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Tonal Pitch Structure as a Tool of Social Consolidation

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***Abstract*—**This paper proposes that in the course of evolution pitch structure became a human specific tool of communication the function of which is to induce emotional states such as uncertainty and cohesion. By the means of eliciting these emotions during collective music performance people are able to unconsciously give cues concerning social acceptance. This is probably one of the reasons why in all cultures people collectively perform tonal music. It is also suggested that tonal pitch structure had been invented socially before it became an evolutionary innovation of hominines. It means that a predisposition to tonally organize pitches evolved by the means of 'Baldwin effect' – a process in which natural selection transforms the learned response of an organism into the instinctive response. In the proposed, hypothetical evolutionary scenario of the emergence of tonal pitch structure social forces such as a need for closer cooperation play the crucial role.

***Keywords*—**Emotion, evolution, tonality, social consolidation.

I. Introduction

MUSIC, similar to language and religion, is a ubiquitous phenomenon [1]. All currently known societies have music [2]. The oldest, unquestionable musical instruments – bone flutes – are more than 40.000 years old [3] but, since singing is probably the most ancient form of music [4], the origin of music is much older [5]. Moreover, the recognition of musical syntax is implicit [6] and is acquired during childhood [7]. In fact, every healthy human is able to recognize music except a small group of people with congenital amusia [8]. People suffering from amusia have problems with the recognition of music from their birth independent of the amount of time spent on music lessons. All these facts suggest that music is a part of the human nature [1] and can be understood as a biological adaptation [9]. If it is true, music has to fulfill an important biological function. In other words, musical abilities had to give some evolutionary advantage over those who were unable to engage in music activity. Although many authors insist that music is useless in terms of biological function e.g. [10], [11] others indicates that the evolutionary advantage of being musical can be related to functions such as indicator of fitness in mating [12], [13], communication between mothers and children [14], group consolidation [15], [16], and information about the group cohesion [17], [18]. Because the process of evolution is gradual [19], [20] and music is a complex phenomenon recognition of which engage many mental mechanisms [9] the proposed explanations of musical functions are not mutually exclusive. After all, the different selective pressures could have shaped different musical features depending on the particular functions. It is proposed that the evolution of musical pitch structure is due to its consolidating function thanks to the process of spectral synchronization between individuals engaged in music activity.

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Social consolidation has often been indicated as an adaptive function of music which led to the evolution of music faculty [15], [16]. According to many scholars this function is possible thanks to musical rhythm that enables sensorimotor synchronization to a musical beat [21], [22]. The ability to synchronize to music allows performing music collectively which enhances social cohesion [5]. However, the collective performance of music consists also in spectral synchronization that depends on musical pitch structure. Similarly to rhythmic synchronization, spectral synchronization is a result of 'brain states alignment' between people who collectively listen to or perform music [26]. In order to successfully synchronize pitches performers have to adequately expect the pitch structure. The most common form of music which predominates among all human societies is tonal music [25]. In fact tonality understood in the broadest sense as such an organization of musical pitches in which some pitch is more important than others [24] is the only kind of musical pitch structure that has been observed in all currently known musical cultures [25]. The perception of such a musical pitch structure elicits specific emotional reactions which are often described as tensions and relaxations [27].

II. The Social Specificity of Music

From the ethnological perspective music is a social thing. In many tribal societies all people participate in music activities often singing and dancing together [1]. Even in Western societies that differ definitely from the hunting-gathering groups of our ancestors in which music probably has evolved, the social events are frequently accompanied by music. National anthems are sung collectively during official events. Music is used during religious ceremonies and rituals as a special tool enhancing the feelings of religious identity. Football fans sing in order to facilitate sportsmen. Finally, music is an indispensable part of many parties and private gatherings. Even though not all participants of these social events sing or play music they exhibit a need to listen to music. This widespread use of music as an element of social meetings suggests that there are some characteristics of music which help people to socialize. One of the results of the collective singing but also just listening to music is synchronization between people [5]. Synchronization facilitates social cohesion and promotes the identity of a synchronized group [5]. The most popular form of synchronization which is realized by the means of music is so called sensorimotor synchronization [21]. It is possible thanks to musical rhythm [22]. The specific, endogenous mental phenomenon which influences the perception of musical rhythm is musical pulse [23]. Musical pulse consists of the sequence of beats which appear regularly in time. This sequence creates a framework for musical rhythm. As a result people are able to perceive musical sounds (tones) as discrete time units. More importantly, musical pulse allows people to expect following tones, which is necessary to synchronize with them. Therefore, without musical pulse the motor synchronization with music would be impossible. In case music is perceived collectively, it becomes also a reference point that allows people to synchronize their movements between them. Interestingly, only modern humans among living primates are able to synchronize with music [2]. The fact that the ability to synchronized movements to beat is unique among primates suggests that this ability has probably been selected because of social function of music. However, musical structure consists not only of rhythm but also of pitches. The most common form of musical pitch structure which predominates among all human societies is tonality. In fact tonality understood in the broadest sense as such an organization of musical pitches in which some pitch is more important than others [24] is the only kind of musical pitch structure that has been observed in all currently known musical cultures [25]. The perception of pitch structure can be understood as an interpretation of the following harmonic sounds by the human nervous system. In this process the frequencies of sounds are interpreted as pitch and mentally organized as discrete units – scale steps – according to a culture-specific musical pitch system [2]. Collective listening to the pitch structure as well as collective performing it causes the alignment of brain states among individuals [26]. This alignment is due to spectral synchronization which occurs between brains of the performers or listeners. Apart from that, the perception of tonally organized pitch structure elicits specific emotional reactions which are often described as tensions and relaxations. Since these emotional reactions often called as tonal qualia [27], [28] are inter-subjectively experienced by the performers or listeners the process of spectral synchronization leads also to emotional synchronization. Sharing similar emotional states in synchrony can be additional clue of social cohesion [26]. Experiencing similar emotions at the same time informs people that they have similar intentions, goals, and needs [29], [30]. Although music elicits emotions by the means of different mechanisms [31] the expectations of pitch structure are at least equally important as other mechanisms. Additionally, it seems that the emotions elicited by the perception of pitch structure are specific solely to music. Therefore, the consolidating function of music is possible also thanks to spectral synchronization.

III. The Characteristics of Tonal Pitch Structure

The perception of pitch is a complex phenomenon. Pitch as a perceptual aspect of sound is "[…] the attribute of auditory sensation in terms of which sounds may be ordered on a scale extending from high to low" [32]. But this aspect of the pitch perception is not enough to recognize musical pitch structure. First of all, apart from continues perception of pitch humans recognize pitches in a discrete fashion as separate units. These units are the building blocks of the phonological systems of all tonal music [33]. As a part of the cognitive reality of music, these units (pitch classes or tone chroma) are cognitively organized in a specific way. This is an additional, circular dimension of pitch [34]. The circular dimension of pitch refers to the position of a particular pitch class within the octave. Such a cognitive order of pitches is based on the fact that pitches which stand in octave relation are perceived as possessing some kind of equivalence. Independent of the huge diversity of human musical systems [2] both the octave equivalence and the use of discrete pitches are often indicating as the examples of musical universals [35]. However, apart from these elementary building blocks of every musical pitch structure, tonal music is endowed with the additional characteristic – the hierarchy of pitches. It means that different pitch classes are perceived as possessing different degrees of stability [36], [27]. These different tinges of stability (the aforesaid tonal qualia) seem to be crucial for the recognition of musical syntax. Different pitch classes thanks to their different degrees of stability are composed in tonal music according to some tacit rules [37]. For example, the most stable pitch class – pitch center – is a reference point for other pitch classes and is called in Western music theory tonic. People familiar with Western music recognize intuitively tonic, although they are unaware why [6]. But the use of pitch center as a reference point for pitch organization is not restricted solely to Western music. It is in fact a ubiquitous, musical phenomenon [35]. While the recognition of pitch center is accompanied by the feeling of stability, the recognition of leading tone elicits feeling of uncertainty and is often described as unstable tone. The emotional characteristics of pitch classes seem to be the main clues indicating structural relations between pitches. After all, one does not need any professional knowledge of a music theory in order to recognize tonal melodies.

IV. The Instinctive Character of the Recognition of Tonal Pitch Structure

It seems that in the process of perception tonally organized pitches are favored from birth. It has been observed that the brains of only 3 days old babies process musical stimuli differently than non-musical sound stimuli [38]. Musical stimuli evoke the right hemisphere dominance. Interestingly, such dominance was not observed in case the altered versions of stimuli were presented. These versions were either permanently dissonant or composed of the key shifts which cause unexpected changes in tonal centers. The fact that the lateralization of music processing in the new-born babies has been observed only for the simple tonal examples indicates that the recognition of tonal pitch structure is probably based on an intrinsic predisposition. In other words, the infant brains search for such auditory stimuli that enable the new-born babies to perceptively organize these stimuli as a reasonable pitch structure. This right hemispheric specialization in processing music is similar to the left hemispheric specialization in processing speech by the new-born infants [39]. Such an early developed specialization suggests that humans can be endowed with the inborn proclivity to the recognition of tonal pitch structure.

From the structural point of view tonality as the main element of musical syntax resembles some elements of language syntax. Although tonality is often compared to language grammar [37] the fact that there is no connection between tonal relations and propositional meaning suggests that tonality is more like morpho-syntax [40] or phonological syntax than grammar. Both in the case of phonological syntax and tonal pitch structure discrete, meaningless units (phonemes and tones) are organize according to some generative rules. The similarity between the instinctive character of the recognition of speech structure and the pitch structure of music is not restricted only to the structural specificities of these two phenomena. People learn the rules of their mother tongue phonology and the tonal music in an implicit fashion. It means that they are not aware of the rules which they use to recognize speech and music. They also do not need any instructions or teaching in order to recognize whether a spoken phrase and a performed musical piece are correct or not. Although music abilities, in contrast to speech, are often understood as a very specialized form of competence which necessitates many years of strenuous learning the effect of implicit learning of musical syntax has been observed independent of musical expertise [41]. All these facts suggest that the recognition of tonal pitch structure could have emerged as the specific adaptive ability of hominines in the course of human evolution.

V. The Social Emergence of Pitch Structure

The communication between individuals by the means of syntactically organized pitches necessitates that all individuals know the rules of a particular syntax. However, since evolution operates on the level of genes [42] all possible evolutionary changes must be related to the genetic changes which occur accidentally. Only because of many such accidental changes (i.e. mutation or recombination) within a population a natural selection can act. Therefore, it is difficult to imagine the selective pressure on an accidental appearance of the predisposition to syntactically organize pitches in the environment in which no-one use syntax. What an advantage can gain an individual who is able to use and recognize a tonal pitch structure in case nobody else is able to do the same? A possible solution can be the Baldwin effect [43].

The Baldwin effect is the process in which some culturally invented behavior is transformed into an instinctive behavior as a result of natural selection [44]. At the beginning of this process animals with the developed nervous system adapt to a new challenge by the means of learning [45]. Since learning is present among all modern primates it is reasonable to suppose that also hominines in our evolutionary lineage were able to invent and learn new behaviors in the case of new challenges. Apart from that, these hominines lived in groups. In such circumstances cultural information could have easily become an important part of environment creating so called cultural niche. An important factor which influences the selective pressure operating on animals which live in groups is social cooperation [29]. In order to make cooperation easier cooperating individuals should communicate their needs and intentions. Therefore, the examples of cultural information observed among social animals are various forms of learned communication systems. A need for closer cooperation could have forced our ancestors to create a form of consolidating ritual composed of vocal expressions. In order to confirm loyalty early humans could have actively participate in this rite. It means that they should have known the sound sequence characteristic to the ritual. Even today the knowledge of religious repertoire is an indication of being a member of a particular, religious community. Hominines as vocal learners [46], [4] learned this vocal ritual by the means of literal imitation. Since the ritual lasts many generations and learning allows the population to participate in this ritual long enough it is possible that some hereditary variation appears that causes an individual learns the sound sequence instinctively. It has been proposed that one of such an instinctive learning which could have evolved among our ancestors is the ability to recognize pitch center [47].

VI. Conclusion

The presented Baldwinian scenario shows how natural selection could have led to the evolution of an instinctive recognition of tonal pitch structure in the social environment. Of course, this evolutionary scenario is hypothetical and speculative. However, the proposed explanation answers the question why in all cultures people collectively perform tonal music.

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