

[Homepage](#)

Entities and Brain Organization: Logogenesis of Meaningful Time-Forms

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Abstract

The central nervous system function of time-form entities are examined. The term *Logogenesis* is introduced as a concept to denote genetically programmed development of mental concepts and time form-entities, as a counterpart to morphogenesis which concerns development of structure. Special attention is given to the time-form logogenesis of natural language entities of emotion communication, and their natural syntax. How time-forms are used in music to generate living, meaningful performances from written scores is described and proved with computer generated classical music, in the context of four modes of time experience, t1, t2, t3, and t4. The modes apply to different time scales and use different natural data processing properties. Models of appropriate peptide dynamics are suggested for some of these amygdala-related processes. Some properties of modified time consciousness in relation to these modes are also discussed.

Time Entities and Space Entities

The questions are very simple: Nerve activity within the brain consists of continuing streams of firing nerve cells, of myriads of synaptic potentials and fields. In this sea of seemingly overwhelming activity how can entities arise? Where are they to be found?

Somewhere within the myriads of substreams of neural activity perceived entities and thoughts make their appearance. We shall try as far as we can to consider through what processes entities may be formed. We will consider entities in *space* like a table, called objects, and entities in *time*, for which there is no common name. Most particularly, and perhaps somewhat uncommonly unfortunately, we will examine the nature of entities in time which we pervasively use in our daily life - in thoughts about our feelings, in communicating emotions and in our musical thought and activities.

An entity must have boundaries. For a table, however, not only the boundaries but also the space beneath the table may be considered as part of the entity. What are the patterns of neuronal activity that include both the table and the space in which it exists?

Neuronal activities of the visual cortex and a number of separate areas of brain functioning cooperate in creating the concept of table, both in its perceived and imagined processes. What defines a table in experience is created mentally. The retina knows nothing of "table", in spite of its differential, analytic sensing. To know that there is an entity, and that that entity moreover is a common object, and furthermore, is called "table" requires interactive processing of several involved brain areas whose interconnections are still only cursorily understood. From these interactions somehow, a unitary experience, an entity, is assembled and some agency of the brain in effect "says (to itself)", this is a

table. Mystery upon mysteries -- and we are not even yet including this "table" in a *flow* of thought, as occurs spontaneously. As soon as we are considering a flow of thought, time processes extraneous to the percept of the object 'table' are immediately involved. The perception of the 'table' is immersed in the perception of time, though the object itself is in space and may be considered as stationary.

But when you move your gaze, or turn your head, or both, the image on the retina and in the mental screen upon which the retinal image is projected, move. Yet we know even when this image is moving in this manner, that the table is stationary. If that same table is actually moving with respect to the observer, who is not turning his head or moving the eyes, then that moving retinal image is directly experienced as moving. Even when the observer's head and eyes are also turning and moving, the table can also be experienced as moving. In nearly all these cases, the brain is able to distinguish the object 'table' from its motion and obtain a combined percept that includes both the object and its kind of motion, regardless of turning of head and eyes. Since it includes motion, it includes experience of time. And since change is preferentially sensed by the nervous system, movement actually facilitates the recognition of an object-*entity*.

Genetic basis for entity recognition: Logogenesis

The mother's face and smile are meaningfully perceived virtually as early as this can be measured, i.e. in a few-weeks-old infant. Animal studies suggest that some objects like a mother's teat are perceived so early and readily that it can be assumed that there is a genetic basis for such recognition. The capacity for recognizing faces in humans, and the animal's ability to recognize conspecifics of either sex are genetically programmed. Thus some entities "live" in us by virtue of our genetic program; their recognition may be compared to Plato's *idea*, with the proviso that here the "idea" arrives from biology rather than from pre-existing harmony - from the harmony of DNA functions, a consequence of natural law. The genetic processes responsible for this function should teach us greatly about the how the brain accomplishes this, once the appropriate genes and their corresponding proteins are known.

It is already gradually becoming clear how structural entities are being built by the genetic apparatus, i.e. the processes of morphogenesis. Logogenesis -- the genetic development in the individual of entities in consciousness: genetically developed entities of meaning, of feelings and concepts, and genetically programmed interpretations of conscious percepts -- should yield to similar approaches. For example, a suitable mutation (or several) could conceivably change an animal's recognition of a conspecific to that of another species. If this occurs it would allow the pursuit of the detailed neuronal processes that have been *changed* by the mutation. We may expect to learn more about the functioning of the brain by such means than by observing brain function itself in detail with electrodes and other sensors, or even by imaging techniques. When *logogenesis* will be understood through molecular biology, it should permit us to track down the difference between entities of learned and innate knowledge.

In recognition of entities as objects, there is interplay between the innate and the learned. But no matter what the interplay, the game is played out in the experience of time.

Logogenesis of time forms - sentic forms.

Curiously, we know rather more about logogenesis in the production and recognition of time-entities or objects, than we do about space-object logogenesis.

Objects with trajectories in time but not in space are rarely named. Since they seem to lack "solidity", they are seldom given names even though they appear frequently and often recurringly. Their boundaries are not defined through the visual, nor the tactile systems. How do we know their

boundaries, then? When something ends in *time*, how do we know what has ended? In hearing sound, silence may mark an end, or on the other hand, it may merely indicate an "interval", a time analogous to the space between the lattices of a fence. Yet we frequently know when such an entity has ended. What is the nature of that something and how do we know if it is an entity?

t1, t2, t3, t4, Four time processes of time-form communication

Time for a physicist is a line where time goes from left to right, and the present is a point along that line. Any process in physics occurs from t1 to t2, two points along that line. The speed at which the point representing the present travels along that line is unspecified, and unspecifiable, a circumstance which does not worry a physicist. But the brain processes involved in time-consciousness are more particular. Different aspects of time experience involve different functionalities: there is more than one time-sensitive agency involved in our various experiences that involve time.

Here we shall be concerned with four different processing and experiential ways, operative on different time scales. A time object or entity has its invariance that makes it an entity, just as a space object has. What is the nature of that invariance?

An object in space includes its boundaries and is perceived in time. An object in time, however, has its own span of time, but is additionally experienced in the larger time-flow in the same direction, along with other preceptions, in a similar way as is a space object. We call this t1.

Time processing *within* a time-entity or object is a *second time process* superimposed: The time-object has a beginning, a middle and an end as it extends extension in time, and may also be experienced with memory and anticipation. Time scans across the time object and as it does so *memory* accumulates of its extension, and *anticipation* is gradually satisfied.

A *third temporal process* recognizes the speed at which the trajectory is traversed, or what is commonly called *tempo* in music (analogous to scale of a spatial entity).

A *fourth temporal process* occurs in the *millisecond range*, where durations are not perceived as time durations, and yet act to form characteristic perceived patterns, patterns which we note particularly in music rhythms and pulse, and in the shaping of speech, intrasyllabically.

Unlike the space object which we normally experience in the flow of time t1, a temporal entity is perceived through at least four distinct temporal processes. Instead of three dimensions of space and one of time with the experience of a spatial entity, plus the other sensory variables such as color, we are dealing with four dimensions of time in the experience of a time-entity, plus the dimensions of the sensed variables, e.g. sound.

Let us take an example. A person sighs. The sigh occurs in the flow of time-experience, say on a Saturday afternoon (t 1). Another person perceiving the sigh, and the person sighing, both know that the sigh began, took its course, and ended (process t2), i.e. had a particular trajectory in time, how the loudness and pitch rose and fell precisely, say. After the sigh there was no sigh and before the sigh there was no sigh. And further they know, let us say, that it was a medium long sigh, neither a very short sigh nor a very long one (time process t3). We can independently vary each of these dimensions. To a first approximation, distortion will not occur as the first dimension is varied, ie. whether the sigh is on Saturday afternoon, or morning. A time entity has an invariance, just as 'table' has. To understand its specific shape, it needs to be experienced in time dimension 2 as an entity, with recognition of its particular trajectory (analogous to the shape of a table). Thirdly, a limited degree of variation is possible

in time dimension 3, the tempo, analogous to the spatial scale of a table. Time dimensions 2 and 3 interact similarly in the way how a table might be distorted by compression or expansion in one dimension, ie elongated or squeezed together. If it squeezed or elongated too much it will not be recognizable as a table any more. (Interestingly, with some biologically programmed time entities, the latitude of variation in this third time dimension is comparatively narrow, say $\pm 50\%$. This is analogous to a narrow band spatial filter.)

The fourth process (t4) may be illustrated by considering the gait of a person. Seeing such persons from behind, we may be able to recognize them quite readily: the pattern of the gait is seen as uniquely their own. This is a subtle pattern in time, and the nervous system resolves this with a millisecond range resolution that permits the entire pattern to be selectively experienced and classified. It works regardless of the exact tempo of the walk. It is "relative" pattern.

A similar process takes place *within* the beat in music, and we shall discuss this further, in a later section. Recently, neurons have been identified that selectively respond to duration, at such time scales (Cassaday, Ehrlich and Covey (1994)).

Let us now return to the example of a sigh. As one hears a sigh, fairly early during its course one already knows it is a sigh (the fragment is compared with *memory*, either innate or learned, very likely innate in the case of a sigh) , and thus one *anticipates* its continuing course - in this one is either correct, in which case a degree of satisfaction occurs, or not - in which case one registers a degree of surprise, or of irritation, a sense of a *mistake* having been made in the execution of the sigh; or less often, in having been induced into wrong anticipation. A sense of toying with one's emotions may also be felt, something in fact "unnatural". What is this naturalness which is being violated here?

The crux of the matter is that these entities in time can have "*meaning*". Logogenesis of such specific time-entities provide a natural dictionary of emotional meaning - meaning which is innately programmed, and innately understood and communicated.

We have called such time-form entities used in the communication and generation of emotions *essentic forms* , or more briefly, *sentic forms*, and have isolated these forms for a number of emotions, in particular for anger, grief, love, sexual desire, joy, hate and reverence (Clynes 1973, 1977, 1988).

Such time entities have a contagious function. Their syntax is described in a later section.

Laughter and yawning may be taken as well known examples.

Serial Processing

In the memory process, serial order is an important factor. The direction of time is constant (unlike spatial orientation) so that what was *before* a particular event always remains that way in short-term memory (backward masking excepted, which occurs in the range of 30-50 milliseconds). Only in long-term memory is it easy to make mistakes concerning the order in which events have happened. Short-term events such as a pattern of speech maintains its order in time effortlessly. People do not normally reverse the order of syllables when they perceive a word, or even a sentence, nor do they reverse the order of notes within musical phrases. To do so in fact involves a special effort. *Reordering* the serial events is an *unnatural* process per se. The *natural* process is the placing of these events in the *correct serial order* - although we are so used to this that we do not easily see how extraordinary it is! We achieve this automatically in speech, music and many other events in daily life. The remarkableness of this ability is virtually completely neglected.

We don't know by what agency words remain (or are placed!) in the order they are "laid down". In a computer, there is no inherent requirement to keep the elements of the storage in a single order; only if they are given time labels is that order uniquely determined. A series of elements stored in an array may be read out as easily from left to right as from right to left, say, but they can easily be read out in random sequence also. A spoken sentence, however, necessarily remains in its proper order in memory, and is much more difficult to reproduce in reverse order, if at all possible. Actually, even if one attempts to reproduce a sentence in reverse order, one will tend to reproduce each of the constituent syllables as they were heard, and not themselves reversed in order. Finally, even if we could reverse each syllable, the actual sound involved in the syllables would still not be properly reversed. So we may say that *it is virtually impossible for any conscious person and presumably animal to simply reverse the temporal order in which an experience is stored*. This means that the beginning, middle, and end of a temporal object are nonarbitrary.

Although we can look at an object in space at all angles, left to right or up and down, we can look at a temporal object only in the direction in which it was experienced - an important property that seems trivial unjustly.

Temporal forms have a shape which is determined by at least one sensory variable in addition to time. For example, sound volume. Because time has only one physical dimension, while space has three, the combination of time and sensory experience has a smaller dimensionality than the corresponding combination of a space object. Consider for example, sound, which in addition to duration has attributes of pitch, of loudness, of tone color, all of which may have their own trajectories. An object in space, however, may show a great many more attributes in addition to the three spatial dimensions with its virtually limitless variety of spatial shapes: space objects can have color and texture in all their variety, it may have smell, taste, and tactile qualities. With the relative impoverishment of shapes within sound it might seem surprising how great a variety of experience they can nevertheless provide. In fact, it may be the very economy of dimensionality which helps it to focus more directly into the reaches of emotion than the overabundant dimensional variety with which the visual system is constantly bombarded. (Because it is part of the function of the emotional code of dynamic shapes, that if any variable simultaneously expresses a dynamic form inimical to the meaning, the other variables that well express the meaning are diminished in their expressive and communicative power.)

The evolving nervous system has an option of treating inputs as parallel or as serial. Parallel inputs such as the visual system are suitable for spatial experience. Time forms necessarily require serial processing, but they also can accomodate a great deal of parallel processing. A single sound, for example, carries with it simultaneous information concerning pitch, loudness, direction, and even tone quality. Several sounds occurring together can be perceived relatively clearly, and better if they are spatially separated. Parallel processing is carried out simultaneously with serial ordering such as that of syllables and of a series of tones in music. And it is accomplished relatively effortlessly, without effort of consciously separating serial and parallel processes.

Just as there are innate and learned aspects to the recognition of spatial forms, there appear to be also both innate and learned aspects in the recognition of temporal forms. The brain is programmed genetically to produce and perceive certain patterns of sounds, for example the various cries of newly born babies, and many of the cries of birds and other animals. The invariant temporal direction of such time forms make them very suitable as signals, and provide special advantages. Living organisms have developed specific time forms which they use to communicate - assured that these signals will be likely to be understood. Such forms have arisen in evolution especially to generate and communicate internal states we have come to call emotions. Though quite a number of psychologists in the past doubted that emotions "exist" because they are not "things", that is, objects in space, nature has given their expression a status in certain ways more notable and powerful than that of spatial objects.

Body-mind windows in the action of time entities.

A person's gait is a time-entity. We easily recognise someone we know even from behind, seeing only his/her gait. Like facial recognition, for which separate brain structures exist, gait recognition involves highly sophisticated data processing, with millisecond range resolution, and memory for that time-entity. It is possible that specialized brain structures like those for facial recognition may exist for the perception of such time-entities and their storage in memory. Certainly, each animal species too tends to have its own unique gait, which we readily "know". Perhaps it is because of its evolutionary advantage in distinguishing among animals that we (and probably other animals) have developed this ability. Dynamic aspects tend always to be more impressive than static ones, since they are excite receptors to a greater extent. (It would be interesting to do an experiment say with cats, to see whether they will recognize a cat-like walk in an otherwise uncatlike model.)

A different aspect is invoked if we consider that a particular feeling may be generated by such a time-form entity. The connection between the form and the feeling, genetically based, becomes then an inherent 'window' across the mind- body barrier. A one-one relation existing between them, within given circumstances, gives us to understand that the forms are not arbitrary, and that our minds are hardly free to respond to them other than as the inherent connection ordains. That there is such a connection is most obvious for the various forms of laughter, for yawning, and perhaps also for crying, all of which cannot be taught at school, nor eradicated by dictators. Nor could one explain to a visitor from another galaxy say, who did not have such an inherent program, what these time form patterns feel like. As to *why* they feel like this, we cannot even explain to ourselves.

The interaction of the mind and body in executing action (Clynes 1969,1970) whether expressive or nonexpressive is hardly understood, but is clearly experienced even in lifting of a single finger. But we should draw attention to the possibility that action can be precisely controlled without kinesthetic feedback: as it happens continually in the muscularly mediated adjustment of the focus of the lens of the eye, merely by our intention to look somewhere; or in the regulation of blood flow to those parts of the brain engaged in a particular thought process. There may exist time form entities which are not consciously experienced, yet originate from mental requirements.

Our new, non-elitist understanding of the language of music

As the gait readily reveals an individual within the human species, or a species among non-human species (some humans who are very well acquainted with a group of lions, say, may even be able to distinguish individuals among them by their specific gait) so we have found that in music such repeated patterns are similarly able to communicate identity.

We have found that the *Composer's Pulse* is such a time-entity. It is described, like a gait would be, as a specific time-amplitude function. To explain: in the case of music one begins with an even grid pattern of time-slots where notes could be found, a kind of temporal lattice. The Composer's Pulse then represents a *combined* time and amplitude warp of that pattern, a warp that distorts the equal temporal grid on which notes can be placed, and also provides a substantial amplitude pattern imprint across a group of notes. Such a combined twofold warp pattern is applied recursively throughout the music piece, as if the composer were "walking" (or perhaps, on occasion, storming or meandering) through the piece. Additionally, in the case of music, this warping time-entity *is active on several levels of organization*, simultaneously, in a hierarchical manner. Perhaps it is somewhat as if an individual who was walking were also *talking* at the same time in his/her particular, individual manner, and that the pattern of the speech reflected, on a different scale, the pattern of the gait - but with the proviso that the talking pattern be coordinated with the walking pattern.

With the Composer's Pulse we have an example of *meaning* carried through millisecond modulation of sound patterns. The meaning is also evident in the muscular gestures in which the Pulse can be evident motorically (eg. conducting). There is a one-one correspondence between the warp of the Pulse matrix and the form of the muscular repeated gesture (although the latter is dimensionally poorer). The warp predicts the gesture although the gesture cannot itself predict the warp, having less number of variables - the warp has 6 degrees of freedom, with a four-element Pulse. (If one were to measure several muscle tensions of the arm within the dynamic gesture however, there would be more variables available for this reverse prediction.)

Typical examples of meaning might be the strength and ethical restraint of the Beethoven pulse, the non-sexual longing of the Schubert pulse, the natural piety and enthusiasm of the Haydn pulse, the enveloping security of the Brahms pulse.

Ethnic pulses too carry emotionally oriented meaning: The feisty enthusiasm, the vital energy and temperament of the Hungarian Pulse of a Csardas, the sexual tension and macho-ness of Spanish music, the floating, joyfully sensuous lightness of the Viennese Waltz pulse, the pride and élan of the Polish Polonaise pulse, the joyful serenity of the pulse of certain Northern Indian music (Ragopati), the varieties of energy flow and feeling in African music, and so on. The nature of the meaning, as may be evident, tends always to be more precise than can be rendered in words.

Folk music today is not anymore even an endangered species: it is already extinct. No more folk music is being composed - it takes generations of refining and honing of the melodies for a beautiful folk song to arise through social nurturing. The Rock music of today is generated commercially and represents mostly the lowest common denominator, ie. emotional qualities that *sell* best, not that best express ethnic character. To a great extent, Music has ceased to be a muse and has become a whore. That has resulted in classical music becoming an endangered species.

But the new understanding of the language of music that we have now makes it possible to stage a rescue operation, to rescue classical music, because we can now make its expressive process and meaning readily available to anyone, not just to a strangely selected elite. No longer are athletics and coordination indispensable parts of learning music. They are abolished from music, to which they never belonged, except through dire necessity.

In this new way, we can choose the natural time-entities per se, creatively, without producing them with our bodies, have them pass through our mind-body windows, and activate our feelings, emotions, and insights in the way only music can. The entrance to a "better world", as Schubert said in his song 'An die Musik', a world in a sense our true home, is now open to essentially all of us - not merely as passive consumers, but as creative interpreters, as participants.

Molecular Basis of Logogenesis.

The basis of spatial entities in morphogenesis is mediated by the specific forms of proteins, and their folding. *Clocks may be regarded as converters of space forms to time forms.* Logogenesis of time-forms is most likely carried out by similar mechanisms as morphogenesis, with the mediation of specific molecular clocks to translate from space form to time form. Some molecular geneticists regard the genetic molecular apparatus as a language process with meaning. In logogenesis this carries across the body-mind barrier into genetically built inherent meaning: Meaning which finds its roots in specific proteins and how they fold, and in specific DNA sequences of genes, and one would presume developmentally in the action of neurotropic factors, and trk receptors, such as the recently discovered trkB and trkC, and their corresponding genes and gene regulators, a machinery basically similar to that

of morphogenesis. It is probable that when the genes for laughter are found we may rather soon thereafter have our first relatively detailed description of logogenetic processes.

Continuity.

A central problem (though one that is rarely a subject of scientific concern) is how from discontinuous events in time and discontinuous entities in space - molecules, electrons - continuous experience can be generated.

Continuity in space can be generated in two ways: 1. through superposition of individual effects, a property of a field. For example, the needle of a meter may have a stable position on space - a continuity - because its coil automatically summates the individual effects of the billions of electrons that generate the "field"; nature's superposition principle makes this possible. Or, the earth swings around the sun because the gravitational effects of separate particles of sun matter are superimposed. The superposition is perfect, one may add.

The effect of summation of individual events may be sensed by a sensor sensitive to the field at some point(s) in space.

The second way continuity is achieved in nature is through structure, eg. a crystal, a leaf. Sensing structure however means making a model, whether it is a lock and key fit of a special part, or a re-creation of some aspect of the structure elsewhere in the brain, as a "model". This model of course has to be sensed further, perhaps as a key and lock situation, or eventually as a combination of field with key and lock (otherwise an endless chain of "models" ensues).

Computer memory, a chain of ones and zeros, represents a special case of structure. In the brain memory is frequently accompanied by a time categorization that gives us information about *when* this memory was acquired. And how is this "when" represented? Nobody knows.

Continuity *in time* is a separate problem about which even less is known. How do we know the beginning, middle, and end of a specific time course? How can the brain make a model of this? Are there field effects that specifically allow recognition of a particular time course of a variable?

We may of course consider that clocks with settable flags - interrupts - acting like alarm clocks that let us know when "time is up". We can imagine some agency setting the alarm. But the problem is far more demanding than that. While some timing aspects of the brain appears well to work like that (e.g. deciding before falling asleep when to wake up), the sensing of logogenetic timeform entities clearly does *not* work like that.

At the very beginning of a logogenetic time form (such as a sigh, a yawn , laughter, a love expression, an anger, grief, hate , sexual, joy, or reverence expression, to name most of those that we have studied) we do not know *what* is sensed. The sense of "what" develops in the course of the time form. But after 300-400 milliseconds we already know "what" is being expressed. "What" has already become conscious. But the expression continues on. Only as it continues for 1 - 4 seconds depending on the particular emotion or quality, does the feeling itself *accumulate* . The first recognition is mental only. The time form has to complete itself in order for the *quality* of feeling to be experienced. If it is terminated prematurely, chopped off, then the feeling - built up to that point of the single expression - tends to be actually blocked from that point on.

We may explain the process as follows: At the beginning, a key-lock molecular operation starts a clock,

with an "on " signal, a particular logogenetic time form is selected and cumulative receptor binding begins. This cumulative receptor binding is sensed as a developing feeling. (This may involve some kind of cumulative field effect, on the "other side" of the receptors.) At the end, a second key-lock is activated shutting off further accumulation. Before further receptor binding can take place, another "on" signal needs to happen.

Thus if the off signal is not permitted to happen, or if it is not given sufficient time to act, there will be no possibility of a second expression accumulating further feeling.

Confusion can occur if the interval of time (and its time form) between an off signal and the next on signal is attempted to be interpreted as an expression in its own right instead of a 'reset', i.e. a separation between two successive expressions. In this case the sensing process may attempt to find some expressive meaning in a reset, a time slot necessarily devoid of such meaning. The lack of clear endpoints therefore can cause confusion. This can be seen in music, dance, a hallmark of poor performances, as well as in human and animal communication (musicians talk of the phrasing in music needing to "breathe").

At the second key-lock operation marking the end of a logogenetic time form "satisfaction" is experienced, in a degree largely independent of the particular emotion, but related to the success of expressing the time form "well". Repeated expression will result in increase in accumulation at the receptor sites, and intensity of feeling, provided adequate time is left for 'reset' between successive expressions. (Generally fractions of a second to 1.5 seconds, depending on the emotion. Imagine one laughter merging into another, of the same person, without any break, and you will see what is meant; it is felt as "mechanical").

The clocks and shaping of the logogenetic time forms appears to be largely done through the amygdala, the "gateway" to expression and perception of expression of emotion (Aggleton and Mishkin 1986).

Thus, the time-form entity gives rise to a *continuity* within itself, mediated by receptor binding processes. They result in the generation of "feeling", a feeling which can be blocked if the time-form cannot complete itself. Unlike a table, which can be partially visible and still be considered a table, a logogenetic time-form can fulfil its function only in complete temporal form. While an incomplete form may be mentally recognized as belonging to a particular emotion, it will be experienced as sterile, "intellectual", without the satisfying appendage of its own feeling.

Such a time-form, once begun, induces anticipation - as mentioned before - an expectation of completion within its time-frame of 1.5 - 8 seconds, say (depending on which emotion is expressed). A conscious, or preconscious, image is formed sometime (300 -500 millisecond) after it is begun, and thereafter both expectation and memory are active (experiential time process t2). When completed, the satisfaction nulls out expectation, and memory comprises a single entity, the completed form with its feeling.

A successive expression of similar kind will then *automatically* be compared with the previous one as an entity: if it is in sound, it will be noted if it is louder or softer than the previous one, slower or faster, or a combination of these. Also noted would be a relative change in the time form itself, should it occur, apart from those transformations, for example the relative harshness of the sound. These automatic comparisons generally are part of the biological language process of these logogenetic forms, and add to meaning. One sigh, one peal of laughter is either louder or softer than another. In terms of touch, correspondingly the general pressure is greater or less, and greater or smaller areas of the body are being touched.

Similar comparisons occur willy-nilly in the expression and perception of music, where the time form entities are musical phrases or motifs.

Sameness in all these respects results in boredom, in dropping of the "story", and even irritation. (Boredom has been far too little studied as a quality of experience). This of course rests on the ability to perceive the sameness, ie. precise, effortless memory, and partly on anticipation. (Note: Minimalists have used this property to make ever smaller changes, that consequently can sharpen alertness)

This time experience process (t2) notes the *relative changes* in time-form entities.

There is a further time-experience process t3 which is aware of the general tempo of the entire sequence of entities, the unrolling of the 'canvas' in time. This is independent of the relative perception process of t2 in comparing time-forms, to a first order, ie. the comparisons work quite as well at different t3 tempos. t3 however is remembered independently of t2 aspects.

The entire experience is placed and remembered in t1, the life-line of the individual, e.g. it occurred last week on Tuesday afternoon.

Natural Syntax of Logogenetic Time-Forms.

The natural language of these time-forms that operate in t2 (2 - 10 seconds, forms having beginning, middle and end, involving memory and anticipation) works as follows:

1. **Gain:** The gain of transmission of such a time-form-entity or "word" is a function of the perfection of the dynamic form. The effectiveness of generating the quality of feeling expressed is greater the more authentic the form of the "word".
2. **Symbiosis:** The generation process may be similar in the individual who expresses the form (the sender) as in the receiver.
3. **Iteration.** Appropriate repetition of the "words" augments the generating effect. Appropriate repetition allows a duration of that language element time-form plus a random duration of the order of a small fraction (about 10-20%) of that duration, somewhat like intervals of silence between spoken words, but on a rather slower time scale.
4. **Autosemantic:** The meaning of the "word" is contained in the transmitted form itself.
5. **Filters:** What kind of error messages may be tolerated in t2 forms? What causes distortion of meaning? The kind of processing that t2 forms require is quite different from that we are used to in signal processing, such as frequency response, FFT, and time domain analysis or even wavelet analysis, their combination. Certain errors are quite tolerable, while others, seemingly of similar quantitative aspect are not.

Accordingly a new form of mathematics needs to be created to accomodate these functions. It is the hope of the author to embark on such development in collaboration with mathematicians in the coming years. To illustrate the requirements we may give a two examples: in visual sentic form processing, a work of art may have small parts missing, scratches that interrupt the expressive line, or even entire parts may be mssing. The 'eye' will tent to smooth over the missing gaps and *complete* the form as if no gaps were there. However, even a relatively slight distortion of the shape of the form will be sensed as an obtrusive distortion of meaning. Yet small scaling factors will not materially affect the result. Least squares and other statistical analyses fail to distinguish between acceptable and non-acceptable faults and errors. The problem is to mathematically define the invariance that needs to be preserved.

As a second example, in sound we may cite the phenomenon that an old 78 record of Schnabel for

example contains far more musical content of meaning than a similar HI FI version that conserves the full frequency spectrum and has little noise background. What, again, is the invariance that is preserved in the 78 record but is absent in the new CD recording, and how can it be mathematically defined with respect to noise? While we actually have quantitative solutions to the appropriate microstructure that is essential and may be missing in the new CD version, we need to develop a relevant signal-to-noise theory in mathematics which could be generally applicable to biologically evolved logogenetic time forms, and take into account their special communicative properties, not present in sinusoidal signals and their combinations.

Thus the code of transmission and meaning are not independent as in humanly designed systems, such as Morse Code or PCM, but are unified in the elegant natural design. Sender, receiver, and message are codesigned by nature as a single system. The meaning is the analog form of the transmission. It is demodulated by the amygdala, it appears, the very structure that is also involved in its modulation (hence aptly called by Mishkin the "gateway" to emotional communication). The analog form may be produced in various sensory outputs e.g. sound and touch. The information arrives in discrete bundles, as separate time form entities, but each entity is analog. There thus can be a *chain of such discrete analog forms, the stream of emotional expression*.

The stream may tell an emotional 'story'; it does so in music for example, forming one stream of the double stream of music.

The form becomes experienced as meaning when it passes through the amygdala and activates the appropriate emotional brain circuitry. There is a natural interpretation function of these forms built in to our nervous systems, the converse of the natural function that originates their expression. Gene systems that symbiotically produce such forms and empower their recognition have been identified for some mating song patterns in cicadas, for example, and effects of their mutation observed.

Music involves a second stream in addition to the one above: an invention of a repetitive pattern in time, a continuing self-repeating pattern of consistent form we call the "beat". It is the "beat" that goes to the feet, causing them to move in a dynamic manner related to the character of the beat, and that character involves the musical microstructure *within* the beat, patterns within t4, with time warps of the order of 10 milliseconds, and limens of 1-2 milliseconds.

These are sensed not as time functions but qualitatively, as strong, massive, or light, elastic or sodden, energizing or braking, or, emotionally: confident, detached, ironic, hopeful, cheerful, sexually exciting, longing, gentle, engulfing, as a result of a combined amplitude and time warp, the warp being with respect to the grid of nominal numerical proportions of duration.

In ethnic music the character often relates to the rhythms of the language. With composer's pulses, the characteristic combined time and amplitude warps of a particular composer is significant in representing the identity of *who* is telling the musical story.

Music thus has two streams, both of which are decoded by the nervous system in real time, and involve time-form-entities of different kinds: one stream the unfolding emotional 'story' of the music, the other the repetitive signature, or the gait, figuratively, of the 'storyteller'. This second stream, even more than the real gait, carries implied personality structure with it.

In different historic periods, from Gregorian chant to rock music, one or the other stream may dominate; in the classic period of Bach, Beethoven and Mozart a fine balance is achieved.

Is the Composer's Pulse logogenetic?

The composer's pulse matrix, as far as experience has shown so far, remains rather invariant throughout his life, as it appears to fit in relation to his compositions of different periods. Even Beethoven's third period, when his style of composing underwent a radical and unparalleled change requires at most a minor modification of the pulse matrix. Accordingly, it seems not improbable that the pulse of a composer is something he inherits as a personal pattern, something that is part of his essential constitution, and is not the result of choice, nor probably of experience. It may be that individuals all have such characteristic dynamic patterns, but that only great composers have succeeded in embodying this in their music. That it is not a matter of style is evident from the great difference in the pulse matrices of Haydn and Mozart, who share a similar style, or from the differences of those of Schumann, Mendelssohn and Chopin for example.

At any rate, in the Composer's pulses we have time-form-entities that serve a distinct function, and are processed by the brain as meaningful entities. To what extent these entities derive from biological determining factors will need to be determined further. Studies with identical twin and non-identical twin subjects suggest themselves, if it were not for the scarcity of great composers among them! However, there may be methods other than though composed music that would allow one to estimate an individual's particular pulse pattern. One such study is being carried out by the author with "neutral" music which allows any pulse matrix to be superimposed, to see if individual preferences are consistent with other observable motoric characteristics of that person. Such music may contain distributed scale passages for example.

[Composers whose pulse have been identified so far are Bach, Beethoven, Brahms, Chopin, Franck, Haydn, Mendelssohn, Mozart, Scarlatti, Schubert, Schumann]

Precision as a function of t_4 , and of t_3 .

We may see two very different sources of temporal precision in music:

1. Sensitivity of the nervous system to time differences of the order of milliseconds in the duration of the elements within the beat, that affect the vitality of the beat, and of the music as a consequence. This sensitivity is not experienced as overtly relating to duration and time, but is experienced as other qualities, that have no known relation to time per se.
2. The stability of tempo, the t_3 factor, has been measured to be of the order of 1 in 500 (Clynes and Walker, 1986, 1982). The tempo is in effect the repetition rate of the beat. But that rate is also modulated by the musical structure, such as the four bars of four bar phrases, which tend to superimpose a small but systematic and characteristic modulation on this tempo (of about 1 %). The composer's pulse operates on several hierarchical levels, but its effect is evened out over larger stretches of the music. That means that for a given musical piece, the tempo t_3 is a stable time-form entity, if a piece has been well studied. It is the canvas on which the music is rolled out. The music unfurls in the present moment, but at a rate given by the canvas as it unfolds. The tempo is clearly linked to time in our experience: Faster and slower need no explanation. An interval greater than about .5 secs is experienced as partaking of time.

Yet the time of tempo is very different from the time taken by a phrase, by a sentic form of the expression of a particular emotion. Here, in t_2 , we are aware not of durations, or of repetition rates that also go to the feet, but of beginnings, anticipation and memory. On the 3 - 10 second level, there is structure within the time entity: it has a beginning, a middle, and an end.

So we see that music teaches us about time and time-entities, how we experience these in different

temporal processes and modes, each involving different physiologic and psychophysiologic aspects, clocks, and neuronal circuitry: t4, t3, and t2. Finally, there is evidence (Clynes and Walker, 1986) that the *integral* of t3, over the entire piece, even of several movements, has a notable stability of its own.

Whether this stability is basically a function of t1 is an interesting question. It is well known that some people can wake up at very precise times after sleeping an entire night. How long-term time entities operate with precision is also evident in music as just mentioned, and appears to be related to an appreciation of the total invariant temporal size of a meaningful music-object entity, a major composition of the duration of the order of an hour. The stability appears to be independent of the environment, e.g. temperature, humidity, even it seems time of day. Further studies on this large scale stability promise to be fruitful.

Creation of 'Living' Music performances by computer.

In creating meaningful and moving performances with a computer, we use t4, t3 and t2 processes. But the use of t4 goes far beyond the warp of the pulse matrix we have already described. It also includes the shaping of each tone, and the vibrato that organically enriches it. As in the shaping of syllables in speech, music requires each tone to have an organic shape, a shape related to the shape of the phrase and its meaning. The shape of a note, as its amplitude contour (envelope is the technical term) follows the principle of *predictive amplitude shaping*: the shape of the 'present' note is governed by *what* the next note is *going to be* and *when*. (The shape is skewed forward if the tangent of the pitch time-curve to the next note is positive, backwards if negative). Mostly, except for longer notes, the shaping lies within t4, that is the shape is not experienced as having a beginning, middle and end, but is experienced as a single entity.

The principles of *predictive amplitude shaping* and of *hierarchical pulse* together provide most of the microscore that, combined with the score, creates living, meaningful music (Clynes, in preparation, 1983, 1985, 1986, 1987, 1990, 1992). It shapes music in t4 and t2 (the higher levels - at slower time scale - of the pulse being active in t2). It has no effect on t3, the tempo, which, as a first approximation, is independent of both.

These two principles of musicality - largely unconscious hitherto -- have provided means when programmed into a computer of adequate power (a high power PC), to allow musical individuals to readily create music interpretations of highest quality, without any of the usual technical skill of playing an instrument. That is, the ability to subtly shape music in time is independent of the muscular skill and coordination hitherto required to achieve this. This musical thinking ability actually surpasses in AI terms what has been possible in verbal expressive communication so far. It replaces the old machines that required detailed muscular control, with a more direct link between musical thought and its realization in sound: only the "mind and heart" is involved now in creating musical meaning, not the foibles, efforts and limitations, the athletics of muscular coordination and breath control requiring practically endless training, which are bypassed. Yet it preserves the instrumental sound with which the music speaks.

[Editor's note: the audience was delighted with music played extensively illustrating this at the conference, and saw that it indeed worked]

The extent to which this has become possible is ascribable to increased understanding of the nature and function of timeform entities.

Determinants of t3

An interesting question is what determines t_3 , the tempo? The choice is one of high precision (Clynes and Walker 1982,1986), as much as 1 part in 500. How is this choice arrived at? A feeling of "rightness" is involved that develops over time, as one knows the piece better.

Part of this rightness links with the integral of t_3 : the total time for the piece is implicit in the choice of t_3 . But there are other factors at work. The entities at t_2 level are sufficiently elastic so that variations of say $\pm 8\%$ in the overall t_3 , other things being equal, can be accommodated without considerable loss of meaning on the t_2 level. More than that however would be a more serious matter. We need to look for different qualities of experience than t_2 forms to account for the stability. The repetition rate of the pulse at the t_4 level may provide some clues for this: Here we are encountering aspects of "energy", of "flexibility" and "inflexibility". The "energy" of the repetitive pulse, or the "beat" will tend to increase with increasing tempo (t_3) but diminish after a point, becoming "hurried". Diminishing the tempo will give more relaxation, as a slow walk becomes envisioned, then even contemplative exploration, eventually a stillness. Breathing replaces walking as the motoric analog.

We may note that the same piece when played with a different composer's pulse will acquire a different t_3 depending on which composer's is used. For example a Mendelssohn Scherzo will have a faster t_3 as a Mendelssohn piece, than if it would be played with the Beethoven pulse in a Beethovenian way. The precise tempo of a Mozart Allegro, such as the first movement of the piano concerto in C major K467 for example, is given by the concept of a moderate but determined march, a stepping out. Such a motoric mental analog has a strong influence on the tempo: gradations between running and walking, the imagined size and body constitution of the individual running or walking (vigor and massiveness for Beethoven, little elves in the case of Mendelssohn Scherzi for example). Over and above this there is the question of viewing the musical edifice. Each t_3 choice gives a different view point. The relationship of these various influences in fixing a precise value for t_3 , independent of the environment, as was found in Clynes and Walker 1986, needs considerably more study. Different interpreters have their own preferred values of t_3 , which tend to cluster however, so that one can speak of a normative value of t_3 ; although the mean value should *not* be taken as the optimal, most meaningful value unlike Repp has suggested. Faster values of t_3 , other things being equal, tend to promote a better overview of the large scale features of the piece, as might be expected. Slow t_3 values in slow movements will promote the switch to breathing as the motoric analog. This may be relevant to Arthur Schnabel's expressed view that one within a given leeway, one should tend to play fast movements as fast as can be accommodated, and slow movements as slow as possible, thereby increasing the contrast.

The best estimate that can be given at this time is that the t_3 value chosen by any individual interpreter is closely linked to his/her *concept* of the piece, an entity, like a seed, with overall significance for the entire piece, which, like the agency that generates a dream, is outside the scope of the present chapter.

Logogenetic Time Forms in Sentic Cycles.

In a sentic cycle, an emotional exercise form developed by the author that has been used therapeutically and as a preventive by thousands of subjects over two decades, a subject expresses and generates a series of emotions, by repeated finger pressure expression. Each expression has the duration of the time form entity for that emotion, plus a small quasi-random interval, before he/she initiates another expression of that emotion. The randomness insures that even after years of practise, the user does not know when the next expression will start, so an effect of dialog is created; the subject waits a bit before initiating the next expression, but is all ready to do so. Each emotion is repeated 23-40 times depending on the emotion, and each emotion phase lasts about 2-4 minutes, again depending on the emotion. The repeated expression helps to build up the intensity of the emotion, and is not so long that it satiates the process appreciably, in most cases. The entire cycle takes 27 minutes. While longer periods than 4

minutes for one emotion would tend to satiate that emotion generating process, by switching to the next emotion, a subject feels fresh with regard to that next emotion. This implies a differential receptor satiation for each of the emotions (the sequence of emotions in a sentic cycle is: no emotion, anger, hate, grief, love, sex, joy, reverence).

Two curious phenomena with respect to time experience are systematically observed in conjunction with doing sentic cycles. One is that frequently the time experience for the entire cycle is considerably misjudged: it is shortened systematically; the estimate being, and largely in agreement, that it took about 10 minutes (variance about +2 minutes, estimate is never below 10 minutes!). The shortening of time occurs especially when the cycle is "done well", i.e. the emotions are fluidly and moderately experienced. The experience has some dream-like aspects, in that a person, while sitting quietly, becomes involved in imagination, but there is no sleep at all.

The second phenomenon, probably related to the first, is that the longer expressions, like those of grief for example, which are of the order of 8-9 seconds, get to feel to have a faster repetition rate than they actually have, one gets 'into' that state and it 'flows' in a way that is different than starting out 'cold'. There is a trancelike state quite specific to the process. The time entities are shortened in experience, though not in reality. There appears to be a transformation of the time scale, t_2 . The total estimate of time seems correspondingly to be reduced perhaps as a consequence of shortening t_2 experience. It is possible that something like this can occur with music too, in particular performances in which one is as it were "transported", but no systematic observation of this is known. Certainly actual performances of music do not show any such change in t_2 under conditions of unusually fine performance; the t_3 stability may override that, should it tend to occur. In any case, if it were similar to what happens in sentic cycles, the *actual* t_2 expression would still be as long as usual, it would only *seem* to flow faster.

This paradigm offers a unique way to study a transformation of the sense of time, while still marking time with experiential time form entities that do not change their recorded form in time.

A further effect often observed in relation to sentic cycles is that after doing them there seems to be more time, for the next few hours, to accomplish whatever needs to be done, there seems to be a time expansion of sorts.

Human time consciousness is entirely relative to being human (Clynes 1992). [The author has suggested for specific processing reasons (Clynes 1992) that consciousness itself may be a genetically originated function, rather than a graded one requiring complexity; an all or nothing function like being pregnant rather than a gradually developing one, and one that may be shared with even lower-form animals who like us have no problems with simultaneous (and presumably conscious) sensing of sound, vision, smell and touch, and pain]. Time in physics does not define the present, which is an infinitesimal point traveling along the time axis at an unspecified and unspecifiable rate, according to physics. Therefore, conveniently physics does not and never has to deal with the present; it only considers movement from a T_1 to a T_2 , two points on the time axis. Yet the present is all that exists, the past is gone, and the future is not yet here. To a stone a million years is neither a short nor a long time. The rate of our own timeconsciousness is undoubtedly a function of our genes, and may be changeable with increased understanding of molecular biology. The aspects discussed here could constitute a small step towards understanding what the present is in our experience, how past and future are reflected in it, a process very different from that encompassed by our notion of physical time, which strangely succeeds by leaving out the present from its picture of reality.

Conclusion

The precision of time form entities is made especially evident in music, where a tempo stability of 1 part in 500 and a 1-2 millisecond limen in event perception is evident. Clocks that transform form spatial into temporal form need to be postulated to account for this. The experience of time in the waking condition is seen to exist in at least four different modes, called t1, t2, t3, t4. Of these, t2 is concerned with the generation and communication of emotional qualities. t4 is manifest in the pulse microstructure of music, where 'syllabic' chunks of time rather than temporal entities having beginnings, middle and end as in t2 are experienced. t3 as a determinant of tempo is a mental function that integrates larger structures, and presents a 'canvas' on which temporal events unfurl. The various modes would seem to be represented in the brain by different functions, with different types of clocks. t2 may be active through the amygdala, t3 as a cortical function, t4 as a property of sound processing, and t1 as the general process of time consciousness of daily life. Memory and anticipation is especially adduced for t2 processes, is not present in t4 itself, and is employed only as a highly stable repetition engine, with a content bound memory for rate, in t3. The successful creation of living music performances through global adjustment of newly discovered principles of musicality, which enlarge our understanding of the language of music. They and the theory of music as a double stream, help us understand the nature of music, but also can elucidate, to a degree, the varied brain functions of time experience with time form entities.

Logogenesis may also be a conceptual tool to obtain better understanding of 'instinctive' behavior in the larger sense, in its relation between conscious and unconscious programming.

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Entities and Brain Organization:
Logogenesis of Meaningful Time-Forms

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