, 1974a, 1974b; "pressure to innovate." Lipset, 1979). Lately sociologists have also come to foreground the role of opportunity (Fuchs, 1994). Pressure and opportunity are often confused (cf. Bloor, 1976 and Latour & Wolgar, 1986) but should be regarded as analytically separate.

Opportunity is a critical motivational constraint (I.5c) which might explain one of the unsolved problems of creativity science, how pioneering work (H-creativity) in distinct intellectual fields such as science, art and technology (S-creativity, A-creativity, T-creativity) becomes possible (four of the best cases in science discussed at some length in this book are Jane Goodall, Jens-Jürgen Thomsen, Charles Darwin and Francis Crick and James Watson). This is the core problem of Dimension II (levels of creativity). There is much confusion in the literature on this issue. Educational psychology is mainly interested in the creativity of novices (II.2). Sociology as profession is committed to study the creativity of professionals (II.3) and only philosophers, historians of science, economic historians and archeologists have tended to be interested in studying the highest form of creativity, H-creativity or pioneering work (II.4).

The tendency of disciplines to specialize in relatively narrow areas, has provided us with a number of facts or data about creativity, but it has also blocked the evolution of a common theoretical framework and appropriate methodology to study this phenomenon (Gardner, 1988). But the phenomenon of specialization can be found not only in science (S-creativity), but also in art (see Dutch painting, Wright, 1978/1984, A-creativity) and technology (Marshall, 1890/1916,T-creativity). Interestingly functional specialization can also be found in nature (N-creativity). A case in point is Wilson's (1991/2001) description of the survival and reproduction strategies of cichlids in Lake Victoria. Specialization has the effect, as already noted by Durkheim (1893/1964), to reduce intra-species

competition, but in science it also leads to problems of interdisciplinary communication (Bauer, 1990).

Most educational psychologists do not believe that studies of pioneers (II.4, H-creativity) are of any relevance for motivating children or novices. Novices are believed to be "geniuses" in their own right (II.1). But if children are geniuses, why does the natural curiosity of children tend to die as soon as they enter the school system (Dewey, 1917/1997)? Academic teachers, who in principle are professionals (II.3) teaching novices (II.2) at an advanced stage, where the task is to raise the problem-solving capacity (creativity) to the level of the professional (II.3, compare Schön, 1983; Flyvbjerg, 2001), tend to resent the idea of pioneers (IV.3) as well. In the history of art, pioneers are routinely categorized as "geniuses" (II.5). The latter concept has often recently been used for children who are believed to be "romantic geniuses" (II.1), but politically incorrect when applied to the highest level (H-creativity,II.4). Compare Bordwell & Carroll, 1996).

The best way to work around these difficulties might be to drop the emotionally or morally (Merton, 1976) ambiguous concept of "genius" (II.5) altogether and merely foreground four levels of problem-solving capacity: children (II.1), novices (II.2), professionals (II.3) and pioneers (II.4). There are several advantages with such a categorization. First of all, it foregrounds the role of problem-solving capacity as the core of the level of creativity and not mere motivation. Second it recognizes the obvious role of biological factors (II.1) but also foregrounds the importance of sociocognitive roles. One can become a novice anytime in one's life, as soon as one enters a new, subjectively unknown field. Moreover, it fits the empirical data of groundbreaking creativity (pioneering work) much better. Becoming a pioneer in practice means going through a biographical life transformation (Kupferberg, 1995b, 1998a, 2006a, 2010). But such transformations in practice begin when becoming a novice (II.2) and gradually moving to the level of professional (II.3) before moving to the role of pioneer (II.4). Cases in point analyzed in some detail in this book are Picasso, Matisse and Chagall in painting; Orwell, Hemingway and Plath in writing; Chaplin, Hitchcock and Bergman in filmmaking.

Let us assume that (1) creativity is essentially constrained forms of problem solving (Dimension I) and (2) that the ability to solve problems is distributed differently among individuals due to different degrees of problem-solving capacity or levels of creativity (Dimension II). This raises the problem of how and if problem solvers manage to arrive at the best possible or "correct" answers (Elster, 1983). Although educational theorists (including myself, see Kupferberg, 2009a) have been reluctant to talk

about "correct" answers, it is difficult to imagine a science of creativity unless such a science provides us with correct or at least better answers than previous attempts (creativity as an end product of a process). Such a goal, the "advance of knowledge" (Kitcher, 1993) or the accumulation of a "body of knowledge" (Lloyd, 1991) is, in practice, a core goal of all scientific problem solving, including creativity science.

But what does this mean? Dimension III ("Getting it right") is an attempt to at least arrive at a preliminary answer to such an enormously difficult and highly contested problem. I have divided the overall category of "getting it right" into four subcategories: (1) parsimony, (2) convergent evolution or independent (re) discovery, (3) co-evolution or interdependent discovery and (4) problem solvers facing problem situations. I first stumbled upon the idea of "parsimony" when reading the chapter in Darwin's *The Origin of Species*, which deals with how bee colonies economize the amount of work necessary to build honeycombs. I later found that the concept of "elegance" often used in aesthetic appreciation (Zangwill, 2001) pretty much describes the same phenomenon (compare Pevsner, 1936/1991). I borrowed (prototype, I.2) the overall concept "getting it right" from John Elster (1983, 2000).

Arriving at a parsimonious solution is the core of getting it right (III.1) But how do we know that there is such a thing as getting it right in the first place? Here Dawkins' (2005) concept of "convergent evolution" has been of great help (III.2). The idea of interdependency or "co-evolution" (III.3) arrived from combining Abbott's (2004) theory of intellectual borrowing as a good heuristics of creativity in science, with Dawkins' (2010) fascinating examples of how this works in nature (including an "arms race" between species which I have used to analyze the relation between twentieth-century painting and Hollywood cinema).

Although getting it right is relatively easy to clarify in science (proven priority) and technology (parsimonious solutions), it becomes more tricky when it comes to art where originality can best be seen as inventing novel techniques of originality (Schiff, 1984). For this purpose I found Baxandall's (1985) distinction between historical, professional and personal problem situations a good intellectual tool (for a summary of the model for the purpose of educational psychology, see Kupferberg, 2018a).

Dimension IV, "Protection of vulnerable ideas" is basically a result of two types of empirical research interests I have pursued since the mid-1990s, the role of migration for scientific creativity (Kupferberg, 1998a, 2003b, 2010) and the creativity of immigrant entrepreneurship (Kupferberg 2002b, 2003c, 2004a), research supported by the Danish

Social Science Research Council and the European Commission. In both cases I found that novel ideas tend to be vulnerable at the start and must be protected in order to avoid premature death. Here geographical isolation (IV.1) often plays a critical role (Rudwick, 1996). The latter resembles the Galapagos effect, a core aspect of Darwin's complex (five-factor) theory of evolution (Mayr, 2004/2007).

But intellectual migration between disciplines (IV.2) can also function as a protection of vulnerable ideas as can "skunk works" (IV.3) a concept often used in entrepreneurship studies (Peters & Austin, 1985; Ketteringham & Nayak, 1986) as can the use of confidants (IV.4) among scholars (Gay, 1988; Browne, 1995, 2002). As I began to study artists (Kupferberg, 2012a) I found interesting similarities but also differences between these groups. A surprising discovery was that rules of the game (I.4) also seem to constrain the struggle for social recognition. The latter is dependent not only upon the creative mind (Gardner, 1993) but also upon patrons, mentors and agents (IV.5). Differentiating between these main types of "helpers" (Bruner, 1990) or "support systems" (Sawin, 1995/1997), can help clarify the detailed "mechanisms" (Elster, 2007) for how social recognition works in practice (intimate knowledge), a problem which has been poorly understood both in the psychology of creativity and the sociology of knowledge.

Having come so far, I to my great surprise, found that most of the four dimensions of the emerging field, creativity science, could be simplified even further by a fifth dimension which I call the "structure of creative processes." The latter is identical with the theory of the "four causes" originally laid out by Aristotle (Hankinson 1995, 2009; Lloyd, 1968), suggesting that the core of creativity science has existed for 2,300 years but that it has taken us so long to rediscover it (III.2).

Let us assume that creativity seeks to solve complex and paradoxical problems (Koestler, 1964; Bohm, 1998; de Bono, 1994, 2009; Boden, 1990; Weisberg, 1993, 2006; Popper, 1994b, 1999). For an educational psychologist as myself, what makes creativity interesting is that there is always a personal element (P-creativity) involved in this type of learning (H-creativity). But such creativity cannot be merely subjective. Objective aspects are also necessary, but how are the two aspects to be combined? This is the core problem that a constraint theory of creativity seeks to answer. It is important though not to forget the personal aspect along the road or we have missed the basic tensions, both cognitive and emotional, which makes creativity so interesting to study from the point of view of educational psychology. The two combined, P-creativity and H-creativity,

is what creativity science is here to investigate and what this book is mainly about.

We can describe a learner as a "problem solver" who has become placed in a "problem situation" (III.4) attempting to "get it right." (III.1). But what does that mean in practice? For this purpose it is important not to forget that all humans or problem solvers do as nature does (Popper, 1999) we start with a problem situation. This method is different from Weber's method of Verstehen for the simple reason that Weber confuses "rationality" with "rationalization." Take the example mentioned in Sartre (1965). The French teaching system is highly meritocratic. In order to get the best teaching, up and coming teachers aspiring to the best jobs, compete among the best. One of Sartre's classmates later complained about the outcome of such a competition. How could he, a Frenchmen, have lost a competition for a post in French language to an immigrant? The problem situation is very clear: the best wins (rationality) and the loser's explanation of what happened is clearly a rationalization.

But to understand what make problem solvers rationalize, we need to start with the "problem situation" (Hacomen, 2000). The reason Sartre's schoolmate lost might have been that the immigrant was better motivated and had prepared better for the competition. The schoolmate was just too lazy. But there might be many reasons why some problem solvers are successful, and others are not. This has important methodological consequences if we want to say develop a science of creativity. Thus we need to ask why Aristotle, who was a highly successful pioneering scholar in many areas, got the First principles of astronomy completely wrong (Earth-centered universe, planets moving in perfect circles, gravity as a local force). And why did he believe that eels do not reproduce in the normal way, but come about by "spontaneous generation"? Why did he claim that the natural elements such as water, air, earth and fire were all "indivisibles."

The best way to approach such issues is to ask what in a problem situation constrained the problem. Take the case of Christopher Columbus (Bergreen, 2011/2015). In order to understand why he reacted the way he did (rationalized) when he discovered the previously unknown continent America, we need to look at him as an experienced sailor from Genoa (professional, II.3) who over the years had become strongly committed (Becker, 1951, 1960; Elster, 1979, 1983; Kupferberg, 1999b, 2000, 2002a, 2002b) to the idea or project to find the shortest way to China by sailing west. This bold idea could have cost him and his crew their lives, had he not stumbled upon a new and unknown continent after a month of crossing the Atlantic (physical constraint, I.1). Having grossly

miscalculated the actual size of the Earth (knowledge constraint, I.3), Columbus believed he had indeed reached mainland China. He visited many islands and on reaching Cuba he tried to convince himself that it was part of that mainland. Grudgingly he had to give up that hope, after a mass of indisputable evidence (data, material cause, V.1) all pointed at the conclusion that Cuba was an island and not part of the mainland. Unwilling to give up his life dream, Columbus ordered everyone, from the highest officer to the lowest ship boy, not to tell the truth once they returned to Spain (rationalization).

Personal reality and objective reality (problem situation) might for several reasons fall apart. This is one of the reasons why solving problems can be very tricky and our reactions paradoxical. Why did Columbus not just admit that he had grossly miscalculated the distance been Spain and China from the start? One could just all well ask why the Germans kept on fighting foolishly or bravely, even after Adolf Hitler, their Führer, had given up and committed suicide rather than face the consequences of his political decisions as dictatorial leader for 12 years. Human intentions are very difficult to disentangle, but in order to understand what these intentions are, we at least need to acknowledge the importance of personal commitments (biographical projects, Kupferberg, 1995b) for how problem solvers tackle problem situations (III.4). The theory of the "death of the author" expects us to believe that such commitments do not matter, given that we are all mere "instances" of our national languages (Barthes, 1968/1977). But Thomas Mann also wrote in German and his book *Dr. Faustus* is certainly a very different book from *Mein Kampf.*

Columbus made no less than four journeys to the New World, but he never gave up his dream of one day presenting himself to the emperor of China. A study of his biography reveals the interesting biographical fact that Columbus already as a child (II.1) in the sea town of Genoa (physical constraint I.1), had modeled himself upon the hero of his youth, the pioneering traveler (II.4) Marco Polo. But Columbus also wanted to outdo his hero, traveling west rather than East. What stopped Columbus from reaching his goal was geography, a typical physical constraint (I.1). What kept him going was his role model or prototype (I.2), Marco Polo. But physical constraints and prototypes development constraints, do not always fall apart; they can also fit into each other. When Darwin sailed in the same direction more than 300 years later, knowledge of the physical constraints (I.1) of world geography (knowledge constraint, I.3), had advanced enough for him to know where he was going. Darwin also had a prototype (I.2) to lean on, Charles Lyell's

three-volume work *Principles of Geology*, which for all practical purpose became his prototype (I.2)

Reading the book, helped Darwin (effective cause, V.3) to solve the scientific problem of the origins of species (S-creativity). The latter had remained unsolved since Aristotle tried but failed to solve it more than 2,000 years earlier (Jones, 2001). Darwin's problem-solving capacity as a pioneer (II.4) therefore depended not only upon the fact that he got the data (material cause, V.1) right, but that he had a theoretical model to compare with observed data collected during his five years of travel, the theory of "special creation" (role model or prototype, I.2). In his autobiography Darwin calls his book *The Origin of Species*, one "long argument," against the theory of "special creation."

In science most is impersonal, both the act of leaning on theories which one can learn something from (prototypes, I.2) and which one might end up falsifying (V.4). Barthes seems to have confused this type of impersonality with the problem of motivations (I.V) which certainly are personal. Writing novels are also personal in the sense that writers are strongly committed to the role of the writer (used in a different sense in Barthes, 1960/2000) but also problem-solving strategies. In contrast to scholars, writers (effective cause, V.3) do not approach problems from a methodological point of view (V.3). They learn the relevant techniques (Morell, 2004). The basic rule (I.4) of all art is to evoke emotions (final cause, V.4). Literary techniques are here to help writers accomplish this goal. This explains why writers of fiction use the technique of hiding behind a "narrator" (Booth, 1961/1983). One of the advantages of this technique is that it allows the writer fully to absorb his or her writing self into the world of the depicted characters (what sociologists call "role-taking").

Take the first-person character and narrator of *Lolita,* Humbert Humbert who is certainly not identical with the author Vladimir Nabokov. But from this it does not follow that author of the novel is "dead." Fiction like all art is often a masked way to describe a personal experience (Strauss, 1959; Bergman, 1959). Writing a novel can be described from a mere choice of prototype (I.2). It becomes merely a "formal cause" (V.2). Compare the theory of "art for art." Nabokov himself seems to have been strongly committed to this formalist theory of art (for a critique, see Carroll, 2005, 2010), but this as all creative choices had its reasons. Art is about emotions (Hjort & Laver, 1997) and it is here we should start. But whose emotions are we talking about? But Nabokov is cheating. There are so many professional resemblances between the narrator and the author (bookish professor of literature,

knowledge of inner life of American motels, experience of driving cars on the vast road system of this continental-size nation) that we might be fooled to believe that writer and narrator are one and the same (Roper, 2015). In reality the character with whom Nabokov must have identified himself most strongly was the victim (Lolita) and not the predator (Humbert Humbert).

The biographical facts are the following: as a young boy in tsarist Russia, Nabokov had been seduced by a much older and dear uncle (Boyd, 1990, 1991). Having tried to write himself out of this dreadful memory, Nabokov finally found the form which best described the motives but also the rationalization of his uncle legitimizing how the uncle could allow himself to commit such a gruesome act of betrayal (mirror) without the readers of the novel ever suspecting its real, biographical source (masking). Nabokov wrote the novel while living in North America long after tsarist Russia had ceased to exist (change of historical problem situation, III.4). Nor was he a young boy but a professional teacher of Russian literature (change of professional problem situation, III.4). But all of these were devices, techniques (V.3), which allowed Nabokov, the victim, to better understand the rationalizations of the perpetrator by putting himself in the shoes of his dear uncle, disguised as a whimsical professor of literature suspiciously similar to the author's professional persona.

Misleading the reader was made easier by the framing of the novel as a confession made in front of a court. But fiction never seeks to tells the "truth" (Lamarque & Olsen, 1994). A novel is never an exact copy of biographical reality. Fiction writing is here to evoke or express emotions (the two are not necessarily identical, see Levinson, 2006, 2016; Carroll, 2010), by transforming facts into fiction (V.4). Creativity is paradoxical. But it is also complex. This is the reason we need to be very careful when we compare pioneering work in science, art and technology.

The book is structured in three parts. Part I, *In Search of Creativity Science*, consists of the introductory Chapter 1, "Disciplines in the making: What is science, what is creativity and how are the two related?" Part II, *Elaborating the Theoretical Model* consists of five chapters, each of which tries to deepen our understanding of how creativity is constrained. It can partly be seen as a critical test of the model presented above, partly as a way to clarify the guiding concepts (compare Torrance's well known theory of creativity as "elaborations"), partly as inspiration for readers to find their own examples or whatever type of problem within creativity science that interests them (the role of the reader). Here my work with art teachers at Malmö University and Gothenburg University during the years 2006–