

Chapter 2

Three Creative Mental Operations

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If we would like to describe what a guitar is, we could focus our attention on the physical features of such an object and/or on its functional properties, as well as on familiar notions associated to it. The definition which we can find in a dictionary may be a relevant example of such a way of describing a guitar: “Popular musical instrument, widespread in Latin countries, especially in Spain. It has a flat back and a long neck with a fretted fingerboard. The wooden case has a round hole in the center. It usually has six strings, played with a pick or with the fingers” (Wikipedia). Presumably, nobody would label this description as creative. A creative description of a guitar might be provided by a poem, such *The six strings*, written by Federico Garcia Lorca:

The guitar makes dreams cry.
The sob of the lost souls
escapes from its round mouth.
And, like the tarantula,
weaves a big star
to catch the whispers which shiver
in its black wooden cistern.

Why is this way of describing a guitar so different from the previous one exemplified by the dictionary definition? Firstly, the creative approach involves *widening* the mental framework in which the entity to be described is included. In the above reported poem, such a framework does not concern the more blatant aspects of the guitar but further, nontrivial aspects (such as the psychophysiological reactions – such as dreaming, crying, and sobbing). Secondly, the creative approach involves

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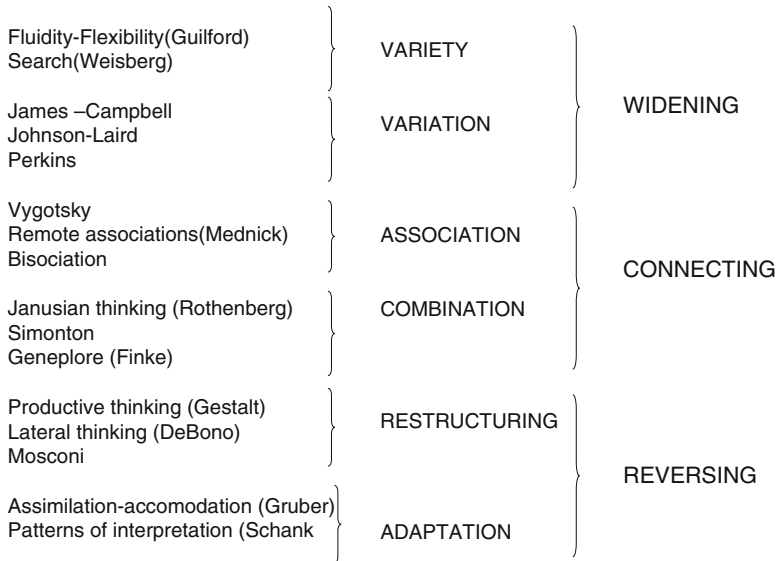
connecting different frameworks: For instance, in the case of *The six strings*, the framework of the human body (the round mouth), as well as the framework of the spider (and its activity, such as weaving), is superimposed to the physical shape of the musical instrument so to lead one to map meanings, originally associated to the former, to the latter one. Thirdly, creativity involves *reversing* the usual framework: according to the common view, a person employs a musical instrument to express his/her feelings; emotions rely inside the person, and an instrument such as a guitar is meant as a tool to externalize and communicate them. According to Garcia Lorca, instead, feelings are inside the guitar. Thus, in the poems, the traditional framework is reversed: the source of feeling is the guitar but not the person.

By starting from the suggestions provided by Garcia Lorca's poem, we can wonder if the three mental operations mentioned above – widening, connecting, and reversing – can be conceived as the three basic processes underlying creative thinking. *Widening* concerns the tendency to keep an open mind; to be aware of the great number of elements that can be identified in a given situation; to recognize possible, not obvious, meanings; to discover hidden aspects; and to overcome apparent constraints. *Connecting* refers to the capacity to establish reciprocal relationships among different elements, to draw analogies between remote things, to combine ideas in odd ways, and to synthesize the multiplicity of disparate elements into an overall structure. *Reversing* consists in changing the perspective, assuming a different point of view, seeing things by inverting relationships between their elements, asking original questions, and imagining what should happen if unusual conditions occurred. Due to the need to have adequate general theories of creativity (Sternberg, 2001), this chapter will try to show that most psychological theories about creativity can be fitted into a model which assumes that widening, connecting, and reversing are the core operations involved in creativity (Fig. 2.1) (see Antonietti, Colombo, & Pizzigrilli (2011) for the application of the WCR – widening, connecting, reversing – model to creativity testing and training).

Widening

The idea that creativity involves widening the mental framework is shared by many theoretical perspectives. Starting from Guilford (1950) and according to the factorialistic perspective, creativity is linked to the ability to produce many ideas, so leading individuals to assume a broader mental perspective. This ability is characterized by the richness of the thinking flow (fluidity) and the ability to follow new directions (flexibility) in order to achieve uncommon and original outcomes. How can such a goal be achieved?

According to Weisberg (1993), a mental framework can be widened by search processes which increase the variety of the ideas to be considered. This author, by analyzing cases of scientific discoveries and technological innovations and production of artistic works, highlighted that creativity always started from existing ideas that have been modified to fit the specific problem or goal in question. The existing



Widening

Fig. 2.1 Prospectus of some main theories of creativity

knowledge provides the basic elements with which we construct new ideas. However, so that such a construction can take place, the old ideas should be changed in order to allow persons to have a highest number of ideas, hopefully different one from the other. According to Weisberg, this kind of changes, aimed at introducing variety in the current mental framework, goes beyond the simple repetition of past responses in the past since it is prompted by the failure of previous attempts and from information so acquired. In fact, information that the person gradually gets while trying solutions that come to mind leads him/her to change the direction of reasoning. Creative thinking is based on a search process which moves from the continuity with the past: we face new situations based on what we have done previously in similar or identical situations, and novelty arises in the form of variations of old themes.

Variation

Variation is thus a strategy to make changes in existing ideas. In fact, by varying the existing idea, I can create new ones, so widening the range of opportunities at my disposal. Already in 1880, William James wrote that new concepts arise from accidental variations of mental activity, which can be either accepted or rejected. This view was taken by Campbell (1960), who claimed that creativity involves variation,

selection, and retention. According to Campbell, in fact, the basis of creative thought is a process similar to that underlying evolution. The production of an innovative idea follows the previous generation of many inadequate ideas. As a consequence, the greater is the number of ideas found – most of which later prove to be unsuitable to the solution of the problem at hand – the greater is the probability that an interesting idea emerges.

Such an “evolutionary” view of creativity, which leads to understanding it as a process of change and selection, has been recently revived by Johnson-Laird (1998). According to this author, creative products result from preexisting elements which are varied in order to create something new. The changes that are produced are subject to three types of selection: neo-Darwinian, neo-Lamarckian, and multistage. The first type of procedure that governs creativity is defined as *neo-Darwinian* since in a first stage ideas are generated randomly and in a second stage they are evaluated according to certain criteria. Only the ideas that pass this evaluation, namely, that meet the restrictions placed on this second phase, “survive.” According to the *neo-Lamarckian* procedure, instead, the production of ideas is guided by a criterion: in this case, ideas are generated only within a predetermined area. There is also the possibility of a *multistage* procedure when certain criteria are used to generate ideas and others to select them. More precisely, the ideas are produced early in the light of a criterion, but, because they are inadequate, it is necessary to apply additional selection criteria.

Even for Perkins (1988), innovation is a process of variation. For this author, however, changes cannot be accidental. Although the basic mechanism is Darwinian – involving the generation of alternatives, selection of the most effective ones, and their preservation – there is an important difference with respect to natural selection: the creative process is not “blind.” In fact, if you were blind to the alternatives, an excessive number of them should be generated to find an interesting one. Another aspect that differentiates the creative process with respect to biological selection is, according to Perkins, that in the former the choice of alternatives takes place not only according to survival criteria but on criteria such as elegance, parsimony, originality, power, truth, and interest. Moreover, in the case of creativity, conservation implies not merely a passive retention of ideas but also the reflection and the construction of further progress.

Connecting

The second operation suggests that creative ideas can emerge from unusual combinations of known ideas. We have to keep in mind that many mythological creations have an underlying associative mechanism of the kind described. For instance, the siren resulted by the association between woman and fish as well as the hippogriff from a bird associated with the horse: in both cases, beings which fail to share common characteristics and live in very different environments were put in reciprocal relationship. The association between different elements, which naturally would not

be linked to each other, does not happen only in cases of eminent creativity but also in everyday life. In the absence of suitable instruments (e.g., color papers and wires), the student of the first case linked the problem of making a lantern with an object – an empty coca cola tin can – that is routinely used for containing drink. The student associated the empty coca cola tin to the celebration.

Association

Already in 1932, Vygotsky had formulated a view of creativity based on the concept of “association.” Creative activity was meant as resulting from associations among elements already known or previously acquired, which leads to the production of new realities. The creative process, according to Vygotsky, would develop in the following phases:

- Firstly there is the moment when people receives, stores, and accumulates, through experience, data, and information from the environment.
- Once acquired the materials, a process of dissociation occurs: the existing object or concept is broken into parts; some are placed in relief, and others are relegated to a secondary plan.
- A process of internal revision – in which the broken parts of the original material undergo deformation, amplifications, and reductions – follows.
- Then an associative phase, in which the parts of the original material are re-elaborated so that other elements are connected in the mind of the person, takes place.
- The result is “translated” into workable products or communicated to others.

Through this process, elements drawn from previous experience are transfigured by the imagination so to give rise to ideas or objects before unknown which can, in turn, transform reality.

This perspective was resumed by Mednick (1962) who claimed that creativity results by the so-called *remote associations*, which allow individuals to connect ideas which are distant from each other. According to him, creativity is the ability to combine, in a new and unusual way, disparate elements that apparently have little in common. Other authors have recognized association as the fundamental process of creativity. For example, Koestler (1964) called *bisociation* the operation consisting in bringing together two creative reasoning structures commonly regarded as incompatible, or to find similarities between different fields of knowledge. Innovation emerges as soon as two different levels of reasoning overlap, so producing something that did not exist. In support of his view, Koestler mentions the well-known anecdote according to which Newton would have discovered the law of universal gravitation after watching the fall of an apple from a tree and trying to imagine the behavior of the apple if it was dropped from increasing heights from the ground up to reach a height equal to the distance of the moon from our planet. The intuition of Newton consisted in having thus put a relationship between

two planes of reality seemingly unrelated: the apple and the moon. Another example coming from bisociation is the invention of the system of movable type printing: Gutenberg would have seen how, during the harvest, the action of the press is exercised over all the grapes packed in it; this suggested the use of a similar mechanism to make sure that the characters leave a trace of the letters printed on the page.

Combination

Another form of connection involved in creative thinking is described by Rothenberg (1979). He proposed the existence of a form of thought – called *Janusian* (from Janus, the Roman god of the two faces looking in opposite directions) – which marks the genesis of artistic and scientific creative products. It consists in composing the terms of an antithesis, namely, in being able to hold simultaneously two opposite elements and attempting, against the initial inconsistency or paradox, to integrate them. The reconciliation of opposites would not be a result of unconscious processes, but of conscious and deliberate strategies: the individual chooses a particular pair of opposites and try to integrate them. Rothenberg cites, as evidence of his theory, autobiographical accounts of scientists and artists, the analysis of the preparatory notes or prerelease versions of literary works and paintings, and a long series of interviews with artists and scientists relating to the mental processes activated during their work.

In recent times, Simonton (1999), in order to give an account of the creative process, postulated the existence of *mental elements*, that is, the fundamental psychic units, such as feelings, emotions, concepts, and ideas. Combinations of well-organized and stable mental elements give rise to *configurations*. Following a process of “consolidation,” configurations can become so cohesive that they can be treated as a unit. The more configurations are integrated, the more psychic functions are consistent and organized. Units are usually combined together permutations. In these permutations, what is relevant is not so much the elements which are combined but the way in which they are combined. The permutations are then selected according to some criteria. First of all, permutations vary according to the degrees of stability: at one extreme, we have the most unstable configurations, called *aggregates*; at the other extreme, the configurations are highly stable. Another selection criterion is the communicability: because the configurations must be expressed in symbols (verbal, visual, etc.) in order to be shared by others, permutations that offer such opportunities are preferred. A third criterion is social acceptance: a permutation, to be preserved, must be able to influence others or to exercise a kind of leadership in an area. On the basis of this conception of the creative process, Simonton argued that creative people have first of all many mental elements available: the greater is the number of these elements, the greater is the number of possible permutations. In other words, creative people are those who have a greater chance of producing new combinations of mental elements. Secondly, creative people have a particular skill in performing random permutations. This should help them to create a rich mental structure of interconnected elements. Consistent with what has been exposed,

Fig. 2.2 An ostrich created by reassembling the pieces of a motorcycle creatively



Simonton proposed to differentiate individuals along two axes: the number of units owned and the strength of the connections among them. The higher the number of units, more – as mentioned – is the possibility to do permutations; the lower is the strength of the connections that link the units, the greater is the likelihood of establishing new combinations. The creative person hence has a mental structure whose elements are highly connected to each another by nonconsolidated associations. The creative person has a distributed mental network where there are more ways to move from one element to another.

The mechanism of connecting disparate elements can take on a further form. In some cases, we can combine among themselves the available elements in a different way than usual, resulting in something original. For example, consider the way in which the pieces of a motorcycle were linked together to create a kind of ostrich, as done by the students of the University of Amiens, which they explained their creative product in the university atrium (Fig. 2.2).

This aspect of creativity is stressed in the *Geneplore* model (Finke, Ward, & Smith, 1992; Ward, Finke, Ward, & Smith, 1995), according to which original and innovative outcomes can result by a process in two phases: the *generative* phase, in which an individual constructs mental representations, and the *exploration* phase, in which these representations are interpreted in order to lead them to suggest creative discoveries. In the generative phase, the representation results as a consequence of

an associative process through which elements are combined together. In this phase, the emergence of a creative product is facilitated if elements are combined in unusual ways. Finke (1990) devised a procedure to foster such a process: he showed participants some simple geometric shapes and then asked them to mentally combine the shapes with the goal to achieve an overall form with a final meaning or a final object that has some usefulness. He found that the combination of mental images is particularly effective in inspiring original ideas.

Reversing

Reorganizing

Reversing is the third operation which is assumed laying at the basis of creativity. Such an operation can be exemplified as follows. During the second world war, when Nazi occupied Denmark, they wanted to impose the obligation in that country for Jews to wear the armband with the Star of David. The Danish king was totally contrary, but had no power to oppose this law. Forced, he signed the requirement to bring this despicable badge of distinction, but he first began to wear the armband. In this case, it was impossible for him to do what he wanted (not signing the edict); thus, he made the opposite: the king, instead of opposing to what the German occupiers forced him, conformed more than was required. In doing so, he found a decent way out of a situation that looked like a dead end: he expressed his opposition against the measure and its solidarity with the Jewish population and thus emptied of its meaning the symbol of disgrace; if the king was wearing the armband, it was not so humiliating to wear it.

Sometimes creativity emerges from a real physical reversal, as in this case. At the beginning of 1900, the artist Gustave Verbeek wished to offer in the *Sunday New York Herald* eight stories cartoons instead of four since the readers of the newspaper asked so. However, the publisher did not want to increase the space devoted to cartoons for financial reasons. Hence, Verbeek invented stories with cartoons to be seen on the one hand and other stories cartoons for the same views on the opposite side. In this way, by reversing the newspaper you can read a new story based on the same pictures (Fig. 2.3).

Reversal may be conceptual, rather than physical. For instance, Magritte in his painting, *The collective invention* (Fig. 2.4), draw a siren by reversing the nature of the two halves it is composed by the following: the upper part of the siren is a fish instead of a woman and the lower part is a woman instead of a fish. An artistic surprise is generated in *The collective invention*, suggesting possible insightful thoughts about the relationships between the human and the natural worlds.

The idea that a reversal in the mental framework is a psychological mechanism which lies under creativity can be identified early. Some suggestions coming from the Gestalt psychology tradition can be interpreted in this perspective. Gestalt psychologists did not use the word “creativity,” even if they dealt with thinking processes implied in discoveries and inventions. What is commonly conceived as

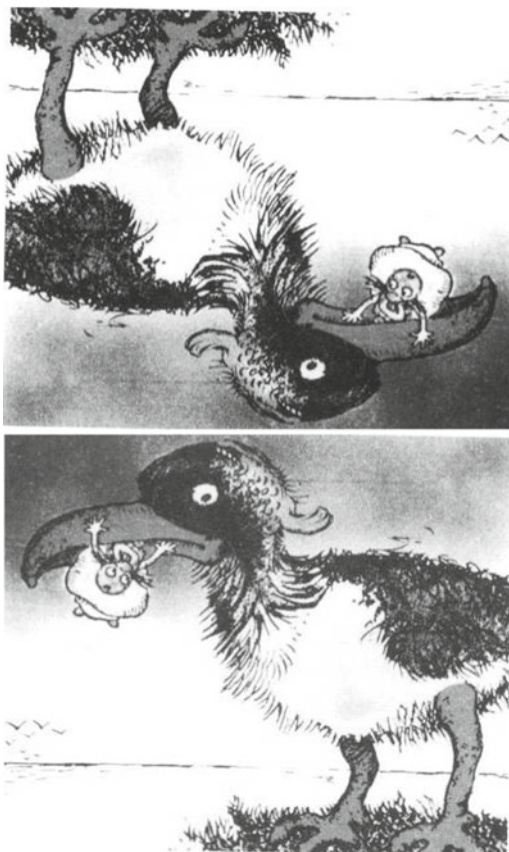


Fig. 2.3 A cartoon designed by Gustave Verbeek, which changes its meaning by reverting it



Fig. 2.4 Renè Magritte, *The collective invention*

“creativity” refers to what Gestalt psychologists called *productive thinking*. Productive thinking involves a restructuring act, which consists in the transformation of the point of view from which the current situation is analyzed, so leading people to identify new properties of the given elements and/or new relationships among them or new functions of the available materials. Consider this case reported by Wertheimer (1959). Two children are engaged in a match of badminton. One of the players is much more skilled than the other one, so that the latter, finding himself constantly defeated, decides to stop playing. The first child wants to continue the game, but he does not succeed in convincing the partner to continue the match. Suddenly he finds a way to achieve his goal by restructuring the situation. Indeed, he proposes again to his companion to play badminton, but with a different challenge: no more one against the other, but in the attempt to make together the largest number of hits without dropping the ball. In this way, his partner is led to perceive himself as an ally but not as an opponent. The first child gets what he wanted, namely, to continue the game, by changing the structure, that is, the purpose of the game.

The restructuring act appears to be the core of what De Bono (1967) calls *lateral thinking*, a kind of cognitive process which moves from one pattern of reasoning to another one, so inducing people to look at problems in new ways.

In some cases, restructuring involves linguistic factors. In fact, certain verbal expressions can be interpreted in two (or more) ways. We usually tend to decode them in one sense, apparently the most natural, but in fact as to conceal the alternatives. Neglecting the alternative meaning hinders creativity since it prevents people to consider other possible ways to conceive the situation or to solve the problem in question. For example, consider the following riddle: “A surgeon is called to the hospital to operate a guy who had a motorcycle accident. The surgeon prepares for the operation but when entering the operating room, by looking at the patient, says: ‘I can not operate him; he is my son’. The surgeon is not the boy’s father. How is that possible?” The difficulties encountered in making sense of this apparent contradiction are due to the fact that the noun “surgeon,” which may designate both a male or a female, tends to be decoded only in the first sense, so that it is not taken into consideration the possibility that the surgeon is the boy’s mother. This kind of phenomena was the subject of attention and original theorization, within the context of Italian perspectives on creativity (Antonietti & Cornoldi, 2006), by (Mosconi, 1990; Mosconi & D’Urso, 1974). According to this author, when the subject is placed in front of a problem or request, information is provided: the subject receives a message. In this regard, Mosconi distinguished between the *given message* (consisting in what is explicitly told to the subject) and the *actual message* (which includes information not given explicitly but implicitly contained in the message). The actual message is, therefore, always broader than the given message. In some situations, individuals are limited in their mental framework because of an error generated by the difference between the actual and the given message. The person is sent a message (the given message: for instance, a surgeon has to operate a boy), but he/she decodes it, through what is called *primary decoding*, by adding other elements, so producing the actual message (a male surgeon has to operate a boy). In ordinary

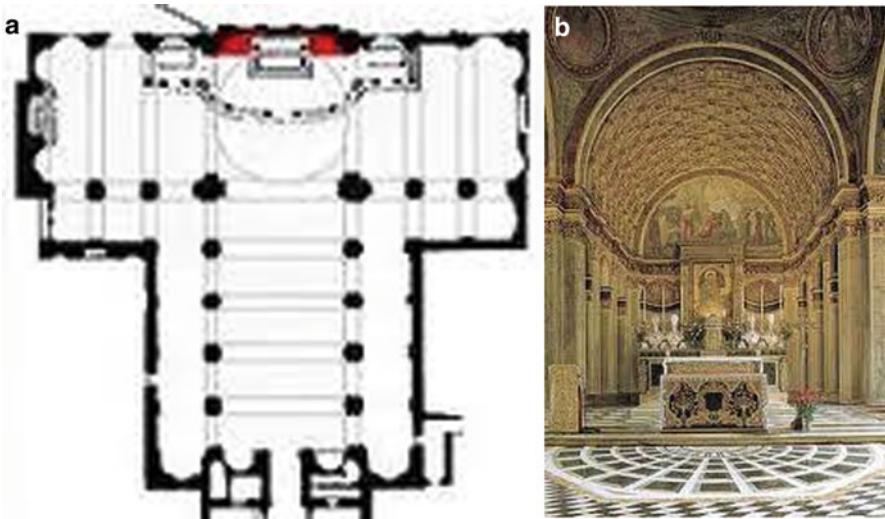


Fig. 2.5 (a) The plan of the church of St. Satiro in Milan. (b) The back wall of the church of St. Satiro in Milan

communication, the actual message is, in general, substantially identical to the given message, because the speaker wants to make him/herself understood by the listener and then he/she tries to express him/herself in a natural way. In certain situations, however, things are different, since the given message is decoded differently. A rule of communication is that, when a question is asked, it is plausible that the statements contained in the message are informative and relevant. Problems arise – such as the aforementioned case of surgeon – because the actual message contains elements which are incompatible with the solution. Sometimes creativity is impeded by a series of constraints and boundaries, not actually required by the original description of the situation, that the subject constructs in his/her mind. Eliminating the gap will eliminate such constraints and boundaries. In fact, this removal opens a new interpretation and thus makes it possible to reorganize the mental field, even in a creative way. Thus, in certain cases, creativity may consist in switching from a meaning of the message to another one, so reversing the representation of the situation.

Consider the order received by Bramante in Milan when he was asked to “give greater depth” to the choir of the church of St. Satiro. Apparently he could not increase the depth of the chorus since there was (and there is also nowadays) a street after the back wall of the church (Fig. 2.5a). Bramante then gave the expression “to give greater depth” a different meaning, which is also implied in the expression, even if it is not clear in its primary decoding. The greatest depth of the choir was not obtained by moving back the back wall (which was not possible for the reason mentioned above) but creating a perspective effect produced by fake pillars aligned in different planes that actually required a few centimeters of depth

(Fig. 2.5b). The message “to give greater depth” included several possible meanings. One of its readings is limited to the possibility of stretching the physical length of the building. Another one is not bound by linguistic mechanisms but includes other options, such as the effect of perspective illusion.

Reconstruction

Some authors have shown that mental reversing may involve a long and gradual process. For example, Gruber (1974) pointed out that not all innovations and discoveries must necessarily come by sudden reorganizations of the conceptual field in question. The reconstruction performed by Gruber of the elaboration of Darwin’s theory of evolution shows the presence of progressive and slow changes in the theoretical system that the British naturalist was gradually formulating. These changes are interpreted by Gruber as a result of adaptation processes consisting of both assimilation of new data to previous patterns of thought and accommodation of prior mental structures to new empirical data. According to Gruber, in fact, the creative process takes place in a complex system that evolves under the direct control of individuals. Gruber highlighted how the so-called microgenesis of insight has its own structure: starting from the initial sketches, the subgoals are set, and these subgoals must be organized in a hierarchical order. The creative mind allows one to recognize, store, and process innovations which occur since it is operating on the basis of a sort of device that amplifies the slight deviations that a person progressively makes in his/her ideas.

The reversing of a mental framework can also follow another path, that is, trying to apply a mental framework outside its normal scope. This is what Schank suggests (1988). According to this author, to understand reality, we must have *knowledge structures*, which are generally derived from repeated experiences. A knowledge structure which was used several times to give an account of events constitutes a *pattern of explanation*. A parsimonious strategy is to treat a new situation as not so different from the previous ones, that is, to apply a pattern of explanation that we applied to other known situations. This prevents us to perform all the processing that would be necessary if we treated the situation as if for the first time we encounter it. Creativity emerges when, in order to face the new situation, we adapt a pattern of explanation, originally set for another situation, to the current situation. Creativity consists in applying a pattern of explanation which is not expected to be applied to that situation. In other words, creativity comes from the misapplication of a pattern of explanation: in front of an unusual event, we fail to apply the typical pattern of explanation for that situation, but we apply another pattern of explanation. The patterns of explanation, when applied out of their familiar context, may produce creative results. The creative attitude is what allows the individual to leave the patterns of explanation to be applied to apparently not relevant situations so that they can lead to discover useful properties.

Conclusions

In this chapter, we proposed a model aimed at synthesizing different theories in order to define an exhaustive and organic view to conceptualize creativity. By omitting the specific aspects that characterize each position, we identified three major mental operations which are at the basis of creativity.

A first group of authors fundamentally believes that creativity comes from the *widening* of the mental framework. If the individual is capable to generate many different ideas (Guilford, Weisberg) or tries to vary existing ideas and select the most promising ones (Campbell, Johnson-Laird, Perkins), he/she may reach interesting findings or may produce something new and valuable. Hence, expanding the mental horizon through variety and variations of ideas may contribute to creativity.

A second group of authors think that creativity emerges when people establish relations between realities which are commonly unrelated (Vygotsky, Mednick, Koestler) or even antithetical (Rothenberg). Original combinations may also result by assembling elements in unusual ways. According to this perspective, *connecting* mental frameworks is the basic process of creativity.

Finally, a third group of authors claims that a creative act occurs when a reversal of the mental framework occurs. This can happen through restructuring (Wertheimer, De Bono, Mosconi) or through the adaptation of an interpretive scheme to novel data so to produce a different vision in which it is possible to grasp not obvious and interesting meanings (Gruber, Schank).

The model we outlined here may be the starting point for devising procedures and materials to assess the creative potential of individuals and to design training programs aimed at enhancing creative skills. To these purposes, a coherent general view is needed, and we hope that our model can provide both researchers and practitioners with such a view. In this attempt, we tried to preserve the valid insights included in each existing theory, to identify the overlapping claims and the shared issues and to integrate, but not only juxtaposing, them in an overall scheme. In fact, the analysis we carried out of the main authors who contributed to highlight the psychological mechanisms underlying creativity led us to recognize that the various theories are not mutually exclusive, but each stresses an aspect of a complex kaleidoscope. If creativity is a multifaceted dimension, mono-perspective approaches seem to be inadequate. Rather, a comprehensive approach can take into account the reasons of each point of view and make them understandable within a general overview, thus providing a solid ground for applicative projects and interventions.

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