Composition: my laboratory for auditory perception research

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Although listening to a wide variety of music and playing piano and violin formed a vital part of my childhood, the initiation of my compositional activities began only after some post-secondary training in the visual arts, and without previous exposure to music theory, analysis or harmony. My approach to composition is therefore that of an artist manipulating sounds and time to create new forms.

My "palette of raw materials" has remained quite constant since my first endeavors, consisting of various elements which I assimilated for aesthetic reasons. It includes a strong preference for the simultaneous presentation of several independent ideas, a tendency to employ irregular metric structures, additive rhythms and polyrhythms, shifting or ambiguous tonalities, and a predilection for linear configurations more than vertical harmonic structures. The cycles, sounds, processes and behaviors of nature are a major source of inspiration, ranging from the incorporation of rhythmic/melodic cells based on birdsong to the integration of complex periodic structures (such as the relation between solar and lunar cycles) into formal designs.

All of these elements are evident to various extents in many previous works of the twentieth century. Varèse, Stravinsky, Ives and Messiaen, for instance, designed striking formal structures composed of various layers of superimposed or juxtaposed musical material. However, I discovered that the specific means of construction employed in these works are rarely articulated by analysts or composition teachers. Therefore, I felt compelled to formulate my own analytical methods in order to understand the strategies employed. Studies in music psychology and time perception proved helpful for tackling the perceptual issues involved.

Because most of my compositions are undertaken in part as studies for future works, I analyze and evaluate the various strategies explored in each one in order to gauge their success and potential. Unlike standard experimental psychology procedures, where various subjects are questioned on their responses, my own enquiries are directed specifically at one subject only -- myself -- although comments of listeners and performers are also noted. I complement this more experimental aspect with listening to and analyzing other works of many different styles, as well as reading essays by composers, theorists, cognitive scientists, etc. Ideas which I derive from the research are tested not only in my compositions but also in conversations with colleagues, in the classroom, and through writings and presentations.

The crux of the problem I have faced is how to create the illusion of coexisting independent ideas in a musical passage. Although an obvious solution is to compose two or more contrasting "layers" and overlay them, it quickly becomes apparent that too much contrast will produce chaos, or information overload, whereas too little may produce boredom, or restrict the potential for development within a single layer. In order to present a valid musical composition, the techniques for manipulating the various layers have to be flexible enough to permit an accumulation and release of tension, analogous to the structuring of contrapuntal works.

The concepts of "auditory scene analysis" developed by Bregman and others (Bregman, 1990) have proved extremely suitable for the articulation of the problem and the search for interesting solutions. For instance, the incorporation of elements and strategies which promote fusion within one layer, providing internal coherence, facilitates the creation of contrast, or fission, between it and other layers. Such fusion can be most easily achieved through the use of redundancy and the establishment of hierarchical structures as in tonality and meter; however, modern musical language is often neither tonal nor metric. The high redundancy of an ostinato, which establishes its own pitch collection and rhythmic hierarchy, has made it a favorite choice of several composers for the more complex sections of their works.

A differentiation by contrast can be achieved by superposition or by juxtaposition. In superpositioning, or true simultaneous presentation of different "layers" of material, the perception of contrast seems most dependent on onset asynchrony, on the presence of rhythmic dissonance at a pulse level or higher, on registral separation, and in general on the establishment of separate "behaviors" or "characters" for the component layers. For example, although a loud layer will generally absorb a soft layer, a layer which has a changing dynamic level can (and will) be distinguished from one which has a different profile. When the distinction between layers is not sufficient to provoke fission, a sense of texture often results.

Juxtaposition can involve either the alternation of two ideas in oscillation, or the presentation of successive ideas without reverting back to a previous one. Apart from the establishment of different distinct characters or behaviors (as in superpositions), some of the strongest factors in the perception of juxtapositions are the specific pitch collection used, the specific tempo, and particularly the contrast in textural density. As in superpositions, the role of timbre in promoting fission seems very weak, probably because of our cultural tendency in Western art music to accept timbral mixtures in orchestral contexts and treat timbral variation as a "mere" coloristic variation in the treatment of a theme.

In juxtapositions, some different issues come into play -- most notably those of temporal perception. For example, if the change between one "type" of musical material and the following is not sufficiently abrupt, the listener may perceive a metamorphosis rather than a presentation of two distinct ideas. When the juxtapositions involve an alternation between two ideas (the form I usually choose, in order to maintain the idea of "simultaneity" on a higher level), any sense of a linear development of one musical idea may be lost if the time lapse between the fragments is too long. What constitutes "too long" is naturally dependent on several factors, including the nature of the intervening material and the absolute (clock-time) measurement of the interval.

My first major experiment in this area, in The Magellanic Clouds, a work for small mixed ensemble, involved the "splicing in" of short fragments of a more chordal, tonal melody into the center of more atonal, textural fragments (Figure 1). However, it was practically impossible to retain in memory the pitch information of the melody across the intervening intervals of over one minute, though in retrospect I attribute some of the failure to insufficient fission between the two patterns because of the specific materials and techniques employed, as well as to inadequate differentiation on the part of the performers. In the same year I tested the same concept on a much smaller scale, in the cadential passage of a movement in my String Trio, where in fact the ear seems better able to track the cadential chords despite intervening unrelated material (Figure 2). The

familiarity of the cadential formula, the more pronounced contrast between the two parts, and especially the greatly reduced temporal framework are assumed to be major contributors to the relative success of that experiment.

Two works produced the following year (Here and There, A Crack for tape, produced on the Buchla synthesizer, and MostELinODatiIES for two violins) were both constructed by the techniques of splicing and layering (literally in the electronic work, by analogy in the other) to explore a variety of superpositions and juxtapositions. The various degrees of clarity and fission help delineate the formal shape of the work in MostELinODatiIES. Fission is achieved through several means, especially through the attribution of individual characteristics to each gesture or fragment, emphasized by a presentation in isolation and as a longer passage. These familiar strategies ensure better recognition when the fragment is subsequently presented in abbreviated form and/or simultaneous with another layer (Figure 3). The average length of fragment decreases throughout the work, partly to delineate a specific formal structure of increasing complexity, but also to compensate for the redundancy introduced by an increasing familiarity of the material.

The ease with which a listener can isolate a melody from an accompanying texture even without recourse to registral or timbral separation was demonstrated in the third movement ("Inlaid") of Designs in Brass (Figure 4). The irregular rhythms and more differentiated dynamic profile of the melody and the higher degree of redundancy of the accompanying pattern are assumed to be responsible for the fission. In the same passage, however, the play of a 6x3 quarter-note pattern in lower brass was not as audible as expected against the main 4+4+4+3 accompaniment pattern. I assume this counterpoint could be brought into the foreground with more change in the pitch structure delineating the 6x3 pattern, without having to resort to a more blatant means such as a change in the relative intensity levels or timbral blend.

Continued exploration of polyrhythms and superimposed strata in a variety of alignments, temporal contexts and densities are visible in most of my works since that time. Sometimes the play is quite overt, as in the fixed-pitch foreground polyrhythmic patterns in The Emperor's New Music (Figure 5) and Sondas Sonoras (Figure 6). Others are more hidden, as in the introduction of Underground Streams (1991), where the cello presents a six-bar phrase repeated once against three repetitions of a four-bar rhythmic pattern in the piano (Figure 7a). The subtlety of this rhythmic dissonance is further obscured by the fact that both instruments are subject to the same tempo rubato, a strong fusion-producing factor. Much more strident is the dissonance between two presentations of a melodic fragment in the two instruments at an interval of one eighth note (Figure 7b). The next passage has a similar type of dissonance, displaced by a sixteenth note, but seems much less harsh, probably due to: a) the fact that the offset affects a later part of the motif rather than the initial notes, b) a lower density of notes per second, c) a lower intensity level, and d) the fact that the two presentations are in the same instrument (Figure 7c). A medium-level dissonance in the same work involves this same motive, presented as a 9/8 pattern in the cello alone, then simultaneously with a 7/8 pattern in the piano (Figure 7d). The dissonance is clearly audible, but the sharing of register and pitch collection seems to reduce the harshness.

In Spring Thaw (1996), the relationship between metric structure and pattern recognition was explored by the repetition of a melodic fragment offset by one eighth note with respect to the barline (Figure 8a). The effect seems to hinder recognition to the point that the second phrase appears related to the first only in a general sense, not as identical but metrically displaced material.

The accompaniment pattern is dissonant on two levels in both cases, though consonant with the notated beat; it presents a 3-beat triplet figure in contrast to the 4/4 metric notation. A more subtle exploration of recognition of the sequence is instigated by a previous presentation of the pitch material (but with varying intensities and octave doublings) in a much slower tempo (Figure 8b). My objective was to familiarize the listener with the pitch sequence in a subtle way, without creating too much predictability or redundancy for the subsequent manifestations.

My most rigorously-planned experiment in temporal perception was that of Poly I (1989) for string quintet, in which the entire work embodies periodicities on various levels. The piece consists of 9 fragments, 3 of which repeat around twice a minute, and 5 around once a minute. Only two fragments are designed to synchronize exactly; the non-alignment of the others was intended to create perceptible relationships of an approaching and a moving away from coinciding, as well as to produce passages of higher and lower density. The fragments themselves are differentiated by a variety of characteristics, embracing short chordal motives, longer ostinato fragments, and one which exhibits an "inner modulation" by changing register and intervallic profile "predictably" at each recurrence (Figure 9). The only layer which is virtually always present consists of a slowly ascending line, beginning in the double bass and ending in the high register of the violin, with a note sounding every 1.5 seconds and moving in intervals which increase in size from 1/4-tones to 3/4-tones at the first "pass", and from 1/3-tones to major 3rds in the final one; the consequent shortening of the line was conceived to counteract the psychological effect of tedium.

The various superpositions (resulting from simultaneous occurrences of fragments) were deliberately treated in different ways to permit closer study. It was discovered that the specific rhythmic placement, as well as the density of the fragments, affected the perceptual effect. Due to the limited number of performers, it was sometimes impossible to present all the relevant notes in instances where several lines were theoretically sounding together. Therefore, decisions were made to establish rules of prominence in the case of overlaps. In some cases, the interruption of the "background" ascending line sounds like an interruption, whereas in others its absence is unnoticed or at least appears logically obscured by the "foreground" superposition. This suggested that the ear is not easily convinced about a fragment's "opacity" by mere elimination of background notes from its vicinity, although such an illusion might be possible to create with more attention.

Although it was never assumed that the periodicities would be heard with confidence as periodic, in terms of clock-time regularity, the design of Poly I was chosen as a potentially useful model for scrutiny. Surprisingly, although some elements of the formal structure are quite audible and interesting, it seems difficult to track the specific changing relations of the various layers, even knowing the design. It is proposed that the main contributor to this difficulty is in the extremely strong "horizontalizing" effect of the work, whereby the tendency to listen linearly rather than vertically is so encouraged by the surface features of this work that the vertical simultaneities are heard only with difficulty.

Sondas Sonoras (1995) and String Quartet I (1997) both employ periodicities on a very local level, as a result of my increasing conviction that, in the absence of relatively simple hierarchical structure, local configurations are by far the strongest influence on the listener's appreciation of form. At the beginning of the String Quartet, three different tempi are presented in a relatively simple-to-perform context by means of dividing the beat into 4, 5 and 6 but with the subdivisions always grouped by four (Figure 10a). A more complex relationship is achieved when

one of these layers slows down in relation to the others ; later on in the work the same effect is produced by different means, as the cellist is asked to play in a different tempo, "ignoring" the others (Figure 10b). These devices reflect techniques explored by Ligeti, Lutoslawski, and Carter, among others, consciously kept within a very accessible range of performance difficulty.

The String Quartet is the most fluid formal structure I have used to date -- the justification was that a high degree of redundancy on the local level precluded the need for repetition (recurrence) on a higher level. The form was designed to encourage a variegated sense of time. With activity shifting from one level to another (pulse to phrase, phrase to sub-pulse, etc.) it was calculated that the listener would find the tracking of time difficult and therefore abandon it, concentrating instead on foreground details.

The concentration on temporal perception is becoming a primary concern for me now, as I explore the alternatives to a linear appreciation that are likely to result from any listening to a multi-layer work. Apart from a multi-linear order, with the focus shifting back and forth from one layer to another, or a varying temporal focus, as the attention shifts from one level of organization to another, there are possibilities of tangential listening and interruptions by moments of retrospection. Through reflection and composition, I am now trying to determine how it is possible to promote one type of listening strategy over another by the specific musical structure. The effect of familiarity, for example, will provoke anticipation, a low density of information with low tension will likely promote retrospection, and an extra-opus link may encourage a focus away from the immediate foreground of the present music. This kind of classification is intimately linked with a search for those factors which will produce tension -- factors which in a general sense are well-known but which in their specifics are very context-dependent and must be redefined by the composer in each work.

Although it can be seen that I am facing problems similar to those faced by composers through the ages, it was not clear to me what aspects of the solutions found by earlier composers were separable from their contexts. In other words, working outside of the tonally- and metrically-organized systems made it necessary to re-evaluate the strategies which worked within those systems. I have found the language and perspectives of the cognitive sciences very useful for reflecting on these matters.

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