Roland Haas
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Music that works

Contributions of biology, neurophysiology, psychology, sociology, medicine and musicology

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Prenatal "experience" and the phylogenesis and ontogenesis of music

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Allow me to begin by explaining the inverted commas in my title. We may confidently suppose that the fetus does not "experience" anything at all – at least not in the everyday sense. If you say, for example, "On our trip to Baden we experienced the wonderful park next to the Congress Casino", this would be a reflexion about your "experience" in the everyday sense of the word. It is reasonable to assume, and perhaps even obvious, that the fetus is unable to reflect in this manner. So the word "experience" is a little misleading. More precisely, I will be talking about fetal *perception*, *cognition* and *emotion*, and what these aspects of "experience" might have to do with the origins of music. Moreover, I will consider both the *phylogenetic* aspect (evolutionary developments over many generations) and the *ontogenetic* aspect (individual developments within a single lifespan) of this question.

Other talks from today's program have addressed the aspects of the interaction between music, the body and biology. My presentation will also address this interaction. The theory that I will present can explain why music has bodily and biological functions and implications. It can also explain why music is associated with movement (dance) and personal identity, and why it can evoke strong emotions in spite of its lack of obvious survival value.

First, I would like to address the question of music's definition. What is music? In the literature you can find hundreds of definitions, or attempts at definitions. Every theory of the origins of music must deal with the problem that music is not necessarily a clearly defined concept. How can you explain the origin of something that does not exist? Ethnomusicologists, who are well aware of this problem, talk about "music" as if they know what it is, without necessarily saying what they assume it to be. After all, many cultures have no umbrella term for music – instead, they talk about specific musical activities such as singing and dancing, or the ritual meanings and functions of such activities. The reason why ethnomusicologists avoid defining music is that every definition of music implies the existence of musical properties that are common to *all* forms of music. In other words: musical *universals*. But for decades, ethnomusicologists have worked on the assumption that there is no such thing as a musical universal. While the ethnological approach has emphasized the diversity of world musics and made us more aware of the arbitrariness and arrogance of Western culture, it may also be inherently contradictory, because if music cannot be defined, musicology has no object of study.

When we talk about music in the West – and any such discourse must by definition be ethnocentric – we assume that "music" is something like the following. Music is primarily an *acoustical* signal – something that we can hear. But music also implies physical *movement*: in most cultures, movement is an essential and intrinsic aspect of all musical behaviour. Music evokes recognizable *patterns* of sound and movement that can be reproduced, repeated and varied; music perception thus involves the perception and cognition of sonic organization. Music is a *social* phenomenon: it is the product of interactions between members of a group and as such tends to unify the group and strengthen its identity, and hence the identity of its members. Related to this point, music is *meaningful*: people are motivated to engage in musical activities because of its specific cultural, social, and hence also personal meanings. Music is *intentional*: people engage in musical activities deliberately, and they intend with their music to create an emotional effect – to manipulate emotions that are simultaneously felt by different members of a group. Finally, music is generally an *acceptable* form of behaviour in a specific cultural, geographic and temporal context; if a culture has a word for music, the sound patterns only become "music" if they are accepted as such, at least by a definable subculture. Since all of these points may also apply to language, it is important in such a definition to define the difference between music and language. The main or definitive difference is that music is *not lexical*: its meanings are not specifically associated with environmental objects or actions. If someone asks you for directions to the railway station, you cannot help them by playing the violin.

If that is what we mean by "music", the question about music's origins may be rephrased as follows. How and why did that complex combination of features that we now call "music" originally arise? It is a fascinating observation that music exists in all cultures and that different musical styles emerged independently in cultures that were isolated from each other for long periods. Recent research by Isabelle Peretz and others in the cognitive neurosciences has even demonstrated that music has dedicated brain structures, which is presumably the case in all cultures. Researchers interested in the question of music's origins have the task of explaining not only these points but also the social, emotional and religious functions of music that seem to be common to all cultures, as well as the main structural commonalities of most musical styles – even if there are occasional, but important, exceptions to all such "weak universals". For example, musical form often involves thematic repetition and variation (development) as well as call-answer structures. The major second interval, or something close to it, is the most prevalent interval between successive tones in melodies from all over the world. In most music, phrases tend to go up at the beginning and down at the end. The average speed of a rhythmic pulse or of music in a moderate tempo (neither fast nor slow) is around 100 beats per minute (or 600 ms per beat).

For centuries, thinkers and researchers have wondered about the origins of music. Here is a quick list of some of the theories that have been proposed and are still being discussed. One theory is that music is related to mating or flirting behaviour. Just as birds attract each other by means of their colourful feathers and impressive displays, humans (presumably males) may attract other humans (presumably females) by the auditory equivalent of plumage: a musical show. That was Charles Darwin's idea, and many people still take it seriously today. Juan

Roederer has suggested that music exists because it trains cognitive and motor abilities. Humans that made more music were more likely to survive because they had better cognitive and motor abilities, so gradually musical behaviours were selected for. Other researchers have considered the importance of music for the survival of groups. Music may hold groups together and thereby enhance their survival in competition with other groups by means of its role in long distance communication or rhythmic working activities. Still others have considered the relationship between music and speech, and the role of imitation.

Of the many theories that are currently being considered in an attempt to explain the origins of music, it is clear that most contain more than a grain of truth. This suggests that music may not have a single origin, just as it does not have a single function. Instead, many different factors may have contributed to its prehistoric emergence.

A problem that is often addressed by theoreticians of the origins of music is the question of whether music is an *adaptation*. Does music really help humans to survive and reproduce, or is it simply a byproduct of other adaptations? This raises a host of unanswered questions. Why is music so strongly emotional and connected with spiritual life? What is the causal relationship between musical structures like rhythm and melody and biological patterns like walking and speech? Did men and women contribute in different ways to the origin of music?

This last question might seem a bit odd. But if you look at discourse within anthropology, or in fact any human discourse, you often find that there is a tendency to assume that "humans" are normally men. Women are implicitly regarded as special or unusual. They are other humans. This sexist bias, which seems to be built into just about every language, culture and research discipline, has also influenced theories of origins of music, not to mention the rest of musicology. The theory I am going to show you today breaks from this time-honoured tradition by putting women in the foreground. It is presumably no coincidence that women such as Ellen Dissanayake, Diane Mastropieri, Mechthild Papousek, Isabelle Peretz and Sandra Trehub carried out some of the most important research that I cite in support of my theory. More importantly, if the theory is correct, women played a more important role than men in the origins of music itself. In the course of my argument, I will also assume that women play, and have always played, a more important role than men in caring for babies and raising children – especially in the prehistoric period when "music" (as defined) was "emerging". I certainly do not mean by this to suggest that women *should* be primarily responsible for raising children. On the contrary in a modern post-industrial context, it has become possible and reasonable for men and women to share these tasks equably. But this is another issue.

The theory that I will describe differs from other theories of the origin of music in another way. It attempts to describe what actually happened as music was "emerging". It sets out a specific scenario for the origins of music. I will start at the very beginning, so to speak, by talking about the human fetus and the sounds that it hears ("perceives" – not "experiences") before birth. I will then propose that the fetus learns to associate emotions with the patterns of sound and movement by a process akin to *classical conditioning*, and that the resultant associations play a role in biochemical and behavioural interactions between the fetus and the

mother. On that basis, I will talk about interactions between infants and adults (usually mothers) and the relevance of prenatal classical conditioning for that interaction – as well as for recent research on infant sensitivities to musical patterns. I will go on to address the possible role of postnatal *operant* conditioning (i.e. active rather than passive conditioning) in carer-infant interactions (*motherese*), children's *play*, and adult *ritual* – all based on prenatally established associations between sound, movement, and emotion. Finally, I will address the possible mechanisms whereby all of this might be projected into adult life, to become what we know as "music".

First of all: What sounds are available for the fetus to hear? Intrauterine recordings in humans and animals have confirmed that prenatally audible sounds include the mother's vocalizations and breathing, heartbeat, body movements, footfalls and digestion. The interesting point for a theory of the origins of music is that all of these sound patterns depend on the mother's emotional state. Any recording of internal body sounds carries information about whether the person is happy or sad, aroused or not aroused.

The fetus can also hear sounds that are external to the mother's body, but these sounds play no role in the present theory, for several reasons. First, they are considerably quieter for the fetus, and therefore more often inaudible. Second, they are less repetitive, so the fetus is hardly likely to learn to recognize them. Finally, it is hardly likely that their perception could be of any use to the fetus. An ecological psychologist would say that external sound sources do not *afford* anything for the fetus, because it cannot interact with them. An additional important point is that every sound the fetus hears, regardless of whether it originates within or outside the mother's body, is muffled by the passage through human tissue and amniotic fluid: the higher frequencies are inaudible.

We also need to consider the separate question of the fetus's *ability* to hear. A large number of empirical studies have addressed this issue. They leave no doubt that the fetus can perceive sound and motion throughout the third trimester, that is, the last three of the nine months before birth. Since the ability to hear emerges gradually, it is not possible to specify an exact point in time at which this ability begins, but a comparison of various literature sources suggests that this point lies between the 20th and 24th gestational weeks – just after the middle of the 40-week human gestation period. The same applies to the sense of balance and movement: the cochlea and semicircular canals are part of the same structure in the inner ear, which appears to develop as a unit. The perception of balance and movement is of central importance for music, since most music involves or implies movement. The perceptual and cognitive processes of hearing speed up with the myelinization of the auditory pathways, which begins around the end of the second trimester.

Now let us talk about classical conditioning of the fetus. For the purpose of argument I am going to compare the human fetus in the third trimester with Ivan Pavlov's famous dog. The two organisms have the following features in common: both have developed, complex sensory systems, and both lack reflective consciousness. Please do not be insulted by the comparison: of course the human fetus is more important to us than a dog, because it will one day become a

human. But in the prenatal period, this human potential has not yet been realized. Besides, this kind of comparison is perfectly normal in the behavioural sciences.

It is important in this kind of theorizing to be aware of our parental instincts and of the possibility that they might cloud our scientific judgment. We perceive babies to be cute and are motivated to protect and nurture them. We can also feel love for a fetus, knowing that it will soon be a baby. As important as such feelings are for human survival and quality of life, we should not let them influence our logical thinking. If a fetus is behaviourally similar to a dog, then so be it.

In Pavlov's classical conditioning paradigm, a dog repeatedly experienced a specific series of events. First, it heard its master's footsteps. Then came some food, and then it salivated. Initially, the salivation was an automatic response to the food. After this series of events was repeated several times, as it often is in real life, the dog learned – implicitly – that the footsteps *predict* the food. It therefore began to salivate on hearing the footsteps, even if no food arrived. This process was automatic in the sense that it happened without any kind of reflective consciousness. The dog did not "know" what it was doing – it just did it.

Since any animal can be classically conditioned, it is no surprise that the human fetus can, too – as several empirical studies have confirmed. In such a study, the fetus might first be presented with some kind of signal such as a vibration, followed by a loud noise to which the fetus reacts by moving – again, a kind of automatic reaction. If this series of events is repeated many times, the fetus "learns" that the signal predicts the loud noise, and begins to react to the signal as if it were the noise.

The interesting question here is what happens to the fetus when the *mother's emotional state changes*. This question is not intended to refer to those special emotional ups and downs that pregnant mothers experience at different times during a pregnancy. Instead, I am referring to the emotional changes that everybody experiences everyday. For example, my emotional state changed when I walked onto the stage to give this talk. If I were a pregnant woman, my unborn child would have shared that emotional change – at least on a biochemical level.

When the emotional state of a pregnant woman changes, and she is in the third trimester, the fetus can pick up a change in the sound patterns created by her voice, her heartbeat and, if the mother is walking, her footsteps. The fetus receives and presumably cognitively processes auditory, tactile and kinaesthetic signals. Shortly after that, it receives a biochemical signal indicative of the same emotional change: emotional states are reflected by hormone levels in the blood. When the biochemical content of the umbilical blood changes, the emotional state of the fetus changes accordingly. The fetus reacts automatically, just as Pavlov's dog salivated when exposed to food.

Now consider what happens if this series of events happens many times, as of course it does during the third trimester. The fetus "learns" to respond to the auditory, tactile and

kinaesthetic signals without having to wait for the biochemical signal, which tends to arrive a little later. In this way, it associates patterns of sound and movement with emotions. Might that be a first step toward the emergence of music?

One function of hormones is to help an organism react quickly and effectively to a new environmental situation. The classic example is the fight/flight response. When an organism is surprised by a dangerous situation, hormones allow its muscles to get extra sugar. This must happen quickly enough that it can either get away safely or win a fight. Thus, hormones are associated with emotions such as fear and anger. But the correspondences are not simple or one-to-one, because every biochemical has various functions, both physiological and psychological.

A complete account of physiological emotional communication between mother and fetus must also consider two important physical barriers that lie between the mother's circulation and the fetal brain: the *placenta* and the (fetal) *blood-brain barrier*. For the present theory to have any validity, changes in the hormonal levels of the blood must be able to pass quickly across both these protective barriers. In fact, these filters pose no barrier at all to hormones. Because hormones are lipophilic (fatty, lipid-soluble), they easily and quickly diffuse across cell membranes.

The expression "biochemical communication" suggests that biochemical messages between mother and fetus travel in both directions. So far, we have considered only the mother-to-fetus aspect. The fetus-to-mother aspect involves fetal manipulation of maternal nutrient supply, which happens when the placenta changes the hormonal content of maternal blood. From a broader evolutionary viewpoint, this effect may be regarded as an example of *parent-offspring conflict*: the offspring tries to get more from the parent than the parent is willing or able to give.

Why might the fetus be sensitive to messages about the mother's emotional state? The survival of an infant depends on *bonding*, aka maternal love. The basis of bonding is mutual attraction: each partner regards the other as centrally important. But there is more to it than that. The mother needs to understand the needs of the baby in order to satisfy them. It helps if the baby can also to some extent monitor the mother's emotional state, which is a reflection of her ability to satisfy its needs. A baby that demands care that cannot be provided wastes the energy of both parties and in that way puts both at risk. The details of this interaction differ considerably from one mother-baby dyad to the next: mothers have different personalities and experiences, and raise their children in diverse physical and cultural situations. Therefore, an infant's chances of survival are greater if it is born with some practically oriented knowledge about its mother's personality and the way she expresses emotion. Diane Mastropieri and Gerald Turkewitz confirmed this hunch in an empirical study. They concluded from their data that the fetus learns to perceive the emotional implications of its mother's speech, and that the resultant acoustic-emotional sensitivity of the newborn is confined to its mother's native language. In evolutionary psychology, any ability or behaviour that increases an organism's chances of survival is assumed to be the subject to natural selection. Since infant mortality is

high in most human societies – think of pre-industrial and prehistoric societies – the fetus is under strong evolutionary pressure to acquire information about its mother's changing physical and emotional states.

The second stage of my account is postnatal. First of all, we have to ask the question of whether, to what extent and how long prenatally learned associations might be retained after birth. What is the duration of *transnatal memory*? A number of experiments have addressed this question. In such experiments, pregnant women in the third trimester are repeatedly exposed to short musical excerpts at moderate levels of loudness – loud enough that the fetus can hear them. While the mothers are perceiving this music, their unborn children, who of course have no "idea" of "music" (or anything else for that matter), perceive meaningless patterns of sound. After birth, the baby is placed next to a loudspeaker and is presented with a series of sound patterns, some of which it heard repeatedly before birth and others that it has never heard. If babies consistently look at the loudspeaker for a longer or shorter time when certain sound patterns are being played, and all other variables are accounted for according to the usual principles of experimental design, we may conclude that the baby is discriminating between the sound patterns according to familiarity, and is therefore able to recognize the sound patterns that it heard before birth. The published empirical data clearly confirm that this is the case.

On the basis of such an experiment, Peter Hepper concluded that postnatal memory for prenatally learned sounds lasts for a few weeks. A more recent experiment by Alexandra Lamont, whose results were not published, suggested that this memory might last for up to one year. While such experiments are interesting and it would be useful to carry out more of them, the present theory does not depend crucially on their results, because the duration of "memory" for prenatal associations between emotions and sound/movement patterns can be prolonged by another mechanism. *Motherese* – that playful interaction between adults and babies that involves acoustic experimentation with the vocal chords and vocal tract as well as touch and movement – begins soon after birth. Presumably, motherese reinforces – but also modifies – prenatally established associations between sounds, movements and emotions. Repetitions of such rhythmic and melodic patterns in motherese may enable prenatal associations to be projected into childhood. Later repetitions during play and ritual may allow these patterns and associations to be projected further into adulthood. A further reason why the present theory does not depend on the specific results of experiments about transnatal memory is that the internal stimuli that underlie prenatal associations between sounds, movements and emotions happen much more often than the external stimuli that are typically presented in such experiments. The resultant associations are presumably stronger and more durable.

Empirical studies by Sandra Trehub and colleagues have convincingly and repeatedly demonstrated that infants are sensitive to musical parameters such as rhythm, phrasing, melody, and even the consonance and dissonance of musical intervals. The researchers have tended to assume that this sensitivity is inborn and somehow genetically transmitted. The theory that I am presenting today suggests that this sensitivity might at least partially be prenatally learned from associations between sound/movement patterns and emotion.

Motherese is presumably a feature of all human cultures. It appears to play a role in speech acquisition, although the exact nature of this role has been questioned by linguists. Perhaps more important is its role in bonding. In both cases, motherese can be regarded as an evolutionary adaptation, because it enhances the infant's chances of survival. The present theory suggests that the specific meaning of the gestures used in motherese, as documented by Mechthild Papousek, may in part be prenatally learned. In recent research about the origins of music, Ellen Dissanayake has proposed that motherese might have contributed to the emergence and development of ritual, which plays an important role in theories of the origins of music.

I have not yet presented a specific scenario whereby prenatally acquired associations between sound/movement patterns and emotions might become "music". This process may be separated into two stages, which I identify as *operant conditioning* and *reflective consciousness*.

Operant conditioning appears to play an important role in motherese. While interacting, both the mother (or other carer) and the baby experiment with patterns of sound and movement. Patterns that they like are repeated. The mother is motivated to continue with the game of infant-carer vocal-gestural interaction when the baby smiles. Thus, the emotional connotations of sound and movement patterns play a central role. These emotional reactions may be based on what the baby "learned" before birth. During an interaction with the mother or other carer, the baby might hear, or accidentally produce, a sound that "reminds" it of prenatal "experience". This association produces an emotional reward that motivates the baby to repeat the actions that led to the sound, which in turn motivate the mother to repeat the action.

This process may be compared to B. F. Skinner's well-known paradigm in which a rat pushes a lever that releases sugar. If the rat pushes the lever accidentally, it gets the reward. This in turn leads to an increase in the frequency with which the rat pushes the lever. Again, this comparison may seem ethnically problematic to some readers. We need to ask to what extent a human infant can or should be compared with one of Skinner's rats. For the purpose of this argument, the answer is essentially the same as for the comparison between the fetus and Pavlov's dog: if the infant and the rat have similar abilities and behaviours, the comparison is valid, provided that it is restricted to those abilities and behaviours.

The final part of my account addresses the question of musical *intentionality*. The above definition of music assumes that music (as we normally think of it) is always performed and experienced deliberately. When did humans first become capable of intention and deliberation – in other words, of planning, considering the past and future from the standpoint of the present? The archaeological record suggests that a *cultural explosion* occurred between 100,000 and 50,000 years ago. Sometime during this period, people started to use symbols consciously. Since you cannot directly observe reflective consciousness from the outside, you certainly cannot observe it directly in the archaeological record. But you can witness the remains of wall paintings and body decorations, and evidence for the existence of funeral ceremonies and migrations, and draw conclusions about corresponding human

abilities. The archaeological record of such behaviours began some 50,000 to 60,000 years ago, but to enable this development humans must have been using symbols deliberately in language for a longer period. Going back even further into prehistory, every kind of acoustic communication in animals may be considered to include symbols. The question here is when – and why – people became *aware* of the symbolic nature of their acoustic communication, an issue addressed, for example, by William Noble and Iain Davidson. It could be that music as we know it emerged at, or following, the point when reflective consciousness gave people the ability to deliberately create sound patterns in ritual contexts, based on what they could already do in motherese and play.

This completes my speculative story of how music may have emerged and evolved. Before closing, allow me to address the distinction between *adaptations* and *exaptations* in evolutionary theory. An adaptation increases an organism's chances of survival and reproduction – of passing its genes to future generations. An exaptation is a byproduct of an adaptation that itself has no survival or reproductive value. Evolutionary psychologists and theorists of the origins of music and language often address the question of whether a given skill or behaviour is an adaptation, an exaptation, or a mixture of both.

The present theory assumes that music is a byproduct of prenatal audition (hearing), prenatal proprioception (the vestibular sense of gravity and movement), postnatal bonding, and motherese. Prenatal bonding and preparation for language may be considered adaptations, because they increase the probability that an infant will survive to reproductive age. But the classical conditioning of the fetus that I have referred to, which can explain infant sensitivity to the emotional implications of sound and movement patterns, may be no more than a byproduct of the fetus's ability to hear and the emotions, sounds and movements that happen to be available in the fetal environment. The fetal ability to hear is in turn presumably an adaptation that improves postnatal bonding and accelerates language acquisition. Motherese may be regarded as an adaptation for the same reasons, but the operant conditioning I talked about, in which infants in the context of motherese, and children in play, prefer sound and movement patterns that give them an emotional reward, may be a byproduct of prenatally formed associations between emotion, sound, and movement. Finally, reflective language – which evidently is an important ingredient in the emergence of that deliberate act of acoustic-emotional manipulation that we call "music" – is presumably also an adaptation in the sense that groups of humans with reflective language were more likely to survive than groups without it. No one knows why the Neanderthals died out – but one of many possibilities is that the modern humans with whom they were competing for resources had more advanced reflective language and consciousness.

The topic of today's presentations has been music and the body. The theory of prenatal origins suggests that music has bodily implications because the human body, and in particular the female human body, represents the origin of music. For example, the reason why the rhythm and pitch patterns that we find in music correspond to the typical frequency range of the human voice, heartbeats and footsteps may be traced back to prenatal experience of these sound patterns.

Music also has personal qualities that go beyond corporality. It may be perceived as loving, angry, male, female, and so on. For that reason, music is often regarded in music philosophy as a *persona* or virtual person. People also identify strongly with musical styles. In the present theory, the strong role that music plays in forming and maintaining human identity – an important area of research in music sociology – can be traced to the relationship with the mother as "experienced" by the fetus. Presumably, the fetus in the third trimester begins to develop a cognitive representation or *schema* of its mother – the first of all cognitive representations or schemata that an individual develops. This representation may at first be no more than a vague and poorly defined combination of sensory inputs that seem to correlate with each other, suggesting that they come from the same source. As the pregnancy progresses, the representation might become more specific, enabling the baby after birth to quickly establish a complex and sophisticated representation of its mother. If this representation is transferred to music via motherese, play and ritual, it may explain some of music's personal qualities.

The mother schema may also contribute to an explanation of the strong link between music and religion in all cultures. For that schema may underlie the strong feelings of reverence and divine presence that are regularly experienced by participants in religious rituals, including private prayer and meditation. It may also explain cross-cultural commonalities in the concept of god in monotheistic religions. But that fascinating, speculative question is beyond the present scope.

Music and the evolution of human brain function

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14.1. History of research and Austria's recent role

Multidisciplinary research during the last three decades has led to notable progress in the understanding of the relationships between aspects of music common to all cultures and characteristic features of acoustical information-processing in the human brain. Increasing evidence of a parallelism between many structural aspects of music and human language points to a common, perhaps even simultaneous origin of music and language during the early phase of human brain evolution. And robust arguments are emerging about the neural mechanism of musical emotions and the possible origin of the human drive to listen to music, make music and compose music. In short, answers to the questions of *why did music develop in the early days of human evolution* and *why is there music still now* may be around the corner.

Historically, the scientific study of musical tone perception started with the work of Hermann von Helmholtz, described in his monumental treatise *On the Sensations of Tone as a Physiological Basis for the Theory of Music* (1863). The next big steps followed hundred years later, led by Georg von Békésy (*Experiments in Hearing*, 1960) and Reinier Plomp (*Aspects of Tone Sensations*, 1976). These studies shed light on the perception of individual complex musical tones, tone superpositions and sequences, and fundamental attributes such as pitch, loudness, timbre, consonance, roughness, chroma, tonal dominance and scales. Initially, the main interest of these studies was to measure and quantify the sensations reported by subjects exposed to tone signals in systematic experiments and correlate the results with the physical parameters of the stimulus – *musical psychoacoustics* thus became a science in its own right.

Later the scientific interest shifted more and more to the underlying physiological and neural mechanisms, particularly to the higher level processing involved in musical imaging (internal hearing and composition) and the affective response to music. This required a truly interdisciplinary approach, with cooperative participation of musicians, physicists, psychologists, physiologists and neuroscientists. The goals became rather demanding, addressing ultimate questions like: Why are humans from all cultures virtually "immersed" in something like music? Why do specific musical forms lead to different moods like happiness, sadness, courage or fear? What was the survival value of music during the early history of human evolution, notwithstanding the fact that, apparently, music does not convey any "concrete" information like language? Why can music be used to treat mental illnesses and why does it affect the immune system? If extraterrestrial civilizations exist, would they have music? These