Chapter 1
On the Psychology of Creativity

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Creative thinking—this combination of words raises the question of whether thinking is possible without creativity, and whether creativity can occur without thinking. But one might also ask: Is this miraculous ability called creativity compatible with the rational act of thinking? Are not irrational elements more important in explaining creativity? Are creative processes accessible with scientific methods at all? Has every human being a creative potential? Instead of providing answers to these questions directly, I structure my paper around the following lead questions:

1. Which methods of analysis are available to researchers working in the field of creativity? What is the source of researchers' knowledge about this issue?
2. What does creative thinking look like, and how does it manifest itself?
3. What are known determinants of creative thinking?
4. Why is there a need for creative thinking?
5. What can be done to improve creative thinking?

Space limitations preclude detailed answers to all these questions, but after reading this article you should feel a bit more informed about the above-mentioned topics.

According to Simonton (2000), creativity is present in all fields of human activity. For example, the building in which you are now was designed by an architect; the clothes you wear were designed by a fashion designer; the chair you are sitting on was designed in a perfect way (hopefully ergonomically); and the book you are reading was designed and produced. Behind each of the things around you, which are normally called *artifacts*, is a person who has created these things with a specific intention in mind.

This omnipresence of creative products in the environment contrasts the comparatively small amount of research that has been conducted on creativity. For many centuries, creative activities were seen as something miraculous, something that comes over a person and needs no further explanation. With the advent of empirical psychology at the end of the nineteenth century, those assumptions

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about mysterious creative acts slowly changed. An impressive increase in research took place in the 1960s and 1970s, stimulated by an important paper written by Guilford (1950), who argued the need for more and better research on this creativity. But besides Guilford's call for research by the scientific community, there was an event outside academia having at least the same importance or even more: space flight and the endeavor to discover the moon and outer space. Historically, creativity research gained huge impetus from the "Sputnik shock" of the Americans (see Amelang & Bartussek, 1997, p. 260). On October 4, 1957, a small satellite started from the Russian space shuttle platform *Baikonur* and orbited the world—a shock for the Americans who believed their nation to be the leading technological force in the world.

Out of concern that the United States was not producing enough creative scientists, large programs (for example, "Headstart") were immediately launched, an effort that helped identify and support gifted people. With the advent of this research, many new insights about creative processes were gained and came to form psychologists' current point of view definitively. Before going into more detail, I first have a look at the research methods for assessing creativity.

What Types of Creativity Assessment Are Available?

A psychometrically sound assessment of a person's creativity is a difficult enterprise. However, many psychologists have tried to meet this challenge. A comprehensive survey of tests for the measurement of creativity is found in Krampen (1993). In general, there is a distinction between language-based and language-free procedures. Language-based procedures require performances that result in verbal utterances. For example, Guilford's concept of divergent thinking (see below) produced a test labeled "Unusual Uses," which required respondents to name as many uses for a given object as possible. The common brick, for instance, can serve as material for building houses but also as a bedwarmer (after heating it), as a weight in a car's luggage trunk to keep the vehicle from skidding on slippery roads, as a weapon against enemies, or as part of a bed made out of bricks. Flexibility of thinking shows up not only in the simple quantity of different uses named but also in the number of different categories like building material, storage medium, weight, or weapon. Aside from flexibility and fluency, there is also an interest in the originality of responses. Using the brick as a sponge is not obvious to everyone and is therefore a more original idea than its proposed standard usage for building.

Another language-based measurement of creativity, the Remote Associates Test, was proposed by Mednick (1962). The task for the respondent is to find a common link between three stimulus words with a low associative link between them. For example, the common link between *humor*, *pitch*, and *night* is the color black. This procedure measures the flexibility of associations. For sure, one can ask whether this procedure really tests creativity. The procedure described assesses the availability of conceptual structures in semantic memory, which is not unimportant

for creative processes, but creative processes are not sufficiently described by this conceptual availability.

Language-free tests for assessment of creativity rely mainly on drawing activities required of the respondent. On the Torrance Test of Creative Thinking (Torrance, 1966), given pictures are to be either completed, newly combined, or produced. Figure 1.1 shows an example for each of the three tasks.

Neither language-based nor language-free assessment procedures have really been able to stand up to criticism. Hussy (1986) went as far to as say that "those measurement instruments for the assessment of creative processes have to be qualified as ineffectual" (p. 78). Even though the psychometric assessment of creativity is not possible by means of reliable and standardized diagnostic procedures, there do exist experimental procedures, which should be mentioned briefly.

Important insights based on experimental studies come from the area of analogical transfer (see Gentner & Stevens, 1983; Holyoak, 1985, 2005). The main question is whether respondents detect the structural equivalence between two different domains spontaneously or rather by means of the experimenter's help. For example, think of the analogy between the solar system and the atomic system (given by the fact that in both systems single elements run on a circular curve around the core and are attracted by that core). Analogical reasoning helps transfer some aspects from the source domain to the target domain. Of course, this facet of creativity is not the whole picture. Results of analogical transfer show the difficulty people have when trying spontaneously to detect the parallels in the deep structure of two domains

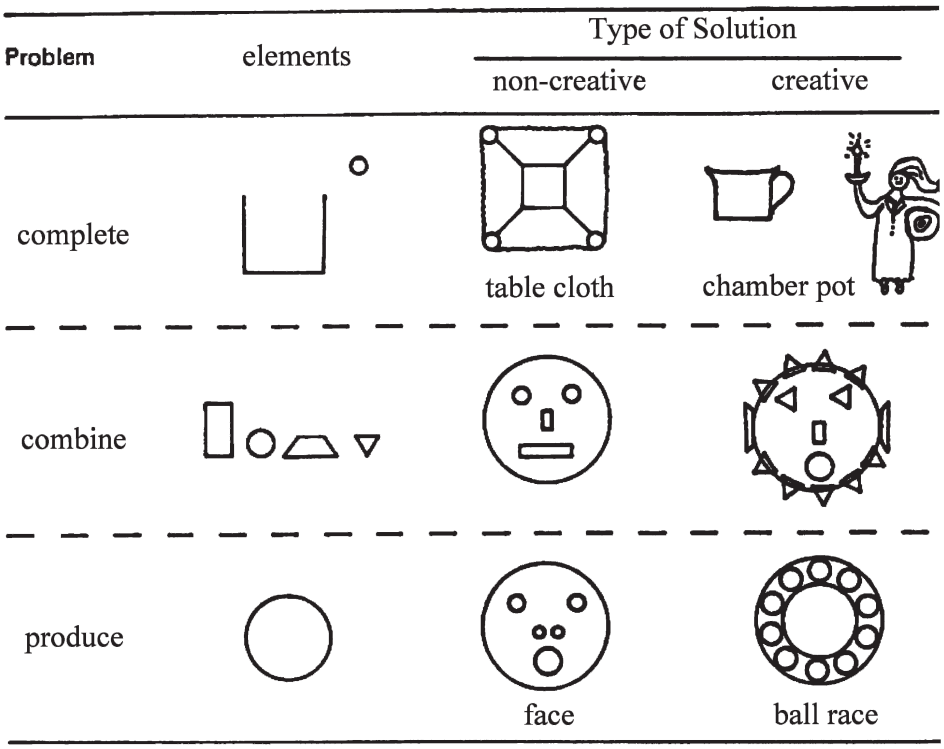

Fig. 1.1 Three examples of creative tasks (completion, combination and production) with nonverbal elements and two types of solution (creative and noncreative)

that are dissimilar on their surface. If hints about the similarity are given, attributes of the source problem can often be used for the target domain. An example is the transfer of solution strategies from one domain to another.

Within the context of scientific discoveries, the principle of induction, which is used in analogical problem-solving, comes into conflict with the principle of falsification. Scientists who want to discover things by means of induction and the use of as many analogues as possible simultaneously have to follow the principle of falsification, which requires strong tests of hypotheses (Bredenkamp, 1980).

The above-mentioned test procedures and the assessment procedures from the area of analogical transfer are not the only instruments and techniques available for research in creativity. Hocevar and Bachelor (1989) mention the following additional techniques: (a) personality inventories, which allow the assessment of certain psychological attributes; (b) biographical inventories, which ask for background information about a person and his or her developmental conditions (the role of biographical analyses as sources for creativity research is stressed by Gardner [1993]); (c) scales for the assessment of attitudes and interests, which ask for specific preferences; (d) person-related assessments by teachers, peers, and supervisors who have seen the rated person for long time periods and know the person well; (e) eminence ratings (e.g., citation frequency, space in biographical texts, and awards); (f) checklist-based self-reports about special performances; and (g) ratings of creative products.

Each of these methods has its pros and cons, so the search for a single type of creativity assessment is misleading. There is no one simple measurement of creativity. Only through a combination of different approaches can a reliable picture emerge. How this picture looks is explained in the next section.

What Is Creative Thinking?

There is the already mentioned popular assumption that creative thinking might be the result of a sudden inspiration, that the solution to a problem suddenly appears in front of the mind's eye (Boden, 1991). Contrary to that popular assumption, psychological research as early as Wallas (1926) indicates that creative solutions are the result of an enduring and long process (Weisberg, 1989). At least the following five phases of creative processes are traditionally mentioned.

Phase 1: Preparation

It is difficult to have a good idea without having worked intensively in the domain under question. Creative inventors know the most important principles of their discipline, and all creative artists have dealt with the products of their predecessors and contemporaries. Creative scientists not only have a long history of ideas behind them but have also reached a high degree of expertise in their domain (Ericsson, 1996). Intensive preparation is a necessary ingredient for important discoveries and

creations. Among expertise researchers (e.g., Ericsson, 1996), a saying goes that, roughly speaking, someone who has spent more than 10,000 h on a special topic can be called an expert.

Phase 2: Incubation

Sometimes it is helpful to stop working on a problem for which a creative solution is needed. During the phase of not working on the problem, the brain nevertheless is at work. Incubation becomes strong after the previous phase has laid the groundwork for a kind of "mental infection."

For a long time, it was unclear what happened during this incubation phase. The dynamic of human memory is responsible for the processes of change in associative connections between ideas and representations over time (Finke et al., 1992). The processes during the incubation phase remain below the level of consciousness of the creative person and cannot be influenced actively. But research on the cognitive unconsciousness has provided experimental data showing that intuitive information-processing occurs (Dorfman et al., 1996; Smith et al., 1995; Ward et al., 1997).

Phase 3: Insight

At a certain point in time, a recombined association passes through the threshold of consciousness and produces a flash of insight—the illumination. Gestalt psychologists have called this moment the " 'Aha!' experience." Occurring after appropriate preparation and after some time of incubation, it is the moment of the creative product coming to mind. In medical terms, one has reached the "crisis."

Phase 4: Evaluation

The creative insight has to be evaluated—not all creative insights are really useful. Evaluation is the place for norms and values, which help decide whether a new idea should be discarded or propagated.

Phase 5: Elaboration

From the first idea of an electric light bulb to its first prototype, a long journey had to be taken. Thomas Edison is often quoted for his statement, "Genius is 1 percent inspiration and 99 percent perspiration"—meaning that a lot of force is

necessary to make a creative idea work. On the way from the first idea to the final product (a picture, a technical product, a text), a lot of surprises and changes can occur as well.

The above-mentioned five stages of a creative process represent normal stages of information-processing. The opening question, "What is creative thinking?" now has its first answer, which I want to enrich by one further idea. This idea comes from the differentiation between convergent and divergent thinking introduced by Guilford (1967). By *convergent thinking* Guilford means logical procedures, which analytically lead to a certain solution. Divergent thinking, which is predominant in creative processes, is characterized by unusual associations, a shift of perspectives, and the enlargement of the horizon. Normally, a problem-solving process starts with the generation of a sizeable number of ideas (divergent thinking), from which one or more are later selected for elaboration (convergent thinking).

A further conceptual classification differentiates between productive and reproductive thinking. Even if a strong demarcation is not possible, one can describe the endpoints of the scale precisely. With *reproductive thinking* psychologists describe cognitive processes that have only to be reproduced for solving specific problems. Suppose, for example, you want to multiply two numbers, say, 369 × 264. Even if the exact operation with those two figures has been never done before, the way of solving the problem (the application of the multiplication process) is known and can be reproduced. By contrast, *productive thinking* means that a new way of arriving at a solution has to be found. It is this productive aspect that makes creative processes similar to problem-solving processes. Both constructs have indeed much in common, especially when it comes to complex problem-solving (Funke, 2006).

What Are Known Determinants of Creative Thinking?

Historically, there are three different perspectives on creativity research: (a) the creative person, (b) the creative process, and (c) the creative product. Because some insights about the creative process were mentioned in the previous section, I now go into more detail on the creative persons and their environment. Some statements about the creative product are also made.

The Creative Person

Is it necessary to have extraordinary intelligence for producing creative products? This question was answered by Galton (1869) from the genetic point of view and by Terman (1925) from the perspective of gifted persons (see also Subotnik & Arnold, 1994). Sternberg (1995) concludes, "Bright but not brilliant" (p. 366), which should be read as follows: Above a certain threshold of intelligence, an increase in this ability has no further implications for creative performances. Getzels and Jackson

(1962) have set this threshold at an IQ of 120. The assumption underlying one's conception of intelligence should not be that there is one single general intelligence but that there are multiple intelligences (verbal, logical, spatial, musical, motoric, personal), as formulated in Gardner's (1983) conception or in Sternberg's (1996) ideas on successful intelligence consisting of analytical, creative, and social competencies.

Besides intelligence, there is the more general question concerning the predictive value of personality traits of creative persons. Martindale (1989) and Simonton (1999), for example, point to the importance of variables such as independence, nonconformism, unconventional behavior, broad span of interests, openness for new experiences, risk-taking, and cognitive and behavioral flexibility. Also, the old debate on genius and madness finds some support because creativity is linked to a certain degree to psychopathology (see Eysenck, 1995; Ludwig, 1995). But those pathological behaviors are not necessarily conditions for creativity—on the contrary, sometimes the creative person demonstrates how psychological deficits can be used in an adaptive way (see Csikszentmihalyi, 1997; Ludwig, 1995; Rothenberg, 1990).

With respect to age, it is often said that creativity has a peak when a person is between 20 and 30 years old and decreases thereafter (e.g., Lindauer, 1993). As far as researchers know today, such a pessimistic statement seems unjustified because many factors help maintain creative production at a high qualitative and quantitative level (for gender differences, see Kämmerer, 2000).

The Creative Environment

Life-span oriented research demonstrates that creativity does not always grow where the best and optimal conditions exist. On the contrary, in many cases challenging experiences seem to increase the creative abilities of a person (Simonton, 1994). This finding is interesting because it shows the importance of a creative environment in addition to the creative person. The environment consists of other persons who are creative in a similar way in the same domain. Martindale (1990), for example, shows that writers orient themselves to what other writers (and selected critics) do. These structures were found by Martindale also in art and music. This research shows that it is not enough to concentrate on a single creative person when trying to understand the creative product.

Aside from the influence of environment, there is also a sociocultural influence (Zeitgeist) that belongs to the creative environment. In history, many countries have experienced a flowering of creativity upon the introduction of democracy and liberal systems, as was the case in ancient Greece. According to Simonton (1994), this pattern may be attributed to tendencies to anchor heterogeneity instead of homogeneity. Cultural diversity seems to be an important factor for improving creative environments. Historiometric analyses of creative products seem to support this view (see Simonton, 1984).

The Creative Product

With respect to the creative product, which is a result of creative thinking, two criteria are seen as important: (a) novelty and (b) the usefulness of a particular solution to a problem. Perceived novelty depends on both the evaluating person and social consensus; a creative innovation can have novelty even if it turns out later that this invention has already been made elsewhere. In this vein, Boden (1994) refers to the difference between personal novelty (P-creativity) and historical novelty (H-creativity).

The second criterion, usefulness, ensures that not everything new is simultaneously labeled a creative product. For a product to be called creative, some of the constraints posed by the problem have to have been solved in an optimal way. For example, if one wants to illuminate a dark room in a building, large mirror systems seem less useful than the electric light bulbs used nowadays.

Besides those main criteria, Lubart (1994, p. 291) mentions three subsidiary ones: (c) quality, (d) importance, and (e) history of discovery. With these additional criteria the gradations of product creativity can be conveyed. For example, it makes sense to say that a qualitatively outstanding new product is better than a half-baked product. The importance of a product is also related to its scope. For instance, a new car-alarm system that distinguishes between animal and human contact with a vehicle and thereby avoids false alarms has a lower scope than a new method for cooking with solar energy. Lastly, the history of discovery can change an evaluation if one learns that the invention came about by pure chance instead of hard work. Normally, respect for creative products increases if they are known to have resulted from a very ambitious long-term effort.

The evaluation of a creative product depends not only on historical context but also on the social reference group. This perspective produces a large span of different evaluations of the same creative product. According to Lubart (1994), different background experiences are responsible for that diversity. Art teachers, for example, who have seen many pictures, evaluate a picture by a child more critically than do the child's parents, who are totally enthusiastic about the first products of their son or daughter but who have no real comparison available. Also, different weighting may be responsible for this phenomenon. Depending on the emphasis given to the different criteria, the resulting span of evaluation can be explained.

Why Is Creative Thinking Needed?

The necessity of creative thinking is not open to question if one ponders the continuation of this world. Even though some products of that creativity confront humanity with the greatest ever potential for self-destruction, creative human activity is also precisely what is important for the survival of the human race. Is it necessary for experts to take lessons in creativity? For sure, because experts, especially, can become blind to new ideas (*déformation professionelle*). As early as 1942, Luchins demonstrated with his water-jug problems that human respondents develop certain

strategies very quickly and subsequently keep using them even under conditions where easier methods are available.

Gestalt psychologists labeled this effect *functional fixedness* and *Einstellungseffekt*. Frensch and Sternberg (1989) demonstrated its influence in an interesting experiment in which bridge players representing different levels of expertise were pitted against controlled computer opponents. One half of the games were played under normal game conditions; the other half, under either superficially or fundamentally changed rule structures. It turned out that the experts suffered from fundamental rule changes more than the novices did but that even then the experts were better and faster than the novices. Nevertheless, these results show that experts have difficulties adjusting their knowledge to new conditions. Sometimes it might be better to know less (see also Gigerenzer, 2006).

By contrast, Krems (1995) describes a series of experiments in which novices and experts (interns, mechanics, and programmers) had to build hypotheses and draw conclusions from given symptoms. Across all analyzed domains it was consistently found that (a) experts modified their hypotheses much more often than novices did when searching for causes, (b) experts were less prone than novices to verification (i.e., more intense attendance to supporting information than to falsifying information), and (c) the ability to change hypotheses flexibly was based more on case-based knowledge than on rule-based knowledge and was therefore bound to certain domains of knowledge and the experience that one had therein. If one looks into these results, the flexibility of experts might be better than was indicated after the experimental study by Frensch and Sternberg (1989).

The necessity of creative thinking is due not only to the potential blindness of experts when solving complex problems. In a world in which the provision of food and water to an exponentially growing human population is becoming more and more important, in which the military potential for destruction is enough to kill this planet more than once, and in which anthropogenic emissions are increasingly interfering in Earth's very sensible natural cycles (see Wissenschaftlicher Beirat Globale Umweltveränderungen, 1999), the necessity of human creative potential is that it seems to be the only ray of hope. Had it not been for creative processes, the whole history of humankind would not have taken the course that researchers have been able to reconstruct.

Therefore, it is important not only to study the conditions of creative activities but also to look for active improvements in creative thinking. Parents, teachers, schools, and universities are in a certain sense institutions of socialization and can do much to improve creative behavior. The final section deals with this training potential.

What Can Be Done to Improve Creative Thinking?

Many programs have been developed for the improvement of creative thinking. Even though there are researchers who believe that creative potential is given to only a small proportion of humans, a larger group of creativity researchers believes that every person can do something to develop his or her creativity. Amabile (1983,

1996) points to the importance of freedom to decide, unexpected rewards, a positive climate for renovation, and a stimulating milieu as factors that improve creativity. On the other side, she names pressure from colleagues or from evaluation as factors that decrease creativity.

According to Sternberg and Lubart (1991), individual and environmental factors have to be combined. Sternberg (1995, pp. 363–364) formulates several recommendations and attitudes in order to increase creative output:

1. Develop a high motivation for being creative in a certain domain. Do not let yourself be captivated by extrinsic motivation (e.g., money) as reward for creative productions—money corrupts! In general, the motivation for creative acts should come from within a person (intrinsic motivation).
2. Show a certain degree of nonconformism; rules that hinder your creativity may be disregarded. But not all rules and habits are bad. With respect to your own performance, the highest expectations and strong discipline with respect to production are necessary.
3. Be convinced fully of the value and importance of your creative action. Criticism and deprecation from others should not bother you. Self-critique should monitor your own progress and how to improve it.
4. Carefully choose the topics on which you focus your attention—look especially for those not highly appreciated by others.
5. Use analogies and divergent thinking as much as possible. But creative thinking also always has an eye on old traditions, if only to disagree with them.
6. Look for colleagues who help you fight against convention and test new ideas. Search for comrades-in-arms who encourage you to take risks.
7. Assimilate as much knowledge about your domain as possible. This strategy helps prevent you from inventing the wheel for the hundredth time. Try not to be absorbed by these data.
8. Make the strongest commitment to your creative enterprise.

As this list shows, no one factor is made responsible for creative activities; they arise from a broad bundle of conducive conditions. In addition to a creative environment, knowledge, personality, intellectual processes, and intrinsic motivation are necessary ingredients. Sternberg and Lubart (1991, 1995) have labeled their concept “Investment theory of creativity,” suggesting that a creative individual “buys low and sells high.” Buying low means picking up and creatively developing an idea underestimated by one’s contemporaries. Selling high means maximally exploiting the developed idea (financially and otherwise) if you convince other persons of its value.

Yet another part of improving creativity is an important aspect of many training programs, namely, that of putting evaluation on hold in the phase of generating ideas. This objective helps prevent summary rejection of original ideas. If evaluation comes into play too early, it can be a strong barrier against innovation. Ahrens (2000) describes the negative consequences of that premature evaluation has on innovation at British universities. Postponing evaluations is a central part of a method called “brainstorming” developed by Osborn (1953). A small group of

persons (6–8) is given the task of generating ideas for 60 min. During this period no critique or discussion is allowed. Afterwards the noted ideas are checked and three questions are asked: Is the idea immediately ready to use? How much do we have to develop the idea? Is the idea useful in principle? The distinction between production and evaluation made by Osborn has been very successful in the context of creative processes (see Taylor, 1964) and has been enriched by many variations (see Seiffge-Krenke, 1974, pp. 264–265). Brainstorming is still a very popular technique used in many companies (see Farr, 1990). Time will soon tell whether "electronic brainstorming" (Roy et al., 1996) is as useful as the older technique.

The history of science demonstrates that creativity depends not only on persons but also on available knowledge within a certain domain. As soon as basic ideas become well-known in a "young" discipline, there is an explosion of creative ideas in that domain. If, after some time, knowledge has increased drastically and the gaps in that knowledge have narrowed, creative inventions also decrease. The domain develops from a positively accelerated development (increasing processes) into a negatively accelerated type of development (breaking face) where the ceiling is reached.

Concluding Remarks

The ideas presented in this chapter explain the necessity of seeing creative thinking as an interaction between a creative personality and a creative environment. The ideas show also that creative performance cannot be prescribed, that it is a treasure to be carefully cultivated, especially in schools and universities. Given the entire accumulation of problems on planet Earth, a major movement is necessary to concentrate humanity's forces on positive goals. Especially with respect to the psychology of creativity, people have to accept that such an endeavor cannot be sustained by individual geniuses.

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