Music

Marc Leman
University of Ghent, Belgium

I. CREATIVITY IN MUSIC

Musical creativity is not a property of musical products but of persons that are involved with musical information processing. It is not a synonym for talent because talent is assumed to be innate whereas creativity can be partly acquired. Neither is it a synonym for intelligence because intelligent people are not necessarily creative, though creative people are in general intelligent (sometimes also talented). A composer, performer, or improviser is considered to be creative when he or she does not merely repeat what has been learned or what others have done before but when a point of view is introduced that is unexpected and that adds new possibilities for further exploration. The latter means that it surpasses spontaneity and that it contributes to society.

Musical creativity is associated with notions such as novelty, originality, and flexibility but also with divine intuition, passion, and the courage to express personal emotions. The Romantic view of creativity assumes that creative composers and performers are extremely gifted people with an extraordinary talent to implement their passions into divine compositions or improvisations. The concept originates from the 19th century developments in musical reification and commerce. [See GIFTEDNESS AND CREATIVITY; NOVELTY.]

In compositional practice, the notion of creativity is
more related to strategies of ill-defined problem solving. Creative thinking in music is believed to display many similarities with creative thinking in science. Consequently, attempts have been undertaken to explore creativity from a rational point of view. In the 1950s, and since then, music institutes have been established whose aim is to foster musical creativity on a rational basis, often in connection with the development of new technology. Ultimately, this Rational view led to attempts in which formalized methods and automated processes share part of the creative process.

Since the 1960s, the concept of musical creativity has been popular in an educational context. In particular, in performance of classical music, jazz education, and improvisation training, musical creativity is believed to be related to the ability to make fast and unexpected decisions, given a learned repertoire of musical idioms and motoric skills. Education in musical creativity has a focus on the mental processes associated with creative production. Music educators are convinced that creativity can be learned by stimulating the personal viewpoint. Some also believe that the active involvement in fast (also understood as intuitive) decision making within an interactive musical environment is helpful.

The study of musical creativity as a process focuses on information processing and problem solving. A distinction can be made between behavioral studies that focus on issues of knowledge representation, learning, and memory structures for motoric actions, and brain science studies that focus on brain activity during creative tasks. Descriptive models of musical creation give a rather general but all-embracing view, whereas recent computational models give a more detailed but limited account of information processing during specific problem solving tasks. [See PROBLEM SOLVING.]

II. social and psychological basis of musical creativity

Musical creativity is a multifaceted concept and its analysis therefore implies a discussion of both the context in which creative processes take place as well as the perceptive, motoric, and cognitive processes that subsume creativity in rapid decision making and in problem solving. Unfortunately, in much of the literature on musical creativity, the role of context is often neglected and authors tend to concentrate mainly on mental processes.

The analysis of the creative context for music aims to clarify the constraints in which music is composed and improvised. Musical creation, in general, is constrained by social factors that depend on global, cultural, economical, and political tendencies within a society. Social conditions have a determining effect on the organization of musical life and thus on the context in which creation takes place. Taking these aspects into consideration, it is important to keep in mind that the timescale in which the conditions of a cultural environment change are in general of a greater order than the timescale in which creative mental processes take place. The latter occur from a few milliseconds (rapid decision making) to a few years (incubation of creative thinking), whereas the contexts in general change from a few years to a few decades or a few centuries. The fact that creative thinking in music often subsumes the constraints imposed by the social conditions is an effect of social interiorization, a transformation from social structure and constraints to mental structures and representations such that successful handling in the social environment is optimized. Nevertheless, creative individuals may be able to break some of the conventions imposed by the contexts.

The ability to internally process and imagine sound is a central feature of musical creativity both when different possible solutions are scanned in reaction to a given musical problem (so-called divergent thinking) as well as when making a decision for one of the possible adequate answers (so-called convergent thinking). Scanning and decision making rely on learned knowledge schemata that are acquired during a learning process by which brain structures adapt themselves to regularities and generalities of musical styles and repertoires. Problem solving and rapid decision making in music are trained and stimulated through musical education. Recently, studies of creative behavior and brain activity have been conducted and cognitive models of musical creativity have been set up.

In what follows, the concept of musical creativity is first situated within a social context. Then an analysis
is given of musical creativity from the point of view of information processing.

III. THE ROMANTIC CONCEPT OF CREATIVITY

The Romantic view of musical creativity assumes that at the center of creation there is the famous inspiration that is independent from the machinery of reason or the compulsions of instinct. Musical creativity is believed to come from the muse. It is much like a gift or talent to extraordinary people who serve their lives as a medium for a supernatural being's immanent appearance in the world. Those, however, that do not believe in divine forces assume that the muse has its origin in an affective disease. Anyhow, creativity cannot be educated but must flow out of a natural drive and emotional engagement.

The Romantic view holds that there are—perhaps unfortunately—a number of side effects that stigmatize the elected artists. Creative artists are believed to display a certain tendency to unadapted social and often psychotic, extravagant, or bizarre behavior. Their creative talents exhibit diabolic powers (like the violinist Paganini), radiate sex appeal (like the pianist and composer Liszt), or are due to tormented minds (like the composers Berlioz and Beethoven), but the society has to accept this because it is in the very nature of being creative to be either possessed or mad. It led to the idea that derangements such as depression, mania, drugs, or personality disorder are important for having an unusual creativity. [See ECCENTRICITY.]

The Romantic view on musical creativity can be traced back to the works of J.-J. Rousseau (1712–1778) who defended informal education and the natural origin of creativity. Yet the typical Romantic picture became popular at the beginning of the 19th century. The Romantic view is said to be irrational both with respect to the origin of creation and with respect to the features associated. The origin of creation is situated either outside the individual, in a metaphysical reality, or inside as degeneration. In the first case, it is considered to be a matter of belief and hence beyond any reasonable understanding, effective exploitation, or education. In the second case, studies have pointed out that there is no compelling evidence that there is pathology in musical creativity. Obviously, the social behavior by which the creative artist distinguishes him- or herself from common people is often cultivated (both by the artist and his or her musical environment), and it is thus part of an image-building machinery that subsumes social factors of the way in which musical life is organized but that is disconnected from the actual creative processes.

The advent of the Romantic conception of musical creation goes hand in hand with the development of industrialization, liberalism, and nationalism in the late 18th and first decades of the 19th century. The revolutionary developments, both in politics and industrialization, inaugurated the decline of the Ancien Régime and its associated organization of musical life throughout Europe. It rapidly led to the installation of a new type of professional framework based on the principles of free market. In that framework, composers and musicians were no longer working in service of a court but became individual entrepreneurs that worked in free competition conditions with other entrepreneur-artists. The cults of the child prodigy, the virtuoso, and the tormented genius (whose work is first misunderstood and later hailed) are emerging effects of the dynamics that is inherent in this new organization of musical life. The free market was made for the bourgeois class minority and lower and middle classes were excluded from it. Nevertheless, it created a dynamics so powerful and all encompassing that its influence is still a dominant factor in the contemporary organization of musical life.

With the decline of the bourgeois society after World War I and the advent of mass media and mass movement in the United States and Europe, the organization of musical life became dominated by a music industry composed of major recording companies, state broadcasting companies, and impresario houses. Musical sound became materialized using recording media and this process of reification favored a tendency to consider music henceforth as a commodity whose return sales are in direct proportion to the success of commercial strategies to exploit Romantic musical creativity. Classical music, a main achievement of the bourgeois society, was no longer the dominant type of music. Instead, jazz music and, especially, rock 'n' roll (in the 1950s) and popular music in general found their way
to the masses. The market for musical commodities rapidly increased and the music industry became one of the most important industries of the postindustrial societies. Given this context, the Romantic concept of creativity was easily extended toward all forms of classical and popular music.

The music industry today is still perfectly aware of the force of the popular Romantic view on musical creativity. The vague ideas of the creative genius are now at the center of the mechanisms in which idolization and excess worship are subject to marketing strategies of major commercial companies. As a matter of fact, the very irrationality behind the Romantic concept of creativity makes it ideally suited to commercial exploitation. Extravagant behavior, sex appeal, and the use of religious symbols are associated features that contribute to image building. It fits with carefully planned strategies that favor idolatry and worship in consumption patterns. In many respects, therefore, the Romantic concept of creativity is an effect of musical reification and commodification, a process that started in the 19th century and that continues today.

**IV. RATIONAL CREATIVITY**

In contrast to the popularity of the Romantic view, some countercurrents offered an alternative view on musical creativity. In particular, during the 1950s and 1960s, the social conditions were present for the emergence of a professional subframework that was entirely different from the free market framework that dominated popular music and music of the classical repertoire. It is the achievement of the so-called institutional musical avant-garde to have explored a view on musical creativity that is in total contrast to the Romantic conception. The origin of this Rational view can be traced back to the 18th century period of Enlightenment where the first successes of the scientific methods (in particular, deduction, induction, and abduction) were taken as a model for a total worldview, in particular also for creation. A more detailed sketch of the sociological background of this development is important to understand the effects on creativity.

The concept of rationalized creation and the consistent way in which it was worked out in connection with new developments in technology formed the foundation of many new developments in musical creativity. The achievements of the avant-garde, given the growing impact of the music industry in all other fields of music, can only be explained by a combination of factors involving the development of new recording technology and mass media institutions, institutionalization within the context of broadcasting institutions and universities, and association with scientific research. From a political point of view too, it is now believed that, at least in Europe, the support for unbridled creativity played a role in an attempt to reestablish the European high culture after the calamities of World War II. Yet this was no isolated European phenomenon. The attention for unlimited creativity is much associated with the zeitgeist of the Golden Sixties, the successes of capitalism in social welfare, and the advent of the postindustrial society.

The avant-garde movement presented itself as the antipode of musical commodification, while at the same time it put forward the reification of music to the extreme. In particular, it neglected the developments in music industry and the free-market framework by a thorough institutionalization via electronic music studios supported by the state. It based the essence of musical creation on technology that transformed abstract sounds into real material objects. The latter is particularly evident in electroacoustic music productions in which the creative molding of sounds requires the knowledge of particular nonmusical skills in acoustics, psychoacoustics, electronics, and computing in order to record on magnetic tapes, to use techniques of cut and paste, stretching, compressing, and filtering, and to make many other sound manipulations.

A main effect of combining technology with musical creation is that musical creativity was no longer believed to lay outside the human being or inside an affective disease (as in the Romantic concept). The technological environment implies that creativity can be controlled and guided by rational thought. Machines become useful as extensions of musical creativity, just like electronic calculators are useful in taking over some parts of mathematical reasoning. Three aspects of this development deserve further analysis because they provide important aspects of the social conditions that enable creative thinking: (a) the role of institutionaliza-
tion in the establishment of contexts for rational music creation, (b) the legitimization of creativity in the technological context, and (c) the impact of methodology and tendencies toward automated creation.

A. Institutionalization and Contexts for Rational Music Creation

To describe the context for rational musical creation it is useful to make a distinction between three types of frameworks: the infrastructure of creation, the professional framework, and the artistic paradigm.

The infrastructure of creation defines the production environment for music. It is typically a production or rehearsal studio, with all the equipment and assistance personnel. The infrastructure is composed of machinery for production, such as a set of magnetophones and sound generators. It imposes a methodology for creativity because the composition process often involves the planning and realization of musical ideas as a function of the available technology. It also entails a division of labor between the composer and the technical staff while at the same time it makes the boundaries between composition and realization more diffuse. As a matter of fact, creativity in the studio causes the composer to acquire engineering skills or to collaborate with other people who may influence the creative process. It is known, but rarely mentioned, that technicians often contributed to the creation process by finding new solutions to problems posed by the composer. In addition, it is often mentioned that creativity is constrained by standards imposed by the music industry. MIDI, an industrial standard for music instrument digital interfaces, has for example been criticized for being too focused on the traditional concept of music making. Alternative composer environments have been developed at universities and artistic centers.

The professional framework defines the way in which the organization of the artistic activities are socially worked out. This level thus pertains to the sociocultural conditions in which the infrastructure is embedded. In the 19th century it was based on private initiative and entrepreneurship of the artist. The support and commands of contemporary (nonpopular) music in the 1950s and 1960s was to a large extent taken over by state commands via radio broadcasting companies or universities. The role of the state in the organization of musical life can be compared with the roles of the church in the medieval times and the courts in the Renaissance and Baroque periods. The main difference, however, was its absolute tolerance with respect to creation. Creativity was assumed to be free from any constraint, even (or especially) the audience. The professional framework thus acquired a status of a pseudoscientific creative enterprise. In contrast to this, the advent of private studios and the integration of technology in popular music has to be situated in a framework of free-market conditions. In such a framework, musical creation is necessarily more functionally oriented and consumer dependent.

The artistic paradigm concerns the technical and stylistic aspects of music production. It entails a methodology that guides creative thinking and it often imposes a stylistic idiom, a sort of musical worldview. In the 19th century the artistic concept is typically called Romantic. It is characterized by a tonal syntax and causal deployment of musical ideas. Musical genres and forms, such as the sonata form, the concerto, or the symphony, provided schemata by which composers constrained their creative thoughts or added new extensions or ideas. The tonal syntax itself implied several rules for the generation of music. This too provided a thorough set of constraints that composers could follow or slightly change. The avant-garde artistic conception was strongly involved with the exploration of new possibilities of sound production, transformation, and manipulation using new technology (electronics and magnetophones) within an institutionalized infrastructure. The focus on novelty determined the peculiar conception of musical creativity as something that is directed on novelty. Avant-garde creativity tried to avoid the constraints of the tonal syntax and rejected most of the traditional musical forms. It focused instead on the use of timbre and noncausal structural principles. In some cases, however, novelty (and use of new equipment) was considered to be a more important category of musical creativity than musicality.

The three levels (infrastructure, professional framework, and artistic paradigm) obviously depend on each other and they reinforce each other. Together they provide the social framework within which creative actions
take place. Very often it can be shown that the social context has a determining effect on musical creation.

**B. The Legitimation of Musical Creativity**

The avant-garde movement gave rise to the idea that, ultimately, musical creativity can be automated and taken over by machines. This idea emerged from the social conditions in which absolute freedom in creative thinking goes hand in hand with a thorough rational approach to musical research. This section goes deeper into the forces that facilitated the development of this idea, and the next section gives an account of the basic conception behind automated creativity.

First, the notion of music research was associated with radiophonic applications. It aimed at a creative *exploitation* of the hitherto unexplored new world of sound objects. The latter were conceived either as isolated objects (e.g., the sound of a train, of footsteps, or of water) or as sound objects in a context of other sound objects. The latter, of course, implies a musical environment. This exploitation was conceived of in a systematic and methodological way, interpreted as a *collège* of musical objects. The above-mentioned context of institutionalization played herein a central role. Music research was originally meant to be an examination of the possibilities of new technology for artistic creativity. Later on, in the 1970s, the concept of music research became more involved with interdisciplinary scientific research, such as in acoustics, psychoacoustics, and informatics, and focused on the creation of new (electronic) musical instruments, less on the exploration of the composer's intuition.

Second, the integration of technology with music established a highly scientized context for musical creativity, both within the context of free-market conditions and in the context of state-supported institutions. It is characterized by division of labor (and creativity), by paradigmatic constraints and attitudes with respect to commodification. The division of labor means that the context of creation is maintained by a specialized crew of people. For example, the production of electro-acoustic music implies both the composition and the realization process. It often turns out that part of the creative process is delegated or works in interaction with other people and with machines. The individual creative process thus becomes subsumed in a group creative process. This is the case in the free market as well as in the state supported framework.

A third factor that favored the development of automated music creation is the *artistic concept*. State-supported institutions are often associated with an artistic paradigm that imposes a set of aesthetic beliefs and methodological strategies. It implies a number of bounds and constraints that composers have to accept if they want to use the institutional infrastructure for creation. The free-market infrastructures, on the other hand, have no such ideological constraints, although the constraints are to be situated at the financial level. The amount of money needed to use the professional equipment for creative experimentation is often a major threshold for beginning pop musicians. In the state-supported framework, commodification is not a dominant factor because the institutes guarantee the quality, transmission, and preservation of the achieved results. In the free-market framework, commodification is the ultimate goal. In the free-market conditions, commodification is a driving force of the artistic creation.

The existence of the free market and the state-support framework has led to entirely different schematas for the legitimation of musical creativity. The state-supported framework is characterized by a form of *autonomous legitimation*. It means that no forces other than the inherent forces of the institution play a role in the creative process. Nonexperts, such as an audience, are not allowed to interfere. In the free-market condition, the creative context is characterized by a *heteronomous legitimation*. The ultimate justification of musical creativity is functional and the feedback is determined by the consumer market. In music history the creative contexts were mostly heteronomous. Musical creativity was directed to God or to the Church in medieval times, to the king or to the prince in Renaissance and Baroque times, or to Nature or to the Self in Romantic music. Consequently, the organization of musical life, and the particular implementation of a scientized context for musical creativity, has been highly dependent on the professional framework (market oriented or state supported). The state-supported framework of the 1950s and 1960s led to the view that musical creation can be fully automated.
C. From Methodology to Automated Creation

Automated musical creativity is a goal pursued in the contemporary exploration of creative thinking but it is by no means an entirely modern invention. For many centuries the composition and improvisation rules have been written down as recipes for practical music making (both in composition and in improvisation). Recipes facilitate the creation of new music, although the creative mind will often break the received rules as a function of an original and interesting new finding. In the 15th and early 16th centuries, one often encounters canonic riddles embedded within compositions that require the working out of a puzzle in order to perform the music. Dice music—composed by throwing a die iteratively and choosing, on the basis of the outcome, a possible motive from a table of musical figures—was quite popular in the second half of the (rational) 18th century. In short, recipes and methods in general offer the means to achieve a goal—if not automated—by going through a number of steps. Without a methodology, one is often lost in the complexities of ill-defined musical problem solving.

Music is one of the application domains in which the idea of automated creation has found its most persistent and perhaps oldest application. This is due to the fact that (a) musical signification has no denotational constraints and that it is entirely context dependent and (b) that the materialization of musical ideas can itself be automatically realized into sonorous objects. Trends toward automated creativity can be observed in all forms of music production that rely on technology. As discussed in the previous section the social context of the 1950s and 1960s was favorable to the rational development and quasi-scientific approaches to automated creation. In a quite different context, automated music production is now used for the generation of popular songs and dance music.

The ultimate achievement in automated music making, such as conceived by avant-garde composers in the 1950 and 1960s, was to compose a musical germ out of which a whole composition may follow by self-development. The self-creativity of music is based on the idea of letting music create itself out of a single kernel. It shifts the process of creation to a single thought out of which everything follows automatically. In that sense, the act of composing as unfolding music through time is carried out by an automated creator, while the creative insight, idea, or finding is reduced to its bare kernel. Some argue that the musical creativity is then a combination of the starting idea (the kernel) and the creation of a system that unfolds the kernel. Hence, the unfolding itself is automated, but the potentiality of the system is a human invention, although sometimes a highly scientized one. Examples of this type of thinking can be traced back to Beethoven. It is prominently present in the works of avant-garde composers such as Stockhausen and Boulez and in more recent computer music realizations.

V. PRAGMATIC CREATIVITY

The pragmatic concept of musical creativity states that we know little about the origin and nature of musical creativity. Yet the concept is useful in education and it can be studied and even measured. Educators deny the fact that creativity has a metaphysical or pathological origin and believe that creation can somehow be stimulated and learned. They recognize that some people are more talented and gifted than others and that creativity can be sometimes (though not always) associated with these features. The interest is in the development of tools that improve and enhance creative music making.

Much of the literature on musical creativity focuses on practice and deals with the teaching of strategies in composition and improvisation in the classroom. This literature stresses the pursuit of an active engagement in discovery learning. Educators focus on musical praxis and exercise and not just on the understanding of learned rules in composition and improvisation. Reference can be made to the Kodály approach that starts from folk styles and corporate singing as appropriate avenues for musical literacy. It is also argued that children must develop a background of enriched sensory images and activities to accomplish creative musical thinking and affective decision making. It is believed that children can be stimulated to explore a broad range of musical possibilities and education in general stresses the arrangement of musical materials and a
gradual increase in complexity of the musical material onto which musical creativity is trained.

In short, there is little doubt that the concept of creativity should be central in musical education, yet the approach is pragmatic and does not tell much about the origin and nature of musical creativity. Part of the education process is focused on the acquisition of rules and methods that allow one to understand the way in which sounds interact with human activities. The aim is to set up this interaction so that pupils scan a large range of possibilities and know how to apply musical knowledge to achieve fast and efficient results.

VI. STUDIES OF MUSICAL CREATIVITY

Most studies on musical creativity have focused on information processing. A distinction can be made among three fields of research: (a) behavioral studies, (b) brain studies, and (c) modeling.

A. Behavioral Studies

Behavioral studies of musical creativity are done either in a natural environment or in a controlled experimental environment. In both cases the aim is to observe behavior and to extract general knowledge about the creative process. Often the aim is to set up tests for measuring creative aptitude.

Studies have focused on subjects of all ages. The study of creative musical behavior in children typically involves gamelike tasks. Children are observed when they explore musical parameters such as high/low, fast/slow, and loud/soft. They are given tasks that involve sound imagination. They are observed when dealing with ill-defined musical tasks such as telling a story in sounds, using drawings as an aid, or making a composition with musical instruments. The tasks are recorded on videotapes and analyzed using scores for creative features such as originality, extensiveness, flexibility, and musical sensitivity. Results suggest that children follow consistent patterns in creative attitudes so that testing is appropriate. Other studies have focused on spontaneous creative exploration. Children have been brought into a room in which there were musical instruments. Without any predefined task or interruption, they were observed. The aim was to study how children explore music instruments, to what extent they rely on learned patterns when producing music, and to what extent children develop spontaneous group activities. Several years later, the same group of children was observed under similar conditions and comparison with former observations were made. Creativity turned out to be less spontaneous and more based on learned schemata.

Creativity is often associated with intelligent problem solving. Strategies of problem solving are called creative when diverse pertinent ideas come out of ill-defined problems, when practical problems are recognized, when reference frameworks of different domains are combined, and when the solutions are original. Since the beginning of the 20th century, studies have also focused on compositional creativity in adults, asking subjects to compose music from a given poem. Studies are based on autobiographical records, the study of notebooks and sketches of great composers, final scores, and direct observation of composers at work. These studies have led to a basic framework for setting up variables for creativity research. In this context, Wallas's conjectures of a subdivision of the creative process into different stages has been taken over by many authors. (a) The first phase of the creative process is called the preparatory phase, which is often accompanied by an internal crisis and questioning of old reference frames, taking into account the specificity and complexity of the task. (b) The second phase is the incubation phase, in which the germ for a solution is founded by letting things develop in their due course. There is a focus on different reference frames and application of metaphorical thinking. It is also assumed that the unconscious takes over from the conscious. (c) The third phase is the illumination phase, typically accompanied by the Aha-Erlebniss when a solution is found. (d) The fourth phase is the phase of verification, when the excitement has passed and the solution is tested. Bahle related empirical results to five states: the state of conception, the state of abstract ideas or images, the state of concrete ideas (such as musical motives), the state of realization, and the state of production. [See INCUBATION.]
Further behavioral studies concentrated on setting up specific variables for behavioral research in creativity. Guilford, for example, made a distinction between a convergent type of thinking, which tends to seek solutions unique to the posed problem, and a divergent type of thinking, which tends to scan all possible solutions for a given problem. Musical fluidity or the capacity to produce much (i.e., the amount of time invested in creative thinking), is related to divergent thinking. It is measured in terms of the number of events produced in comparison with creative responses. Other components include flexibility, originality, and elaboration. [See DIVERGENT THINKING.]

Musical flexibility is the aptitude to produce a diversity of ideas in ill-structured situations. It is also associated with the number of categories in which one may classify the given responses. This is worked out in terms of the diversity of pertinent musical solutions for a given task, the number of phrases that are musically different, the elaboration of musical parameters such as register (high, low), intensity (loud, soft) and tempo (fast, slow). [See FLEXIBILITY.]

Musical originality or production of uncommon but pertinent answers is often measured in terms of the rareness of musical content with respect to the ensemble of the experimental population.

Musical elaboration concerns the level of complexity of the musical phrases produced. Other components are concerned with aspects such as problem sensibility and the capacity to recognize practical problems, redefinition or the aptitude to change the function of an object or part of the object and to use it, rhythmical certainty or the capacity to follow a regular pulsation and to improvise on a rhythmic sequence, musical expressive quality, and so on.

The attempt to operationalize creativity in terms of distinguished components has inspired researchers to develop tests for the prognosis of creative ability. Some authors argue, however, that such tests, given their limited testing condition, do not give any valuable proofs of creativity because the tests are not embedded in a social environment. They do show, however, that one person is more skillful than another in solving particular tasks under constrained conditions.

Behavioral studies have led to a so-called cognitive view of musical activities. This view stresses schema-based processing of musical information. Schemata are learned hierarchical knowledge structures. Creative performances and improvisations have been related to the existence of knowledge of large-scale groupings or patterns within music. The control of the performance, guided by those patterns, is hierarchical in that parameters that apply to a larger grouping determine the settings for elements within the group. In contrast to experts, inexpert performance seems to be based on superficial features of music. High-level hierarchical control is furthermore supported by highly flexible procedures for solving local problems, whereas inexpert performers are more committed to solving immediate local problems. Finally, creative performers have the means to monitor their own performances and to take corrective actions in addition to a number of automated actions. Their attention is not fully engaged in technical aspects of the performance. Compositional processes are based on unconscious resources such as general tonal and stylistic knowledge and constraints on form and direction, and conscious resources and processes such as using a repertoire of compositional devices to transform a theme, to extend and develop a theme, and to modify it. [See EXPERTISE.]

B. Brain Studies

Studies that relate musical creativity to the brain are quite diverse. One of the few studies of the biological basis of creativity reports that creative musical behavior is associated with very low values of testosterone in males and with high testosterone levels in females. The data suggest that among a complex interaction of biological and social factors, an optimal testosterone range may exist for the expression of creative musical behavior. Exceeding the range in the course of adolescence may be detrimental for musical creativity in boys. The hypothesis is that talented creative musicians of both sexes are psychologically androgynous. [See BRAIN BIOLOGY AND BRAIN FUNCTIONING.]

There exists a wide range of studies about brain damage and their behavioral effects in famous composers. It has been found, for example, that the loss of verbal functions (aphasia) is not necessarily accompanied by a loss of musical functions (amusia). Some composers that suffered from aphasia (mostly due
to damage in the left hemisphere) were still able to compose music without loss of musical abilities. The French composer Maurice Ravel, however, suffered from an injury to the left hemisphere and had forms of agraphia, alexia, and aphasia. He retained critical capacities, recognized melodies, and could appreciate music, but he lost his creative musical abilities to perform and to compose. Yet he claimed to be able to hear the music that he composed in his head.

The development of sophisticated brain scan techniques, such as electroencephalogram (EEG), magnetoencephalogram (MEG), positron emission tomography (PET), and functional magnetic resonance imaging (fMRI), gave rise (in the 1980s) to the development of a new field called cognitive neuromusicality. The aim is to find out whether specific brain activity can be correlated with musical functions, in particular also with musical imagining and creativity. Recent findings show that acts of creative thinking seem to be characterized by coherence increases between occipital and frontopolar electrode sites. This is different in other mental tasks. Some recent work has also focused on sub-aspects of creativity, such as musical imagery. The phenomenological impression of imagined sounds can be associated with the bilateral neuronal activity in the secondary auditory cortices. Although the question of the format of mental images is not addressed, data suggest that auditory images have perceptual origins. Given the enormous industrial interests and the possible medical applications, it is to be expected that cognitive neuromusicality will become a key science in our understanding of musical creativity.

C. Models of Creativity

If musical creativity is related to musical information processing, then aspects of it can be modeled. Thus far, however, most models have been descriptive in that they give a rather general overview of the different components involved. Some models are computational and are intended to carry out some specific creative task rather than to give a general account of creativity as such. Due to the fact that our knowledge of the physiological basis of creativity is limited (or almost nonexistent), no specific physiological models for musical creativity have been proposed to date.

1. Descriptive Models

Descriptive models of musical creativity may serve as conceptual guides in research and education. Most educators agree that creative activity relies on a repertoire of musical aptitudes that are partly innate but also subject to development and improvement with training. Webster, for example, proposed a descriptive model of creative thinking that is based on the distinction between convergent and divergent thinking on the one hand, and skills and conditions on the other hand.

Webster made a distinction between composition, performance/improvisation, and analysis. They can be considered as goals or intentions of the creator and they are therefore called product intentions. Once such an intention is realized it represents the final product of creation. The creative process is based on a set of skills called enabling skills and a set of conditions called enabling conditions. They form the basis of musical intelligence and interact with the thinking process in a rich variety of ways. First among the skills is a collection of musical aptitudes such as the ability to recognize rhythmic and tonal patterns, and musical syntax in general, the ability to imagine sounds, or the ability to apply a range of expressions in musical dynamics, tempo, or pitch. The musical aptitudes include convergent thinking skills, such as the ability to recognize rhythmic patterns, tonal patterns, and musical syntax, as well as the previously mentioned divergent skills such as fluidity, flexibility, or originality. It is assumed that a number of these aptitudes are innate, although they are subject to development and training. Other skills are based on knowledge of facts, such as the craftsmanship to apply composition rules in the service of a complex musical task and the ability to mold a musical work in accordance with aesthetic sensitivity.

Next to the skills are inner and environmental conditions. Motivation, for example, refers to the drives, both external and internal, that help to keep the creator on the task. Subconscious imagery is the presence of mental activity that occurs apart from the conscious mind and that may help to inform the creative process. Personality, according to Webster, describes factors such as risk taking, spontaneity, openness, perspicacity, sense of humor, and preference for complexity. Environmental conditions, such as financial support or family conditions, may have an additional effect on the
creative process. [See CONDITIONS AND SETTINGS/ENVIRONMENT; MOTIVATION/DRIVE; PERSONALITY.]

One may add to this the institutional contexts for musical creation that were discussed in the previous sections. A central aspect of the describing model, then, is the thinking process in which the distinction between divergent and convergent thinking is embedded within the classical four-stage distinction among preparation, incubation, verification, and illumination.

The describing models provide rather general conceptualizations of the creative process. They have the advantage that a lot of factors can be taken into account but the disadvantage that the creative information processing as such is described in rather vague terms.

2. Computational Models

Computational models of musical creativity aim at understanding the dynamics of creation in terms of computational processes. In the cognitive musicology literature, since the 1970s, several such models have been described. Most models, though rather restricted in scope, apply learning strategies to establish a repertoire of knowledge used for the generation of music. The type of modeling is related to research in artificial intelligence. [See ARTIFICIAL INTELLIGENCE.]

The early models rely on logic-based inference techniques such as rules or grammars. The set of skills that are needed to solve a specific task, such as a harmonization or a jazz improvisation, is typically implemented in terms of declarative and procedural descriptions. Declarative knowledge gives a description of musical objects in terms of facts (e.g., that the C-major triad consists of the notes C-E-G), whereas procedural knowledge gives such a description in terms of a method (e.g., that the C-major triad can be obtained by adding a major third and a fifth on top of the fundamental C). The latter method is more general in that it can be applied to get the major triads of other fundamentals as well.

In the late 1980s, computational models of creativity have been built using so-called connectionist networks rather than logic-based inference systems. The latter are inspired by the wiring of the neurons in the brain. The systems have to be trained by example. The kernel of innovation comes down to the manipulation of stored probability functions or controlled random variation.

Experiments with computational models of creativity have led to more refined general models of creativity. Pressing provides a model of improvisation in terms of real-time perceptive-motoric connections and regularities. The sequential processing of musical information is crucial at three points: (a) the perceptive encoding of sensorial data, (b) the evaluation of potentialities and choice of a response, and (c) the execution and organization of the chosen actions. The automation of certain learned motoric sequences in response to input may free up time to analyze incoming information simultaneously. A distinction is made between a memory of musical objects and a memory of potential actions that can be actualized. The first relates to a declarative long-term memory of musical configurations, whereas the second implies a procedural long-term memory for the learning of variation techniques and techniques of combination according to different contexts and reference frames. The application of both memories in real time relies highly on learning and automatization. Learning can extend and refine the perceptive encoding; it can elaborate the evaluation and make the execution of musical actions more rapid. The limitations of the creative thinking therefore rely on conscious action related to decision making and unconscious action related to automated processes such as perceptive analysis and expression of precoded motoric actions.

Computational models are obviously limited in scope in that they concentrate on enabling skills and related information processing. The computer models, up to now, have not been embedded in the sociocultural environment and therefore the enabling conditions are not represented. In recent years, however, attempts have been undertaken to represent emotions in machines and to build creative musical robots that are embedded in an environment. This provides a promising context for future creativity research.

VII. CONCLUSION

Musical creativity is associated with musical compositions, performances, and improvisations that are
novel but sufficiently musical to make it valuable in a given sociocultural environment. Further questions therefore relate to the minimal amount of novelty needed to be considered valuable creativity, the different aspects of novelty that are required to be considered creative musical output, or aspects of musicality in relation to novelty and tradition. In answering such questions, it is necessary to approach the study of musical creativity from an interdisciplinary point of view—that is, one in which historical, sociological, psychological/neuropsychological, and computational methodologies are somehow combined. Musical creativity is context sensitive in that its production and its reception are determined by a number of social factors that need further study and analysis. It deals also with ill-defined problem solving and fast decision making. The study of musical creativity therefore needs further analysis from an ecological point of view—that is, one in which creative thinking is studied directly and interacting with different strata of the social environment. The study of paradigmatic (historical) examples of musical creativity may provide important cues for setting up a methodology that covers these aspects.

Bibliography


