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## FACTORS THAT INFLUENCE OUR PERCEPTION OF TIME IN MUSIC

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The perception of time is a complex phenomenon. When we say that this summer flew by, that it seems like ages since yesterday morning, that the new piece at the concert was too long, we are referring not to a measurable duration but to a personal subjective sense of that duration. Because we all have such contradictory impressions of any particular duration, we tend to rely on clocks as time-keepers. The uniformity of each second as measured by the clock helps us coordinate our actions with each other. They provide an external reference, acting as substitutes or supplements for the external references traditionally provided by the sun, moon, and other cyclic features of the natural environment.

The body possesses a variety of periodic features that may function in a similar way to the external reference. These range from brainwaves to heartbeat and breathing. All are susceptible to fluctuation to a certain degree, but in a normal state their cycles will be regular and may provide an internal reference by which we can measure the passage of time.

Music is a rather peculiar phenomenon. Being temporal, it is prone to the personal subjective sense of duration. But it is carefully designed to affect that subjective sense, and even to modify or confuse our internal references; if the musical pulse is very close to our own pulse or breathing rate, we have a tendency to synchronize with it. Then we are susceptible to the slightest speeding up or slowing down of that beat.

It can be useful to view the beat in music functioning as a representation of clock time. It establishes a reference which then emphasizes the irregularity of any melodic or other non-periodic elements. In some music, the absence of a noticeable beat seems designed to avoid the time-reference. Timelessness is often associated with the metaphysical: the eternal world of the Gods from which our world was created, or the realm of ideas and absolutes where change is not present. Therefore such music can focus reflection on that level, by moving the listener away from the time-passage of the external physical world. Examples of this sort abound in the Eastern musical traditions, such as the Buddhist shakuhachi repertoire of Japan and the Chinese scholar-priest's

music for the ch in but can also be sensed in earlier Western traditions of Gregorian chant and its traces in subsequent liturgical works such as those of Palestrina. Several 20th-century composers, inspired by the concept of space-time, have designed works which present apparently unrelated gestures outside of a causal sequence; this can produce similar results but the contemplative sense usually depends on a certain sparcity of texture not always present in such works.

These musics accomplish an effect of timelessness by eliminating a perceptible rhythmic pulse; there is another body of music, however, which functions in a similar way by the opposite means: a rapidly reiterated static pulse. Examples of this are found in music of the Javanese gamelan and certain modes of African drumming and singing. This music has aptly been called "trance music", as it instills a sense of timelessness in the properly-conditioned listener by effectively hypnotizing him. It is most commonly found in conjunction with rituals where a semi-hypnotic state is desired. This reminds us that the function of music is quite specific in many cultures, and it is not always that of entertainment. Confusion of functions usually results in a very odd perception of timing in a piece. Other cultures' aesthetics provide interesting material for experimentation, but it must be manipulated with sensitivity. There is no universal ideal of correct timing; each successful piece has its own consistent scale, governing rhythmic features including large-scale formal organization, and influencing choice of intervals, dynamic range, textural density, etc. The prominence of the beat, the choice of tempo, and the variety and density of elements in a musical piece constitute its inner proportions. The resulting dynamic flux may reflect or influence the cultural norms of preferred shape.

Much of traditional Western "concert music" has been characterized by a certain dramatic profile which curves up to a climactic peak towards the end of the piece then gently settles to a final rest. This curve traditionally operates through harmonic structure and textural density, and is often reflected in the melodic shape of the phrase. Such a profile may be one of the most common means by which we estimate the length of a piece. By ascertaining the slope of the curve (an intuitive or subconscious process) we project the moment of arrival of the climax. If it arrives sooner, we are usually distracted by the climax itself from noticing its prematurity. But if the climax is not present by the predicted moment, one may be left impatient and frustrated. The piece will begin to seem too long.

Debussy is a convenient marker for the shift of Western music away from the dominance of this traditional development/climax curve. His fascination with Eastern music is more than coincidence. Since his time, more and more composers have become acquainted with different styles of music that are designed according to quite different aesthetic principles and large-scale formal structures. Although often some of the foreign elements were simply superimposed on familiar frameworks, more and more diversity in essential structure have been appearing throughout the past century. This experimentation with new forms has been encouraged also by the advent of electronic music, which through the techniques of splicing and sound-on-sound encouraged formal structures involving juxtaposition and layering. Meanwhile, direct intercultural contact has been accelerating, to the point where a new genre called "world music" has been acknowledged (represented for instance by Jon Hassell).

When the Western composer borrows structures from Eastern musics where the standard time-frame is significantly different, the listener is likely to be unprepared and thus frustrated by the different pace or absence of traditional schema. Even more confusing (and common) is when the composer has borrowed elements out of context, so that there is in fact a dissonance between inner proportions: for instance, melodic contour might resemble traditional developmental structure while the overall harmonic structure remains static. Potential accessibility of virtually every kind of music in existence has provided the modern composer a complete palette of formal design possibilities. Such extremes have succeeded in breaking down expectations to the point where the composer can theoretically find precedence, and an audience, for any choice of pacing and timing. The problem is in identifying the stylistic reference to the audience as quickly as possible.

The opening gestures of a piece announce the scale upon which the inner proportions are based, thus establishing the time-frame of a piece; they are quite susceptible to interference from the echoes of the previous work, or echoes of the hectic schedule of the previous few hours. The grid of clock time must be sublimated or submerged for the metaphorical musical time grid to be properly established. Frequently in a concert setting the programming (i.e. the order in which the works are presented) often ignores their potential effect on each other, contributing further to the clash of musical time-frames.

The identification of structural scale and proportion can be reinforced or confounded by the performance environment. The sensitivity of the performer to all aspects discussed here will enable him to choose nuances of expression that will be in keeping with the inner proportions of the work. This may include adjusting of tempo and dynamics to the acoustical space of a room -- something that many performers will do instinctively, and many listeners are used to compensating for mentally. The more likely cause of dissonance with the proper time-frame is the programming, as mentioned earlier, and the psychological ambience of the performance space. By this I am referring to the difference in feeling between the local experimental art gallery and the symphony hall. The setting, and even the advertising, can prepare the listener or mislead him. False expectations will interfere with recognition of the musical time-frame.

One of the more manageable approaches to the elusive question of time perception involves the aid of information theory. It seems that our sense of subjective time fluctuates in relation to clock time according to the amount of information we receive per second. The upper limit of bits of information which can be processed by a human seems to be around 15-20 bits/second. Information (measured in bits) refers to those parts of the message which are so significant that the meaning would be to some extent incomprehensible without knowing them. The analogy that I find most useful is that of the telegram, which is written with the highest information level possible, with the least redundancy. There is an obvious loss of nuance in most telegrams, and grammar and natural flow are sacrificed. But the informed receiver of the telegram will be able to reconstruct the message sufficiently, given enough time. In well-proportioned music, on the contrary, the message unfolds slowly enough that the receiver has a chance to absorb the most significant aspects of one part before the next installment arrives.

Determining what constitutes a bit of information in music is the crux of our problem. Basically, it depends on the individual, how well he knows the given musical style, his ability to codify musical events, and his ability to concentrate during the performance. Ostensibly, a note would be a bit of information. But in an extreme case -- e.g. an exceptionally familiar recording -- the first bar might be grasped as one gesture, which in turn would identify the entire piece, so it might be listened to in huge chunks (i.e. a minimal number of bits.) At the other extreme, one note might be heard as a composite of onset transients and sine tones with individual envelope shapes. More commonly, a chord, an arpeggio, or even an entire cadential gesture could be heard as one bit of information. Experience and training thus have a direct relation to the amount of "information" that can be grasped from a musical phrase.

The listener's familiarity with a certain musical style is just one example of how varied the responses will be from individual to individual. The factors relating to the listener can be subdivided into the general areas of personal experience, personal taste, and willingness to listen. Personal experience is intertwined with one's exposure to musical styles. However, it is also dependent on the ease with which one integrates information. Intellectual training (such as a music theory course) can facilitate more efficient codification and therefore aid in memory storage and retrieval which is essential for grasping the coherence of any musical work.

Short-term memory serves as pre-analytical storage; data is retained briefly prior to processing. Psychologists equate it with our notion of the present, or "now", and generally estimate it to have a capacity of around 0.6 seconds, although the aural "echoic" memory may persist for up to 4 seconds. Since this is not even long enough to accommodate a sustained chord, it is obviously of little use to us in analyzing perception of time-passage in music. There has been little substantial research into long-term memory, for precisely the same reasons that the issue in question is so problematic: each individual has such a different background and different way of structuring his experiences and memories of them, that it precludes adequate experimental control and evaluation. I think that in music the educated listener may attempt to stretch his notion of the "now" to match the duration of the piece. That is, regardless of the fact that the aural information has exceeded the short-term memory capacity, an intermediate memory is established where events are stored until their function is clearly established. (This allows us to hear a motif develop into a full-blown theme five minutes later.) In this light, it is obvious why optimum coding is needed for compact storage and retrieval; the compression of data into motifs, gestures, and recognizable events is mandatory for successful retrieval. Such encoding is basically the reduction of the number of bits into a manageable amount. It applies to every aspect of music; unfamiliar timbres will require identification and therefore take up more processing time and storage space than familiar ones.

The difficulty experienced by many listeners on hearing 20th-century "avant-garde" music can be understood quite easily in terms of an overload of information. Unfamiliar timbres producing unfamiliar pitch sequences organized into unfamiliar rhythms can tire the most dedicated listener quickly! That so many modern works are performed only once is understandable, but only compounds the problem. The immense

popularity of the music of Terry Riley and Steve Reich was obviously due to the severe reduction in information coupled with a strong emphasis on periodic elements.

The advent of such "minimal" music demonstrated the other facet of information content: when the information rate is too slow, attention wanes producing the same lack of concentration as information overload. What is too slow? Again it depends on the individual and his state of mind at the time. Those who enjoy minimal music do so either because they are listening to the subtle shifts of timbre and speed and texture which tend to be obscured in more complex music (this was the basic intent of the minimal artists of the '60s) or because they are indulging in the hypnotic qualities to achieve a contemplative state, whether it be true meditation or simply daydreaming.

When we comment that a piece seemed too long, we are referring to some dissonance between our desired subjective time and that endured while listening to the piece. This can be a result not only of the composition's inner design, or a weak performance, but because one's chair is uncomfortable, or one is worried about dashing to the airport after the concert, or any of a variety of factors obviously unrelated to the music at hand but still related to one's perception of time. When these factors are extreme, the listener will usually be able to distinguish between factors in the composition and those extraneous to it. But often the situation is more subtle and complex.

Physical factors can influence perception by their rôle as trackers of external time. Distractions during performance effectively remind us of external clock time and thus disrupt our following the figurative time scale presented by the music. Our internal references can also interfere with proper reception of the musical information; any change to body metabolism will affect perception of external time and may affect the processing rate of information: hearing the same piece in the morning after two cups of coffee will be quite different from hearing it in the evening after dinner and wine.

A "convincing" piece of music is usually one where the composer is a master of time distortion. This is achieved by shifting information density, involving repetition of some elements and contrast of others. When the mind becomes used to a certain rate of information, it may perceive each second as being  $x$  number of bits long. Therefore, when that rate changes, the impression might be that the length of the second has changed.

The rate of information tolerated has (unfortunately!) an upper limit. It follows that some of this can be "used up" by things other than the piece of music itself. If the airport deadline is "on one's mind" then part of the mind will be occupied with calculating the distance to the car, estimating the number of minutes required to drive there, weighing the likelihood of traffic jams, etc. It stands to reason that the level of 15-20 bits/sec. will no longer be available for listening to the piece of music.

The rate of information that one has been receiving prior to the hearing of a certain work will also have an effect on one's tolerance of its density. This was already discussed in relation to programming. It can also apply to non-musical activities of the previous day or month. If one has been living a quiet life in a cabin without any means of

musical broadcast, then a trip into town for a concert may be anticipated with excitement, and a high rate of information will be welcomed. However, this positive receptive stance may quickly sour if the form of the piece is foreign and dissonant with the familiar soundscape of the cabin's environment. A more common example would be one of attending a concert after a hectic day at the office, where one might prefer to hear something quiet and familiar, requiring a minimum of information codifying and processing.

It is not difficult to imagine that time somehow had a different feel to it back in the seventeenth century. If so, then music must have shared it. But now we have recordings that uproot 17th-century musical works to be superimposed on our modern time-frame. So we can play such a recording, and follow it with a recording of Varèse, and Zappa, and Shostakovich, and by so doing construct a complex interweaving of musical densities. The net result may be that we will begin fine-tuning our individual senses of time to appreciate an ever-widening range of densities (of information) on an ever-widening scale of time perception. Oddly enough, this may be returning to a more ancient appreciation of the multiplicity of time-frames; when one realizes that the sun and moon cycles were used as external references, it can be deduced that the concepts of polyrhythms were familiar -- for the solar and lunar day differ by 51 minutes. This influence can be seen clearly in much of the music of Indonesia, where music was used as explicit imitation of natural cycles.

Experience and broad exposure are essential to the listener who wishes to develop the ability to discriminate between the piece which conflicts with his preferred aesthetics and the piece which conflicts with itself, or is indistinct in form. Compositions that do incorporate magnificent proportion and balance are the ones where we forget all sense of time and lose ourselves in the music. The reason that we find them so rewarding is that they release us from our normal struggle of reconciling our subjective time with the indifference of clock time, and for a few minutes we can experience a flow of time that is completely different, skillfully manipulated, and refreshing.

A "good sense of timing" is sometimes regarded as the intuitive gift that will differentiate the great composer from the dilettante. But it seems more likely to me that such a "sense" is present in all humans to some degree, and the difference is that some people are more aware of the rewards of sharpening that sense. Music is an ideal medium for developing our perceptions of and thoughts about time. It can be completely abstract and relatively free of the realm of clock time that binds most scientific research. I propose that the dedicated musician or listener would benefit from being more sensitive to the many factors that create the impression of musical time.

**bibliography:**

The sources consulted during my research on this subject are far too numerous to list here. [A more extensive list can be found in the bibliography of my thesis. RM]. Their authors include not only composers but also physicists, psychologists and philosophers. The following is a sampling which can lead the interested reader to further investigations.

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