Generative Processes in Music

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Generative Processes in Music

The Psychology of Performance, Improvisation, and Composition

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Edited by

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Preface

JOHN SLOBODA

This book was conceived to remedy an imbalance in the Psychology of Music literature. The vast majority of serious psychological research has been devoted to an analysis and understanding of the processes involved in listening to music. This is reflected in the existence of a major journal with the title *Music Perception*. There could not be a journal entitled *Music Performance*, because there just would not be enough research to fill it.

The reasons for the relative neglect of generative processes (including performance, improvisation, and composition) are various. I wish to comment briefly on three of these: cultural bias, measurement problems, and problems of control. I shall then turn to some general comments about the contributions to this volume.

Through a long social and historical process contemporary Western art culture has become characterized by functional specialism. In the case of music, as with most other art forms, a gulf has emerged between producer and consumer. Adult producers are typically few in number, often institutionally trained. Adult consumers are typically large in number, usually untrained, and often unskilled in most forms of music production. With the advent of sound recording and other forms of mechanical transmission it has become possible for the various functions to be completely separated in both time and space. Consider, for instance, a Beethoven symphony. A group of performers construct their interpretation in necessary isolation from the composer, and also from the audience for whom the performance is intended (for example in a recording studio). A member of the audience may then 'receive' the interpretation in social isolation from both composer and performer as a disembodied aural experience. This is particularly true of the domestic listener who may, through use of headphones and darkened room, create the impression of being totally and exclusively enfolded by sound. Even at the concert there are usually strong social and geographical factors which separate listeners from performers. Performers and listeners go in and out by separate doors; they do not interact with one another. Any form of audience interruption is usually violently resisted. Such constraints tend to reinforce an 'illusion' which projects the sound of the music away from the realities of its origins

in human work, both physical and mental. As in the puppet theatre, the modes of production become veiled in mystery, and we may have no particular wish to venture behind the proscenium arch.

In such a culture it is, perhaps, inevitable that the listener's response to music should become the primary focus of the psychology of music. This focus would, however, be less than fully comprehensible in cultures (maybe the majority of the world's musical cultures so far) where functional specialism had not gone so far. In many cultures it would be strange to hear music without joining in in one way or another. The separation between performer and composer is also necessarily less clear. Especially when the music is without notation, the originator of the music must necessarily perform it to communicate it. Also, composition/improvisation is often a social process, with several individuals in a group contributing substantially to the form of the music.

One of the recurrent themes of the contributions to this book is inextricable connection of generative and receptive processes. Their separation can only ever be partial. The reality is that all music must reflect the psychological propensities and capacities of humans as composers, performers, and listeners. To an extent, each type of involvement with music includes the others. Composers temper their compositional processes against their own aural judgements (see Lerdahl, Chapter 10) and their understanding of the performance characteristics of various instruments. Performers refine their performances against both their own aural awareness and their ability to image alternatives (see Pressing, Chapter 7). Listeners grasp a work of music by attempting to sing or hum parts of it, or by engaging in some form of rhythmic movement. They may also 'compose' variants or elaborations of the music in informal (but not necessarily overt) behaviour. Sagi and Vitanyi (Chapter 8) go so far as to propose that the ability to receive music is constrained by the extent to which people are capable of generating variants within a particular genre. In a similar vein, Dowling (Chapter 6) shows that young children's ability to discriminate tonal from atonal melodies is dependent on the level of singing ability that they have achieved.

We may suppose, in fact, that the impulse to generate and perform music is as inherent a part of the human constitution as is the impulse to generate language. The research reviewed by Dowling (Chapter 6) shows that very young children produce spontaneous songs which incorporate but by no means mimic elements of adult productions. Just as in language development, song development seems to go through a set of ordered, rule-governed stages. It may be that the failure of early generativity to flower into full-scale compositional ability is a result of both the ubiquitous concern of the 8–11 year old with 'correctness' and also traditional educational styles which undervalue experimentation and self-discovery. Where opportunities are given for self-directed musical productivity (for

example Swanwick and Tillman 1986), children demonstrate an impressively varied yet ordered progression of compositional strategies right through the school ages. Davidson and Scripp (Chapter 9) support this picture by an intriguing study of children's spontaneous notations for music.

A second reason for the neglect of generative processes relates to problems of measurement in psychological science. It is always easier to collect one's data in the form of responses from a limited and pre-ordained set (for example yes–no decision, same–different decisions) than it is from relatively unconstrained and multidimensional behaviour. This concern for precision and simplicity in measurement has led to a concentration within the psychological community on rather simple laboratory tasks. Claxton (1980, p. 13) paints a humorous but not altogether inapposite picture of the typical study in cognitive psychology:

> cognitive psychology does not, after all, deal with whole people, but with a very special and bizarre—almost Frankenstinian—preparation, with consists of a brain attached to two eyes, two ears, and two index fingers. The preparation is only to be found inside small, gloomy cubicles, outside which red lights burn to warn ordinary people away. It stares fixedly at a small screen, and its fingers rest lightly and expectantly on two small squares of black plastic—microswitches. It does not feel hungry or tired or inquisitive; it does not think extraneous thoughts or try to understand what is going on. It simply processes information.

In terms of music psychology, this 'Frankenstinian' orientation has led to many studies in which subjects hear short computer-generated fragments through headphones and then are required to make some (usually binary) judgement about them, whose accuracy and reaction time may be measured relatively simply. The advantages and limitations of this approach are well known and discussed (for example Sloboda 1985; Longuet-Higgins 1987) and need not be rehearsed again here. Suffice to say that every single empirical contribution to this volume has, at one stage or another, adopted a different approach to measurement. In general, subjects have been allowed to produce responses of some complexity and length, free from excessive experimental constraints. This approach is essential is one is to make any meaningful contribution to the psychology of performance or composition.

The problems of recording and analysing these responses have been approached in a number of ways. Some researchers rely on auditory transcription into conventional (or amended) notation, and then perform formal or informal anayses on the transcripts (for example Gruson, Chapter 5; Dowling, Chapter 6; Sagi and Vitanyi, Chapter 8; Davidson and Welsh, Chapter 10). The advantages and disadvantages of the transcription method have been discussed at length by Sloboda and Parker (1985). Whilst transcription produces a record which is easily understandable by literate musicians, it runs the risk of making the performance seem more coherent than it actually was (by the transcriber's 'intelligent'

cleaning up of inherently messy data). It is also necessarily selective, and cannot reliably record information about expressive parameters of the performance. There also remains the problem of how to turn such transcriptions into quantitative form, for the application of statistical techniques. The contributors to this volume solve this problem in a number of ways, ranging from highly elaborate coding schemes (Gruson, Chapter 5) to informal stylistic analyses (Sagi and Vitanyi, Chapter 8).

Other researchers have used mechanical and electronic means of recording performance parameters in a precise quantitative fashion (for example Clarke, Chapter 1; Gabrielsson, Chapter 2; Sundberg, Chapter 3; Rasch, Chapter 4). This allows for more sophisticated statistical analysis, the testing of precise models with quantiative predictions, and the capturing of highly important expressive dimensions of performance. The disadvantages of this method arise largely from the data overload that is generated, and from the fact that it is much more difficult (although not impossible) to apply informed musical intelligence to the interpretation of data. The ubiquity of the computer has made the first problem more manageable and has, one suspects, been largely responsible for the modest upturn in the quantity of this work in the last ten years.

A third set of researchers have used tasks which require subjects to write down the end-products of their cognition in notation, traditional (Davidson and Welsh, Chapter 10) or otherwise (Davidson and Scripp, Chapter 8). This is a particularly useful method of studying composition, especially when coupled with verbal protocols. The disadvantage of the method is that schemes of quantitative measurement are hard to devise, and are usually descriptive in nature. They are, however, particularly rich sources of ideas and insights.

The third reason for the neglect of generative processes is linked to the second, and relates to the difficulties of devising suitable experimental controls over generative behaviour. Without some form of control over the conditions under which subjects exercise their generativity it becomes very difficult (but not entirely impossible) to extract any generalities about the processes involved; and without generality there is no science. The range of controls deployed in this volume varies from the very broad (in the case of improvisation and composition) to the very tight (in the case of some performance studies, where note, speed, and fingerings are specified). For instance, Sagi and Vitanyi (Chapter 8) offer the minimum constraint of a text. Subjects of varying abilities and backgrounds are required to improvise any tune they like to that text. Davidson and Welsh (Chapter 10) adopt a similar but rather more constrained tactic. They offer their subjects a rhythm, and ask them to assign pitches to the rhythms so as to produce a melody which must modulate in a certain way. Again, subjects of varying levels of ability are tested. Gruson (Chapter 5), in her study of piano

practising, simply specifies the piece to be practised, and leaves everything else up to the subjects.

Clarke (Chapter 1) is at the other extreme in his studies of expressive performance. He studies piano performance so as to control (by exclusion) the possibility of subjects using pitch and timbral variations, and then devises melodies with special qualities to test very specific hypotheses (such as that sliding the bar line along a single melodic fragment will affect expressive performance of it in systematic ways). Subjects are required to produce accurate performances of these melodies. Control is also obtained in another way by several authors. Instead of gathering data by looking at many different subjects, they obtain relatively large amounts of data from one or few subjects, looking for generalities *within* the behaviour of individual subjects (for example Clarke, Chapter 1; Gabrielsson, Chapter 2; Rasch, Chapter 4). It may be more important to show that the behaviour of an individual is systematic and rule governed, than to show that many individuals are systematic in precisely the same way. Indeed, in the study of artistic behaviour one may argue that one would neither expect, nor wish for, high degrees of uniformity between subjects.

The final part of this preface is concerned to make some general points about the contributions to the volume, and to highlight some specific aspects of individual contributions.

The first thing to say is that most of these contributions report pioneering work. There is no long tradition of research into most aspects of music generation. Thus, to my knowledge, Gruson (Chapter 5) is the first person ever to have subjected rehearsal behaviour to systematic quantitative analysis. Davidson and Welsh (Chapter 10) are the first to apply systematic analysis to a compositional task undertaken by groups chosen to represent differing ability levels. Sagi and Vitanyi (Chapter 8) have created the first large-scale corpus of improvisations by untrained people. With the pioneering comes an element of risk. It is not clear which of these approaches and ideas have a future. Some of the work is necessarily exploratory, and without the substantial backing of related research. It is not clear that all the theorizing contained here will actually be confirmed by data. Lerdahl makes a provocative and highly original claim about what constitutes a viable relationship between methods by which composers compose and how listeners listen. Will composers be able to use Lerdahl's constraints to guide them towards composing structurally rich yet comprehensible pieces? We do not yet know. Can Pressing's impressive theory of improvisation be tested against actual improvisations? The ideas are rich and plausible, but do they have predictive value? Such issues are raised but not resolved here.

The second point about the contributions is that they are truly interdisciplinary in nature. The contributors are roughly equally divided

into those working in psychology departments or other scientific setings, and those working in music or socio-cultural studies. The individaul contributions draw on ideas from linguistics, sociology, neurophysiology, acoustics, artificial intelligence and computer science, as well as psychology and music. This diversity of approach is welcome, particularly when similar ideas recur in contributions from quite different sources. It does mean, however, that several languages and perspectives rub shoulders with one another, and this sometimes makes for tensions. Psychologists may well find the contributions of the musicians unsatisfactory because of their apparent disconnection from the task of data gathering. Experimentalists may well find the rather informal analyses in some of the papers disappointing. On the other hand, musicians may well find the interpretative caution of some psychologists irritating and pedantic. Others may find the cultural narrowness of the types of music discussed less than satisfactory. Neither I nor the contributors should have to apologize for this. As a reflection of the 'state of the art' this volume represents the growth pains of a young discipline, full of ideas and enthusiasm, but not wholly co-ordinated in approach or methodological priorities.

Chapters 1 to 3 form a relatively coherent group of contributions, all focusing in slightly different ways on the question of what makes a musical performance. It is abundantly clear that a mechanical performance reproducing exactly what is contained in the notation rarely makes a satisfactory performance. Clarke (Chapter 1) emphasizes the role of performance in exemplifying structural aspects of the music through expressive gradients, discontinuities, and contrasts. He embeds several ingenious experimental studies within a theoretical framework that emphasizes the importance of hierarchical mental representations as a means of controlling performances. Gabrielsson (Chapter 2) supplements Clarke's study with some naturalistic data on rhythmic performance. This data confirms that performers make systematic and significant deviations from strict metricality, but also that it is hard to make generalizations about the nature of the deviations. The same figure may be played differently in different contexts, or by the same performer on different occasions. Sundberg (Chapter 3) describes some ingenious studies where a computer 'learns' to play expressively by being supplied with a set of rules for modulating timing and loudness in certain musical contexts. These rules are modified by playing the results to a panel of human judges and asking for judgements of appropriateness. Sundberg amplifies the interesting point that 'apt' expressive devices are very often not explicitly identified as such by judges, but simply contribute to a sense of 'rightness' about a performance.

Rasch (Chapter 4) summarizes his painstaking and elegant work on synchronization in ensemble performance. He is one of a tiny number of researchers who have examined any aspect of ensemble playing. He

reports many intriguing results, including the finding that musicians achieve better synchrony at faster speeds than at slower speeds. It also seems that a degree of asynchrony increases the perceptual clarity of individual lines, even though listeners are not consciously aware of quite large degrees of asynchronization in musical performance. Finally, Rasch provides an elegant mathematical justification for the fact that ensemble of more than 10 players tend to need a conductor while smaller groups do not.

Gruson (Chapter 5) reports a pioneering study on rehearsal strategies of musicians at different levels. She finds that people at any given level do not change their strategy much over the course of learning a given piece, but that significant strategy differences do exist between different levels of expertise. For instance, experienced players are more likely to repeat musically coherent sections of the piece. Beginners are much more likely to repeat individual notes. The general drift of her evidence is that experienced rehearsers are more aware of the structure of what they are rehearsing, and that this makes rehearsal more efficient.

Dowling (Chapter 6) explores the strong links between perception and production in the development of musical competence in young children. He reviews the literature on developmental aspects of song production and reports two new empirical studies. The first shows that children as young as three years old can reliably discriminate tonal from atonal melodies so long as their song performance is relatively advanced. The second study explores the structure of nursery songs as opposed to folk-songs and art songs. The analysis shows that nursery rhymes very rarely depart from strict diatonicity, and Dowling argues that such songs are optimal for children extracting and internalizing rules of tonality. This chapter is, in a sense, the pivot of the book, since it reminds us that children's song has elements of reproduction and improvisation inextricably intertwined. The preceding chapters deal exclusively with reproductive performance. Those to follow deal exclusively with the creation of new music through improvisation or composition.

Pressing (Chapter 7) provides a monumental survey of concepts from a number of disciplines that are relevant to an understanding of improvisation, and outlines a theory of improvisation that concentrates on the psychological bases for moment-to-moment choices within an improvisational structure. The theory is associationistic in nature, and proposes that improvisation proceeds by means of choices of elements which either *continue* or *interrupt* some aspect of the immediately preceding context. In its concern with the note-by-note structure of an improvisation it contrasts with the contribution of Sagi and Vitanyi (Chapter 8). Here, the emphasis is on global features of structure and style in the spontaneous improvisations of ordinary Hungarians. A principal finding of the study was that the majority of untrained subjects were able to use *some* coherent strategy to provide a

melody, often based on forms available in their culture, but to some extent affected by the nature of the words they were required to set.

Davidson and Scripp (Chapter 9) present intriguing data from children aged five to seven who were asked to notate various musical fragments without explicit instruction. What is particularly impressive about these data is the coherence of the schemes devised by children. Even at age five, many children devise abstract symbols to represent particularly the rhythmic structure of the music. By age seven, pitch becomes an increasing focus for notational attention. Interestingly, at age five performance skill and notational skill seem largely uncorrelated; but by age seven the two seem to have become 'yoked' together into a unified domain of musical intelligence.

The final two chapters in the book turn to the skill of composition. Lerdahl (Chapter 10) draws some logical yet provocative consequences from his influential work with Jackendoff (Lerdahl and Jackendoff 1983). If a listener understands music by constructing a hierarchical mental representation of it, then effective compositions will abide by constraints which allow listeners to do just that. Lerdahl identifies a number of specific constraints, and shows that serial music falls foul of several of them. This, he argues, is the reason why such music is so impenetrable.

Davidson and Welsh (Chapter 11) adopt a data-driven approach, in contrast to Lerdahl's theory-driven one. They look at the processes by which music students of differing expertise construct a melody given certain conditions that the melody must fulfil. Their analysis yields some tempting pointers as to the nature of compositional expertise. The more expert group worked with larger units (as shown by the size of section they would play over). They also engaged in more reflection, while the less experienced group worked in an enactive fashion (for example trying out possibilities at random until hitting on one that 'worked'). The study also highlights the dissociation of skills at this level. Even very gifted performers can be 'poor' composers without specific practice.

It is customary for the editors of multi-author volumes to draw some general overarching conclusion from the set of studies he or she has gathered together. I am reluctant to do this. My reluctance stems from the fact that the unity of a set of papers is often to be found, not in their outcomes, but in the shared assumptions that motivated them. In the case of this volume, many of the contributors attended an international conference on Psychology and the Arts held in Cardiff in 1983 (Crozier and Chapman 1984). It was primarily as a result of conversations there, and a sense of shared purpose, that the idea for this book was born. To find, therefore, that the contributions point in the same general direction is as little of a surprise as it would be to discover that the occupants of a given aeroplane are all headed for the same destination.

In the case of this volume, I would identify five core assumptions which run explicitly or implicitly through the majority of contributions:

(1) Music generative capacity is inherent in all human beings, although it may be developed to a greater or lesser extent.
(2) The capacity to generate any but the most primitive musical sequences is based on the ability to derive sound sequences from higher-order structures or rule systems.
(3) These rule systems have some universal constraints on them (arising from general facts about human cognitive capacity) but incorporate specific constraints picked up from the prevailing musical culture.
(4) Specific instruction is not necessary for skill acquisition, but practice is. Through practice, and possibly through general developmental changes, similar stages in skill acquisition can be observed in the several generative domains.
(5) Many aspects of skill become partly automated, and not open to conscious introspection. Their nature must therefore be elucidated by observation and analysis of generative behaviour rather than (or in addition to) verbal self-report.

The papers in this volume all attempt to put flesh on the bare bones of one or more of these assumptions through theorizing and/or empirical observation. Their success may be judged by the degree to which the reader is more inclined to assent to these assumptions after reading the book than he or she was before. If the reader wishes for elucidation on different but equally important issues, such as the role of motivation and emotion in sustaining and shaping generative behaviour, or the nature of effective training in these skills, then he or she must search elsewhere. If the search is successful then I would certainly like to know about it.

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Contents

1

Generative principles in music performance

ERIC F. CLARKE

Introduction

The aim of this chapter is to give an account of generative principles involved in music performance at two levels. One level concerns the representation of musical structure in a form that gives a coherent and intelligent input into a motor system. The word generative is understood here in the same descriptive and analytic sense as in Chomsky (1957), and in the more recent music theory of Lerdahl and Jackendoff (1983). The second level at which generative principles are identifiable is in the production and control of the expressive aspects of performance, which function so as to convey a particular interpretation of a musical structure. This sense of the word generative is much closer to the idea that something is actually generated, rather than simply being describable in terms of generative principles. These two usages of the term correspond to rather different psychological orientations, and while there are certain circumstances in which the two become closely associated, one purpose of this chapter is to illustrate the distinction between them.

The generative structure of musical knowledge

Playing music is an activity that is comparable in cognitive complexity to speaking a language, and comparable in its demands on motor control to playing a sport like tennis. It has thus been a focus of attention for psychologists interested in issues of motor control (for example Gates and Bradshaw 1974; Shaffer 1981), and for those interested primarily in musical cognition (for example Bengtsson and Gabrielsson 1983; Sloboda 1983). The motor programming perspective adopted in most recent work on motor control has, however, diminished the separation between these two lines of enquiry by emphasizing the importance of cognitive structures in the control of movement. Continuous reference to a large body of musical knowledge is required in music performance if the result is to be

fluent and intelligent, making it difficult to maintain a definite distinction between the cognitive structures of abstract musical understanding and those embodied in a motor programme for musical performance. This discussion of the knowledge structures that form the basis for musical performances therefore starts at a comparatively high level of abstraction by considering first some aspects of music theory.

Although the relationship between music theory and psychology is rather loosely defined, most music theory not only incorporates psychological principles of one sort or another (for example gestalt principles in Meyer 1973), but also takes the explanation of musical experience as one of its primary aims. It is, in other words, a theory of how people hear music, as well as a theory of how music is formally structured.* The structures described by music theory can therefore be taken as reasonable indicators of the nature of cognitive structures for music, particularly since recent work (for example Shepard 1982) has tended to confirm the perceptual significance of these structures.

The most widespread characteristic of musical structure embodied in music theory is its hierarchical nature (see Narmour 1983 for a recent review). In the parameters of both pitch and rhythm, structures are represented almost without exception as being organized in a series of levels, between which relationships of reduction or elaboration operate. Although hierarchical structures should not simply be equated with generative structures, they are nevertheless closely related, and as a number of authors have shown (for example Longuet-Higgins 1976; Sundberg and Lindblom 1976; Lerdahl and Jackendoff 1983) truly generative theories can be shown to have considerable explanatory power.

All of these studies make use of tree diagrams as representations for a generative structure, although it is not a requirement that a generative structure be represented in this way. Since a tree diagram is a useful shorthand that conveys generative relationships, I will make use of it for illustrative purposes in the following discussion. In considering the generative structures of musical knowledge, my aim is to examine their more global characteristics, rather than the precise nature of the generative principles themselves. It is the topology of generative relationships that is of interest, or put another way, the pattern of hierarchical structures that constitutes musical knowledge.

The issue can be tackled only in relation to specific performance conditions. It is inevitable that the knowledge structures that underlie a performance of a piece from memory will be different, at the highest levels at least, from those associated with a free improvisation, or a sight-read performance from notation. Starting at one extreme, performances of

* Note that this is not the case with all music theory. For example many of the structures discussed in Forte (1973) are of a level and type of abstraction that makes it extremely unlikely that they could be perceived in any direct fashion.

classical music from memory appear to offer the most deeply embedded generative structures. Though something of an idealization, we can imagine a performer who, at the start of a performance, has a complete knowledge of the generative structure of the piece, from the very highest level, where the whole piece is represented as a unity, down to the lowest level, where each individual note is represented. Figure 1.1 is a schematic representation of such a knowledge structure. Evidence for the highest level in this structure is rather sparse, and is confined to statements by a number of composers (Mozart, Beethoven, Hindemith) which indicate that they were able to hear (or imagine) their own compositions in a single 'glance'. Since these composers were also performers, the unified conceptions of which they claimed to be capable can be regarded as the basis of performances as well as compositions.

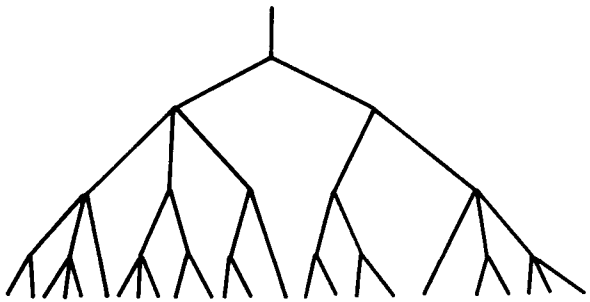

Fig. 1.1. Schematic representation of an idealized knowledge structure for a memorized musical performance.

The evidence for totally unified structural knowledge is a little tenuous, but does not affect the essential point that high-level musical structures acquire unified cognitive representations. It is easier to accept that a performer may have a unified conception of each of three large sections, for instance, that together make up a movement. These units connect with all the individual events of the piece through the multi-levelled branching structure that a tree diagram illustrates. It is difficult to know quite how one might experimentally test the existence of these very high levels of generative structure, but tonal structures of a fairly abstract nature (and hence at a fairly high hierarchical level) such as the concept of key, or tonal area, have been demonstrated to have psychological reality as well as theoretical value (see Krumhansl 1983).

The idea that a performer who has memorized a piece of music has a complete generative representation is an idealization not only because the structural depth of the representation is uncertain, but also because it seems implausible that a complete structural representation of the