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If music is the food of love, what about survival and reproductive success?

ELLEN DISSANAYAKE
School of Music
University of Washington

• **ABSTRACT**

This article departs from many discussions of the origin, evolution, and adaptive function(s) of music by treating music not as perceptual qualities (pitch, timbre, meter), formal elements (prosody, melody, harmony, rhythm), performed activity (singing, drumming), or genre (lullaby, song, dance). Rather, music is conceptualized as a *behavioral and motivational capacity*: what is done to sounds and pulses when they are "musified" — made into music — and why. For this new view, I employ the ethological notion of *ritualization*, wherein ordinary communicative behaviors (*e.g.*, sounds, movements) are altered through formalization, repetition, exaggeration, and elaboration, thereby attracting attention and arousing and shaping emotion. The universal sensitivity of infants as young as 8 weeks to such alterations of (or operations on) voice, facial expression, and body movements, when these are presented to them by adults in intimate dyadic interactions within a shared temporal framework, suggests an evolved, adaptive capacity that enabled and reinforced emotional bonding. Such proto-aesthetic (proto-musical) operations existed as a reservoir from which individual cultures could draw when inventing art-saturated ritual ceremonies that united groups temporally and emotionally as they did mother-infant pairs. Music in its origins and evolution is assumed to be multimodal (visual and kinesic, as well as aural) and a social — not solitary — activity. An appendix describes important structural and functional resemblances between music, mother-infant interaction, ceremonial ritual, and adult courtship and lovemaking (as differentiated from copulation). These resemblances suggest not only an evolutionary relationship among these behaviors but argue for the existence of an evolved amodal neural propensity in the human species to respond — cognitively and emotionally — to dynamic temporal patterns produced by other humans in contexts of affiliation.

Keywords: origin and evolution of music, mother-infant interaction, ritualization, affiliation, multimodality, ceremonial ritual

INTRODUCTION

At the end of an overview of recent research in the neuroscience of music, Robert Zatorre (2005) turns to a perpetually intriguing subject, musical emotion. How does music create its undeniably strong emotional effects and why should these be so powerful? Zatorre reports that the brain areas that are recruited during euphoric musical responses are those involved in mechanisms of reward and motivation "… similar to those involved in mediating responses to biologically rewarding stimuli, such as food or sexual stimuli" (Blood & Zatorre, 2001). He goes on to ask why music, an abstract pattern of sound, should have any commonality at all with such survival-related systems. "It is a stretch," he says, "to suggest that music is essential for life or reproduction."

That may be so. However, one can find at least five good reasons for considering music to be an evolved propensity of humans, like talking, mating, forming families, playing, or telling stories.

(a) *universality*: it exists in every social group that has been known over time and across the globe;

(b) *costliness*: in most societies substantial amounts of time, energy, and material resources are devoted to music and music-related events, much more than would seem warranted for a peripheral and unimportant endeavor;

(c) *pleasure*: like other adaptively important behaviors, such as eating or engaging in sex, or socializing with intimates, music is emotionally highly positive and rewarding;

(d) *juvenile predisposition*: young humans — even babies — willingly and even spontaneously (without being taught) move and even vocalize to music;

(e) *cultural importance*: in all societies, music is an integral part of the most culturally important events — religious practices that are concerned with valued beliefs and knowledge.

These five observations do not automatically assure that music is adaptive. Steven Pinker, for example, has pointed out that one can assign some or all of the same five attributes to attractions that are adaptively neutral or even maladaptive: sweet and creamy desserts, alcohol, recreational drugs, masturbation, and pornography — all of which are by-products of appetites that would have been adaptive to ancestral humans (Pinker, 1997, p. 525). Nevertheless, these five observations indicate that it is no more irrational to explore the possibility that musical behavior is adaptive than to assume reflexively that it is not. Although it may seem to be "a stretch" to suggest that music is essential for life and reproduction, this need not mean that we give up and call it an unsolvable mystery. Or if music did emerge from behaviors that had an adaptive purpose, which I will suggest, that need not mean that — as music — it is simply a by-product. Music, or at least some music, may still be adaptive for good reasons that relate to that original purpose.

I. The evolutionary question and a hypothesis

Some of the difficulty in thinking about the adaptive value of music, in evolutionary psychology as well as in music psychology, arises from treating music as a trait of exceptionally talented individuals or as an experience of passive perceivers. Music psychologists typically study responses of individual subjects to individual musical stimuli; evolutionary psychologists are primarily concerned with competing individuals.

Yet let us instead think of music as it would have been practiced over tens of thousands of years in the ancestral populations of hunter-gatherers in which it originated. Because we cannot observe Pleistocene peoples, it is necessary to extrapolate from what is known about music in contemporary or recent aboriginal societies. Even though it is problematic to clump these groups into one standard hunter-gatherer prototype, it seems reasonable to assume that their life ways and musical behavior resemble those of early humans far more than modern, postmodern, and globalized lives and music.

In such groups we see that music is

(a) performative and often improvisatory;

(b) communal — something that most or all of the group engage in together;

(c) multimodal — song, instrument playing, dance or movement, dramatic performance, and visual display typically co-exist;

(d) culturally essential and valuable — concerned with the subjects of ritual ceremonies such as finding food, being safe in battle or hunting, healing, maintaining or restoring prosperity, aiding transitions through important life stages, and so forth; and

(e) usually "religious" by nature and intent — a means for accessing the supernatural and becoming physically or psychologically transformed. Even though there may be secular and individual uses of music, the predominant occasions for pre-modern music are sacred and communal (Alcorta & Sosis, 2005; Dissanayake, 2006).

Taking these factors into account, it appears that an adaptive hypothesis should address not some extreme talent but a general human capacity. We must think of music practice and experience as something that everyone does or could do — as common as talking, swimming, driving, telling jokes, or cooking. We can all become better at such things with practice and some people become real experts, but that rarely stops us from doing them. People vary in their natural abilities — it is part of what is called "species diversity". Extreme ability or disability are at the ends of a bell curve. Music making and experience can be considered a general human behavior that benefits all humans, not only the best musicians (Cross, 2003a).

If we think of ancestral music as performative, communal, multimodal, culturally essential, and transformative, we can look for behavioral "proto-musical" antecedents of these characteristics in our species and other primates. Once these are identified,

we can chart a hypothetical two-tier progression from proto-music to music, and perhaps finally propose an adaptive function of musical practice and experience.

I hypothesize that the cognitive capacities and emotional sensitivities that are used in human music as it is and has been practiced in societies all over the world emerged, for good evolutionary reasons, from affinitive mechanisms in interactions that evolved gradually between ancestral mothers and infants as early as two million years ago, long before music as we think of it existed. We can call these capacities and sensitivities *proto*-musical and even find their antecedents in the ritualized behaviors of other animals. Unlike many other survival-related behaviors, they were performed *dyadically* — by two communicatively engaged people. They specifically used and built upon neural substrates and hormonal mechanisms for social affiliation and coordination that already existed in primates and other mammals and became essential for the survival of helpless infants and for the reproductive success of mothers. In a later, *cultural*, development — ceremonial rituals — these same biological capacities and sensitivities became "arts," including or especially music.

II. Behavioral antecedents of human music

Understanding the proto-musical features in mother-infant interactions as they evolved *circa* two million years ago (and, in Section IV, positing their subsequent cultural development as ritual music during the past hundred thousand years) can help us understand why musical emotion today may be so powerful and pleasurable.

A. The evolutionary predicament that led to the origin of proto-music

Compared to other primates, human infants are unusually immature at birth and are dependent on adults for an exceptionally long time. Human altriciality (immaturity) is the outcome of two incompatible trends that developed over several million years of hominization and conflicted at the time of parturition — increasing bipedality and expanding brain size (Leakey, 1994; Morgan, 1995; Small, 1998).

Over time, certain anatomical changes helped facilitate the birth of large-brained infants (*e.g.*, broadening and shortening the pelvis and reshaping the female birth canal; developing a separable pubic symphysis in females and a compressible skull in infants; changes in the rate of postnatal brain development).[1] The gestation period also gradually became reduced so that infants were born at an increasingly helpless state (Gould, 1977; Portmann, 1941). The trend toward difficult births and greater infant altriciality (immaturity) was well underway about 1.8 to 1.6 million years ago in *Homo ergaster* (Falk, 2004, p. 499; Mithen, 2005) and *H. erectus* (Flinn & Ward, 2005, p. 31).

(1) Between birth and age 4, the human brain triples in size (Morgan, 1995).

In addition to anatomical modifications, special behavioral and psychological mechanisms gradually developed to ensure longer and better maternal care of infants,[2] as we see today in the affectionate early interactions between mothers (and other caretakers) and infants in every society in the world.

B. UNIVERSAL ELEMENTS OF MOTHER-INFANT EARLY INTERACTIONS

In all cultures that have been studied, people behave differently with infants than with adults or even older children. Their voices, facial expressions, and head and body movements become altered in characteristic ways. To babies, adults universally use high-pitched, soft, breathy, exaggeratedly undulant, rhythmic, repetitive vocalizations that are variously called "motherese," "parentese," or "infant-directed speech" (Fernald, 1992; Monnot, 1999) or "babytalk" (Miall & Dissanayake, 2003). Facial expressions (*e.g.*, wide-eyes, raised eyebrows, open mouth) are made larger and held longer (Chong *et al.*, 2003). To attract an infant's attention the head may be bobbed sharply back and then dropped forward. Slow, repetitive head and body movements (*e.g.*, nodding, swaying) further invite the baby to interact. The sequences of babytalk are temporally organized on a common pulse (Malloch, 1999). As early as 4- to 8-weeks of age infants expect the behaviors of interacting adults to be contingent — that is, temporally interdependent with their own behavior (Murray & Trevarthen, 1985; Nadel, 1996; Nadel *et al.*, 1999). Micro-analyses of videotaped interactions reveal a closely-attuned dialogue or duet: the signals are presented and processed multimodally in spatial-temporal sequences ("packages" or "bouts") that may be co-active (simultaneous or matching), overlapping, or alternating ("taking turns") (Beebe, 1986; Jaffe *et al.*, 2001).

Again, it is important to recognize that the interaction is a *dyadic* behavior: adults act as they do because babies indicate by their responses — their own vocalizations, facial expressions, movements, and timing — that they prefer these particular vocal sounds, facial expressions, and head and body movements. They are active participants in what analyses of videotaped interactions show is really a dialogue or duet. That is to say, infants are born ready to solicit or resist adults' signals and thereby elicit, influence, and reinforce adults' behavior to them.

C. ADAPTIVE BENEFITS OF MOTHER-INFANT EARLY INTERACTIONS

Researchers have described a number of adaptive or functional benefits to infants of early interactions or their components — from achieving emotional self-regulation to predisposing the learning of language (Dissanayake, 2000b, p. 393). The most important function with regard to my argument here is that the mechanisms of early

(2) Prehistorians have posited the existence of intense maternal care at 1.8mya (*e.g.*, Leakey, 1994).

interactions serve to communicate and coordinate the emotions and behavior of the interacting pair and thus to create and reinforce their emotional bond.

Certainly it seems likely that dependent infants would have benefited from being perceived as distinctly lovable. By noticeably attracting, soliciting, participating with and responding in kind to the ancestral hominid mother's contingently-presented affinitive signals, an infant would help to sustain its mother's positive affect — her psychobiological brain states of interest and joy. Coordinating with maternal expressions by crossmodally matching, mirroring, and otherwise imitating them would have attracted better maternal care and commitment. These interactions would have had important reinforcing effects in regions of the maternal brain that predispose to affiliation. Hominid mothers who made repeated and exaggerated vocal, visual, and kinesic signals of affiliation to infants would thereby have augmented and strengthened, through proprioceptive feedback, their own positive feelings towards increasingly helpless and demanding infants (see Ekman, 1992; McIntosh, 1996; Zajonc, 1985; Zajonc, Murphy, & Inglehard, 1989). One can propose that mother-infant interaction, with its peculiar characteristics, is an adaptive behavior that enabled ancestral infants to enjoy increased survival and their mothers to have greater reproductive success.

III. A HYPOTHETICAL PROGRESSION FROM PROTO-MUSIC TO MUSIC — FIRST STAGE: RITUALIZATION

Few would argue against a claim that the mother-infant relationship in humans has been adaptively important and I am not the only one to suggest or agree that — to one degree or another — it might be an evolutionary source for human music (*e.g.*, Cross, 2003b; Fitch, 2005; Hodges, 1996, p. 46; Mithen, 2005; Panksepp & Bernatzky, 2002, p. 139; Roederer, 1984).[3] The hypothesis developed here differs from previous ones, however, in several important respects. Thus far, it has emphasized (a) the *evolutionary predicament* that led to infant altriciality and the consequent importance of reinforcing emotional bonding between mother and infant and (b) the exquisite *temporal coordination of the dyad* that has been revealed by contingency studies (Murray & Trevarthen, 1985; Nadel *et al.*, 1999). Additionally, in this section, I describe music (c) as originating in a *behavioral-motivational capacity* that uses special "*protomusical operations*" performed by mothers (d) on their *affinitive* visual and kinesic as well as vocal signals to infants. This re-conceptualization of music sets the argument at a different level of abstraction from the usual assumption that it is maternal singing or prosody that was music's evolutionary or

(3) My first published version of the hypothesis proposed here (Dissanayake, 1999) was derived from a paper presented in 1990 to the Human Behavior and Evolution Society meetings in Los Angeles.

proto-musical origin. The relevance to my hypothesis of an account of what mothers *do to* affinitive visual, vocal, and kinesic behaviors requires a detour into the ethological concept of ritualization.

A. The visual, vocal, and kinesic signals spontaneously produced by mothers for infants are modifications of ordinary affinitive communications used by adults

The altered and unusual facial expressions, sounds, and head and body movements that mothers use in early interaction with their infants are modifications of friendly signals used generally and universally in adult human communication. It can be assumed that early *Homo* species used them, as many of these signals appear, in unexaggerated forms, in affinitive contexts in many other primates. Such facial (visual) signals include *Look at* (simply holding one's gaze on something indicates interest, as compared with a roving eye that searches the environment until it finds "something to look at"); *Flash* (short up-and-down movement of eyebrows, often accompanied by a smile); *Raise Eyebrows* (which also widens the eye); *Bob* (a quick backward movement of the back of the head, which functions as a friendly invitation or encouragement, depending on proximity or the accompanying verbal message); *Smile* (a universal expression of positive feeling); *Open Mouth* (accompanies other friendly expressions, indicating pleasure and receptivity); *Nod* (agreement); and (in especially intimate contexts) *Mutual gaze.* These signals are used spontaneously by adult humans with each other to indicate positive *affinitive* readiness or intent (Grant, 1968, 1972) and they appear even in psychiatric patients, where they are predictive of cooperative inclination (Schelde & Hertz, 1994).

Similarly, the high pitch and soft undulant vocal sounds of motherese are exaggerations of the affinitive prosody in adults that indicates deference or non-dominance (Puts *et al.*, 2006) and the emotion of "happiness" in both natural and synthesized speech (Frick, 1985; Scherer & Oshinsky, 1977).[4]

The kinesic actions of mothers — touching, stroking, patting, holding the hand, embracing, grooming, and hugging their infant, and with an open mouth pout-kissing against its body — echo a large number of the affinitive social behaviors noted in wild and captive primates (deWaal, 1989; King, 2004; Nicolson, 1977; Silk, 1998),[5] as well as being common adult gestures in humans of sympathy and affection.

(4) Panksepp and Bernatsky (2002) have suggested that some strong emotional responses to music may ultimately derive from receptivity to acoustic properties that resemble separation-distress calls of young animals, thus being deeply rooted in "the epicenter of affective consciousness in mammalian brains" (pp. 143-4).

(5) Although affectionate touching is common in our closest primate relatives, bonobos and common chimpanzees, they do not engage in a significant amount of infant-directed vocalization, despite an otherwise rich vocalization system (Falk, 2004, p. 493).

B. WHAT MOTHERS DO TO AFFINITIVE SIGNALS RESEMBLES THE PROCESS OF RITUALIZATION OF BEHAVIORS IN OTHER ANIMALS: THESE "OPERATIONS" CAN BE CONSIDERED AS PROTO-MUSICAL

In early interactions, mothers modify their affinitive signals to infants as if to draw the greatest attention to them — that is, to make them maximally effective as unambiguous communication and maximally affecting emotionally (Fernald, 1992, pp. 419-20). It is interesting to point out that such manipulations of communicative signals characterize the process of ritualization of behaviors described by ethologists for other animals (Eibl-Eibesfeldt, 1989, 439-40; see also Hauser, 1996; Huxley, 1914; and Tinbergen, 1952). Whether or not mother-infant interaction can itself be considered as an evolved ritualized behavior, one can nevertheless describe noteworthy similarities between characteristic elements of ritualized behaviors and mother-infant interaction as well as between these and musical behavior. These similarities support my hypothesis that elements of mother-infant early interactions are proto-musical. That is to say, although evolved for another context (mother-infant bonding), they were the evolutionary origin or reservoir for capacities that could eventually be used and developed specifically for what today is called "music."

1) **Special kinds of alterations to ("operations" on or modifications of) ordinary behavior:** In ritualized behaviors, head and body movements, facial expressions, and/or vocalizations that are ordinarily used in an instrumental context *are formalized (simplified or stereotyped), repeated*, and *exaggerated* (as in rhythmic touching, nodding, or a prolonged open mouth smile) and used in a new context to communicate a different, non-ordinary message. In mother-infant interaction the instrumental context for, say, touching or smiling is grooming or showing happiness and the new message conveyed by these behaviors when modified becomes intense affection, attentive reassurance, or delighted regard. In addition to these modifications that typify ritualized behaviors, human mothers may add dynamic variation (*elaboration*), and when infants are old enough to enjoy games and teasing, *manipulation of expectation.*

Interestingly, these fundamental features of ritualization as described by ethologists are the "operations" that musicians, like other artists, perform in their work — what they do with tones, chords, motifs, rhythms, timbres, and so forth, in order to attract attention and hold interest as well as to create, sustain, and mold emotion. They can be called "*aesthetic* operations" and their manifestations in maternal-infant contexts can be called "*proto-musical.*" One can then say that human infants are born ready to respond to aesthetic or proto-musical features such as formalization, repetition, exaggeration, dynamic variation, and manipulation of expectation as it is these operations upon visual, vocal, and kinesic signals that enable their emotional bond with their mothers. We can assume that our Pleistocene ancestors evolved to be receptive to these operations and would have been able to employ them when inventing ceremonies that were comprised of arts, including music. (See section IV).

2) **Typical intensity**: Ritualized signals usually have a "typical intensity" so that they will not be mistaken for the "ordinary" precursor behaviors they were derived from (Morris, 1957). That is, they become more regular as well as larger, slower, louder, or more sustained. Musical behavior also sets up regularities and, as in ritualized behaviours, deviations from expectancies convey emotional information such as mood and intent, as well as degree of inter-coordination.

In addition to (1) and (2), the affinitive signals made by mothers to infants underwent three further important changes or additions during their modification for use in early interactions:

3) **Temporal organization**: The interactive behaviors take place (are presented and perceived) sequentially, in bouts of 1.5 to 3 seconds, on a time base, so that each partner in the dyad reacts and responds contingently to the other's signals within one-half second or less, anticipating and participating in an ongoing, changing, co-created engagement. I propose that the dyadic coordination developed in mother-infant interaction is likely a precursor of human music in which individuals mutually coordinate their voices and body movement in temporally and dynamically structured sequences.[6] Daniel Stern (1971) was the first to refer, aptly, to this "split-second world" of the infant, independently confirmed by other researchers (Beebe, Stern, & Jaffe, 1979; Murray & Trevarthen, 1985; Nadel, 1996; Nadel *et al.*, 1999). Infants expect contingency in their mothers' behavior to them as early as eight weeks of life (Murray & Trevarthen, 1985; Nadel *et al.*, 1999), months before classical attachment is identifiable.

4) **Multimodality:** The mother's signals and the infant's responses occur in multimodal packages (*i.e.*, simultaneous presentations of voice, face, and body movement) and appear to be neurologically processed multimodally by each as well (Beebe, Jaffe, & Lachman, 1992; Schore, 1994). As described earlier, the music of pre-modern humans is also typically multimodal, combining dance and other movement, percussion, song or other vocalization, mime, and visual display into a temporally-structured performance.

5) **Supramodality:** the mother's signals have supramodal dynamic features, such as intensity, contour, rhythm, or duration, that occur in every modality. Intensity and contour may characterize vocal, visual, and kinesic behaviors, individually or together.

(6) Malloch and Trevarthen (*in press)* refer to proto-music as "communicative musicality," which they consider to be the originary source in the brain/mind of musical behavior in humans. See also Panksepp and Bernatzky (2002), who posit "primitive brain systems that may be critical for the affective-emotional appreciation of music" (p. 134).

For example, intensity may be of *amplitude* (louder or softer sound, bigger or smaller movement or facial expression) or *speed* (faster or slower kinesic or vocal movement); contour may be temporal or spatial in direction and shape and visual as well as auditory in mode; rhythm and duration may also be visuospatial or aural-temporal — that is, a sequence may be metrically steady or irregular, predictable or unpredictable, and sustained (long) or abrupt (short) in time or space. Thus in actual interactions, behaviors can be directly imitated or matched supramodally (analogically) in another modality (as when a strong upward kick of the baby is reinforced by the mother's simultaneous vocal crescendo and widened eyes) and have the same or a similar emotional meaning (Stern *et al.*, 1985) — what Stern (1985) calls "affect attunement."

It should be noted that these five components (or modifications of affinitive signals) that characterize mother-infant interaction possess significant emotional and cognitive salience. Through their conspicuous features, they attract attention, sustain interest, and evoke emotion. Subsequently exapted for use in other affinitive contexts — such as courtship and ceremonial ritual practices — I propose that they became additionally adaptively significant as they fostered bonding of mated pairs and coordination and cooperation among members of a group.[7] Such continued development allowed for further individual and cultural elaboration, resulting in eventual emancipation of these proto-musical components from their original source.

IV. A HYPOTHETICAL PROGRESSION FROM PROTO-MUSIC TO MUSIC — SECOND STAGE: THE INVENTION OF CEREMONIAL RITUAL

Like music and the other arts, ritual ceremonies occur universally in human societies. Indeed, the arts and ritual tend to occur together. Although human ceremonies are not instinctive — and indeed are culturally highly varied and complex — I propose that they build upon the proto-musical capacities and sensitivities that developed during human evolution to create and reinforce the mother-infant bond. That is to say, ceremonies consist of emotionally-salient and evocative formalizations, repetitions, and exaggerations of vocal, visual, and kinesic signals that characterize all animal ritualized behaviors. To these are added the temporal organization, dynamic variation, and manipulation of expectation that were evolved in human mother-infant interactions, the whole being presented as "music",[8] a multimodal package of what are today called the "arts of time" or "temporal arts" — dance, mime, chant,

(7) See the Appendix for a summary of the use of proto-musical features in courtship and mating, which is an important part of my overall hypothesis.

(8) Alcorta and Sosis (2005) have pointed out that music is a universal feature of religious ritual (see also Bohlman, 1997).

song, percussion and instrument playing — to others who respond dynamically and formally in unison or antiphonally.

The structural and featural resemblances of the arts of time to early interactions support my hypothesis that the former could have originated in (be derived or "exapted" from) the proto-musical competencies that had evolved and were in use ancestrally in the affinitive interactions between mothers and infants. Emancipated from their maternal-infant origins, the elements of what eventually became music were probably first developed and elaborated by individual cultures, ancestrally, in religious practices (ritual ceremonies), which served to unite groups temporally and hence emotionally, as their proto-musical sources did for mother-infant pairs.

A. The psychobiological motivation (or intention) for ceremonial participation

Although ritual ceremonies are cultural inventions, all human groups practice them so they must be biologically-predisposed. Prehistorians have traced the earliest appearance of "art" to as long ago as 250 to 50kya (Alcorta & Sosis, 2005, p. 347), basing their evidence on archaeological artifacts like shaped pencils of red ochre or shell beads that indicate symbolic thought (White, 2003). Although musical practices tend not to leave material traces (except for a few bone or clay instruments or a rare instance of perhaps dancing footprints embedded in the clay floor of a cave), I suggest that ceremonial practice of the temporal arts may have originated earlier than symbol use, the usual point at which prehistorians identify the emergence of "art" (*e.g.*, White, 2003). Sounds — whether made with the voice or percussive and other instruments — and movement to these sounds are not inherently symbolic. Be that as it may, why did symbolic or pre-symbolic ritual practices arise and what were they meant to accomplish?

Humans have a basic motivation to achieve some level of control over events, resources, and relationships that are significant in their lives (Geary, 2005) and are distressed when this control is lacking. During human evolution, hominid brain organization eventually enabled what evolutionary psychologists have called "decoupling" and "metarepresentation" (Cosmides & Tooby, 2000). Instead of reacting to events as they occurred or following the promptings of instinct, ancestral humans at some point could remember past events that were desirable or undesirable and then try to control — recreate or avoid — them in the future. One outcome of metarepresentative ability was the invention of religious ceremonies (rituals) which, whatever else they may be or accomplish, are typically intended to influence supernatural agents to act in beneficial ways — assuring success in endeavors such as hunting or warfare, healing the sick, attaining or preserving prosperity and avoiding evil, securing fertility, successfully passing from one life stage to another, and so forth. Religion, like music, is a universal characteristic of humans and it is ritual that lies at the heart of all religions (Alcorta & Sosis, 2005; Durkheim, 1969; Rappaport, 1999; Turner, 1967, 1969).

Cultural anthropologists customarily discuss ritual in terms of specific material artifacts, cognitive beliefs, and social functions. Here I would like to echo evolutionary anthropologist Richard Sosis (2003) in his claim that it is ritual *behavior* — participation — that creates believers: without ritual indoctrination and practice, religious beliefs lack both emotional salience and motivational force.[9] Thinking or even saying "I hope I don't get killed in battle" is less emotionally convincing than joining with one's fellows in dances and chants that are believed to assure victory. As Radcliffe-Brown pointed out in 1922, "ritual" achieves its enculturating and unifying (cognitive) effects by "producing changes in or structuring feelings" (Radcliffe-Brown, 1948; see also Rappaport, 1999).

I would like to go further than Sosis, also, and claim that "ritual participation" should be thought of as "*arts participation.*" That is, I suggest that emotional/cognitive change and structuring occur, as in mother-infant interactions, through participation with others in sequences of exaggerated and formalized, dynamic, multimodally-presented, emotionally-evocative kinesic, visual, and vocal behaviors — *i.e.*, through the temporal arts. Simply participating in coordinated activity with others requires behavioral (neuromotor) control that can produce a feeling of emotional and cognitive control as well as engendering and sustaining affinitive emotion and accord among members of a group (Dissanayake, 2000a, b).

B. The adaptive function of participation in ritual/music

Even when a society's rituals do not themselves accomplish their ostensible intended functional purpose (*e.g.*, success in hunting, warfare, or healing), two other interrelated adaptive effects can be suggested: reducing individual anxiety and coordinating and unifying a group.

Studies show that the effects of stress are reduced when individuals have a sense of control over uncertain circumstances (Huether *et al.*, 1996; Sapolsky, 1992; Whybrow, 1984). "Doing something" (Lopreato, 1984; Malinowski, 1948; Rappaport, 1999) to address uncertainty (as in a ceremonial practice, with the additional reinforcement of participation of one's fellows) is arguably more adaptive than doing nothing or acting alone. Certainly the physical and psychological coordination required by participation in music creates, maintains, and is iconic for emotional concord and unity of belief and may well help to instill the "conformist" behavior necessary for human cooperation (Boyd & Richerson, 1990; Merker, 2005). It is suggestive that archaeologists have noted an increase in indications of ritual activity (*i.e.*, art production) at times of environmental stress, such as changing climate or

(9) Although Sosis (2003) discusses "ritual behavior" without mentioning arts, certainly the exaggerated and temporally-coordinated behaviors of the arts in rituals would only augment their emotional salience and motivational force. In a later paper (Alcorta & Sosis, 2006), music, chanting, and dance are considered to be essential to ritual transmission.

competition with invaders over resources (*e.g.*, Brody, 1977; Mithen, 1996; Taçon, 1983; Taçon & Brockwell, 1995; Taçon, Wilson, & Chippindale, 1994).[10]

Indeed, neuroscientific studies have revealed that brain opioids, oxytocin, and prolactin systems are key contributors to social affect and attachment processes (Carter, 1998; Carter & Altemus, 1999; Panksepp *et al.*, 1999, p. 223, p. 225).[11] Although, to my knowledge, the neurobiology of participants in ceremonial/musical events has not been specifically studied, it is arguable that the proto-musical mechanisms that underlie such participation are likely to release these same neurohormones. Evolution would not produce new mechanisms for social behavior if existing mechanisms — such as those that subserve maternal bonding and infant attachment — could be deployed equally well (Keverne *et al.*, 1999, p. 264).

The studies cited by Panksepp and other studies support arguments for the adaptiveness of religious practice in general (*e.g.*, Alcorta & Sosis, 2005; Wilson, 2002, 2005) by suggesting that social participation reduces the debilitating effects of anxiety.[12] As well as being a "bonding" or prosocial hormone in humans, oxytocin has calming effects — decreasing blood pressure and lowering cortisol levels, thereby relieving stress (Carter, 1998; Carter & Altemus, 1999; Üvnas-Moberg, 1999). The presence of oxytocin in maternal-infant interaction as well as in other prosocial behaviors argues for a relationship between these behaviors or at least a claim that all utilize already-existent neurohormonal mechanisms to promote prosociality and emotional bonding. Further development of this neurohormonal substrate could have laid the evolutionary ground for emotional and physical entrainment (Brown, 2000; Merker, 2000), thus fostering the creation of feelings of social bonding and even altered states that are experienced as transformative (Freeman, 2000; Oubré, 1997).

(10) The Venda of South Africa, however, reportedly make communal music when food is plentiful, *not* during periods of hunger or stress (John Blacking, cited in Mithen, 2005, p. 209).

(11) Although such shared neurochemical influences seem to contribute to all social behaviors, existing empirical data are beginning to allow the conclusion that special-purpose sociomotivational systems also exist within the mammalian brain. Even though distinct brain circuits exist for the behavioral expressions of sexuality, maternal nurturance, play, and perhaps other forms of social affiliation [and the temporal arts?], all of these systems appear to derive much of their motivational urgency from some shared substrates: one can postulate a coherently operating bidimensional brain system for the generation of social affect (Panksepp *et al.*, 1999, p. 223).

(12) The American anthropologist Richard A. Waterman (1971, p. 168) describes how Yirkalla songs (which are, of course, embedded in multimodal ceremony) may release tensions and conquer personal dysphoria.

V. Conclusion: is music adaptive today?

I have argued that ceremonial music is derived through cultural elaborations of psychological and behavioral mechanisms that first evolved to enable mother-infant bonding and, subsequently, the coordination and emotional unification of members of social groups. Mother-infant behavior is performative, dyadic, multimodal, and biologically essential. Ceremonial music is performative, communal, multimodal, and culturally essential — even transformative. However, music today, at least as treated by most academic psychologists, is generally conceptualized rather differently — *e.g.*, as "an abstract pattern of sound" (Zatorre, 2005). Even though it is possible to think of mother-infant interaction and ceremonial music as abstract sound patterns, they are created, experienced, and hence better described somewhat more richly.

If abstract musical patterns of sound are ultimately derived from the same proto-musical mechanisms that reinforced mother-infant and group bonding — the hypothesis advanced in this article — it should not be surprising that these stimulate deep reward centers in the brain. Nor should it be surprising that they may even lead at times to feelings of transcendence, a capacity that may have contributed significantly to the evolution of the human brain (Oubré, 1997). Thus even today, musical behavior may be adaptive as when used by clinically-trained therapists to induce altered states, as in traditional medicinal practices, in order to promote physical and mental healing, to treat substance dependence, and to aid in palliative care (Aldridge & Fachner, 2006; Brown & Theorell, 2006).

One also easily finds modern people — think of the rock, hip-hop, and rave cultures of the young — who experience music as performative, communal, multimodal, culturally essential, and transformative. I would accept that the group bonding experienced by such musical participation is psychologically healthy, reducing individuals' stress and anxiety. In human prehistory and history, it was *participation* in music that produced its group-bonding and group-maintaining effects, which were its adaptive contribution to life and reproduction.

But despite these personal neural rewards and even functional benefits, it remains, as Zatorre says, difficult to argue that composing, playing, or passively experiencing an abstract pattern of sound is "essential for life or reproduction," at least in the sense in which evolutionary biologists think of "adaptively essential." Is Steven Pinker correct in suggesting that music and the other arts today are — like high-calorie desserts, alcohol and other drugs, masturbation, and pornography — simply self-rewarding but nonadaptive indulgences that plug in to pleasurable stimuli that rewarded once-adaptive behavior (like mother-infant interaction and ceremonial/musical participation)?

Pinker's examples all have something in common that is not shared by music as described in this paper. All are essentially solitary pursuits, parasitizing appetites that

evolved to enable fitness at the strictly individual level.[13] As described here, however, proto-music evolved to enable our human way of life in relationship with others. What is more, music engenders emotional states, sometimes with tears — fellow-feeling, comfort for personal loss and pain, affirmation of common humanity, and intimations of transcendence — that are not easily reducible to self-gratifying pleasure.

By enabling the joint fitness interests of the mother-infant pair, the mechanisms of music were especially appropriate for instilling group concord, from which individuals benefited not only by stress-reduction but from the positive psychophysiological benefits of social acceptance and participation (Flinn & Ward, 2005, pp. 34-5). Modern listeners who respond to music primarily as abstract patterns of sound may, I suggest, gain some of these adaptive social benefits even if they listen passively and privately. Few if any people listen willingly or happily to electronic sound randomly generated by computers. Listeners know, tacitly if not overtly, that fellow humans are making the music that they hear and that a fellow human has composed it. In this sense, all human music is experienced socially (Sloboda & O'Neill, 2001, p. 427; Panksepp & Bernatsky, 2002, p. 139-40), reinforcing the human bonds to be found in experiencing abstract patterns of sound that are meaningful and emotionally significant to other humans.

That for five or even ten centuries, in some places, music has been emancipated from its two-million year history and its adaptive roots says more about the recency and aberrance of modernity than about the non-functionality of music. It may be of more than passing interest to music psychologists to know that apart from the nanosecond of evolutionary time that modern societies have occupied in human evolutionary history, the antecedents of music and especially musical participation were essential to human individual and group life.

Appendix: elements of early interactions as a proposed source for human courtship and lovemaking

Parental care of the young has evolved independently in insects, birds, and mammals and, as Eibl-Eibesfeldt (1974, 1989) has astutely noted, elements of infant or parental behaviors have served, in many animals, as sources for ritualized affinitive and appeasement behaviors in adults. Examples include courtship feeding in many birds, high-pitched infantile cries in courting male hamsters, and licking of the dominant animal's mouth or supine puppy-like squirming in submissive canines. Eibl-Eibesfeldt has also pointed out that components of parent and especially infant behaviors (*e.g.*, high-frequency vocalizations, weeping, smiling, making oneself small

(13) One might claim that masturbation and pornography are "social" also in that they rely on or are accompanied by thoughts about a sexual partner. Some people might indeed describe their enjoyment of the pleasure they receive from music as being "auditory masturbation."

and other gestures of simulated helplessness) are regularly used by adult humans to signal appeasement or submission, affiliation, and non-threatening intentions. Along with other elements (see below), parent-infant signals notably occur in human courtship and as "group-uniting mechanisms" in ceremonial rituals, as described in the body of this article. Eibl-Eibesfeldt's pioneering insights of 25 years ago are given added richness and plausibility if integrated with the findings reported in this paper about the reciprocal coordination of mother and infant that is facilitated by the mother's operations on affinitive signals.[14]

In her early study of primate behavior and the emergence of human culture, Lancaster (1975) refers to a large category of communicative signals in baboons and macaques, "mainly found in friendly, bond-maintaining or bond-developing situations, such as play, mating, and mother-infant interaction," as well as signals that keep the group together and coordinate group movement. Like Eibl-Eibesfeldt, Lancaster remarks that in nonhuman primates and humans many of these signals seem to derive directly from very early mother-infant behaviors — hugging, stroking, patting, kissing, and nuzzling.

Examining many species, Eibl-Eibesfeldt (1974, 1989) finds that adult pairbonding occurs only in those that also have parental care and suggests that human adult love play — like courtship rituals in other species — itself originated in parent-infant signals. Among these he lists such crossculturally-observed human courtship behaviors as mutual gaze (an expression of intimacy that occurs in human adults only with infants or in lovemaking), soft vocalizations, caressing and grooming (including "love bites"), interest in the female breast (although he does not specifically mention its heightened sensitivity to touch, whether of suckling infant or lover), and infantilized language. In some cultures, adults may feed infants from their own mouths and Eibl-Eibesfeldt proposes this as a possible origin for tongue-kissing.

The exquisitely coordinated timing of early interactions and the partners' receptivity to subtle changes in dynamics and tempo were not known at the time of Eibl-Eibesfeldt's original speculations, but they add plausibility to his idea that mother-infant behavior is the evolutionary source for adult lovemaking in humans (as distinguished from copulation). Behavioral timing, regardless of its content or modality, has been found to convey vital interpersonal messages about the relatedness between human partners. For example, matching of the timing of speech, particularly the matching of pause durations, is associated with interpersonal attraction and empathy: speakers tend to see each other as warmer and more similar and enjoy the contact more (Jaffe *et al.*, 2001). In a number of societies, prospective lovers coordinate their body rhythms in public rituals that display their "compatibility"

(14) In tracing human adult affinitive signals to parent-infant bonding mechanisms, Eibl-Eibesfeldt's ethological observations augment the insights of Aristotle, David Hume, and Charles Darwin, all of whom have posited a close relationship between the existence of the human traits of sympathy and cooperation and the duration and intensity of human parental care (Arnhart, 1998).

(*e.g.*, Cadar, 1975; Catlin, 1992; Pitcairn & Schleidt, 1976; Proschan, 1992). One may assume that a couple's actual intimate lovemaking is an extension or elaboration of such coordinations.

The husband-father in the human family is unique among primates (Flinn & Ward, 2005, pp. 26-8; Lancaster, 1975, p. 81) and requires evolutionary explanation. Lancaster and others have referred to the suppression of estrus and the continuous sexual receptivity of the female as adaptations that have contributed to human male-female pair bonding and "bond maintenance" (van Anders & Watson, 2006). To these factors, I suggest adding the hypothesis that in human courtship the evolved proto-musical capacities and sensitivities that enabled mother-infant interaction, especially as they promoted temporal coordination and contingent responsiveness, were exapted and transformed into the elaborated and prolonged loveplay that also distinguishes human sexual behavior from that of other primates.[15]

The human ability to keep time should be distinguished from the ability of most animals (including humans) to move in metric, alternating fashion. Humans not only can move rhythmically, but are able to entrain their movements to an external timekeeper (Brown, Merker, & Wallin, 2000, p. 12). Moreover, unlike any other mammal, humans not only are capable of "keeping together in time" as McNeill (1995) has noted, but of leading and responding to another's manipulations of signals as they speed up, slow down, subtly precede, or slightly delay an anticipated "beat," thereby producing various emotional levels of excitement and subsidence. Mothers and infants do not imitate each other directly so much as they echo or complement each other or match each other's direction of affective change (Beebe, Lachmann, & Jaffe, 1997). Rather than exact matching, they are continuously involved in a disruption and repair process involving sequences of match, mismatch, and rematch (Beebe & Lachmann, 1994). Counterparts of these features in experiences of lovemaking and temporal arts such as music are obvious.

The importance of the neuropeptide oxytocin in both maternal behavior and in adult pairbonding, in humans as well as in other animals (see, *e.g.*, Carter, 1998; Insel, 1997; Nelson & Panksepp, 1998; Üvnas-Moberg, 1998), lends additional credence to the evolutionary relationship suggested here between mother-infant interaction and adult lovemaking. By transforming copulation into love play and lovemaking, the human male-female couple would reinforce their affinitive bond, as in the mother-infant dyad. Ancestrally, such bonds would provide encouragement

(15) Bonobos (*Pan paniscus*) are noted for using sexual behavior for bonding and tension-reduction between pairs of juveniles and adult female pairs, as well as between males and females. In contrast to common chimpanzees (*Pan troglodytes*), bonobos have a greater number of ways to invite one another sexually and a greater variety of vocalizations and facial expressions (including mutual gaze) associated with sexual intercourse (deWaal, 1997). Bonobos might be said to have taken the ritualization of primate affinitive signals in a related but somewhat different direction from that of humans.

and reward for males to remain with and to provide for their mates and offspring, a necessity for the survival of helpless, demanding human infants and for their parents' reproductive success.

The many structural and functional resemblances to be seen in mother-infant interaction, adult lovemaking, ceremonial ritual, and the temporal arts thus seem to be neither coincidental nor spurious.[16] These resemblances suggest not only an evolutionary relationship, as outlined here, but argue for the existence of an underlying amodal neural propensity in the human species to respond — cognitively and emotionally — to dynamic temporal patterns produced by other humans in contexts of affiliation. Just as mother-infant interaction and sexual foreplay each focus, entrain, and repay the attention of an interacting couple, the arts of dance, music, and visual or verbal narrative focus, entrain, and repay the attention of two or more. The psychological conjoinment of lovers and of individuals participating in the temporal arts unfolds and is made manifest in dynamic temporal sequences that employ the familiarity, anticipation, theme and variation, surprise, and fulfillment of the mutualities described for mother-infant early interactions. It is not surprising that these activities all stimulate and recruit regions of the brain that are implicated in affinitive emotion and reward.

Address for correspondence:
Ellen Dissanayake
Affiliate Professor, School of Music
University of Washington, Seattle
1605 E. Olive Street, #104
Seattle, WA 98122, U.S.A.
e-mail: edissana@seanet.com

(16) Indeed all prosocial behaviors such as sexuality, maternal nurturance, separation-distress, gregariousness-friendliness, social bonding, play, and social-memory systems share neurochemical controls, including prominently oxytocin and endogenous opioids, not to mention the even more generalized state control systems such as the various ascending norepinephrine and serotonin systems (Panksepp, 1999; Pedersen *et al*., 1992).

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• Si la música es el alimento del amor, ¿qué pasa con el éxito de la supervivencia y la reproducción?

Este artículo parte de diversas discusiones sobre el origen, la evolución y las funciones adaptativas de la música, tratando la música no en relación a sus cualidades perceptivas (altura, timbre o compás), a sus elementos formales (prosodia, melodía, armonía, ritmo), a su actividad interpretativa (canto, percusión) o a su género (nana, canción, danza). Más que eso, la música es conceptualizada como *capacidad de comportamiento y de motivación*: qué se hace con sonidos y pulsos cuando se convierten en música y por qué. Para esta nueva visión, empleo la noción etológica de ritualización, según la cual ordinariamente los comportamientos comunicativos (por ejemplo, sonidos, movimientos) se alteran a través de la formalización, la repetición, la exageración y la elaboración, así atraen la atención, e intensifican y conforman la emoción. La sensibilidad universal de niños de nueve semanas a tales alteraciones de—u operaciones sobre—voz, expresión facial y movimiento corporal cuando están presentadas por adultos en interacciones íntimas binarias, dentro de una red temporal definida, sugiere una capacidad adaptativa desarrollada que permite y refuerza la vinculación afectiva temporal. Tales operaciones proto-estéticas (proto-musicales) existieron como una reserva a partir de la cual cada cultura individual pudo trazar cuándo inventar ceremonias rituales artísticas que uniesen grupos temporal y emocionalmente como hicieron los pares madre-hijo. La música, en sus orígenes y evolución, es asumida como una actividad multimodal—visual y cinética, así como auditiva—y social—no solitaria— Un apéndice describe el importante parecido estructural y funcional entre música, interacción madre-hijo, ceremonia ritual, noviazgo entre adultos y "hacer el amor" (comportamiento diferente a cópula). Estos parecidos no sólo sugieren una relación evolucionada entre estos comportamientos, sino que son argumentos a favor de la existencia de una propensión amodal y neural, desarrollada en la especie humana para responder—cognitiva y emocionalmente—a modelos dinámico-temporales producidos por otros humanos en contextos de filiación.

• Se la musica è il nutrimento dell'amore, che ne è di sopravvivenza e successo riproduttivo?

Il presente articolo prende le mosse da numerose discussioni su origine, evoluzione e funzione/i adattativa/e della musica, e lo fa non trattando la musica secondo qualità percettive (altezza, timbro, metro), elementi formali (prosodia, melodia, armonia, ritmo), attività eseguita (canto, percussione), o genere (ninnananna, canzone, danza). La musica viene piuttosto concettualizzata come una *capacità comportamentale e motivazionale*: cosa accade a suoni e impulsi quando vengono "musificati" — resi musica — e perché. Per questo nuovo punto di vista, impiego la nozione etologica di *ritualizzazione*, dove comportamenti comunicativi ordinari (ad esempio suoni, movimenti) vengono alterati tramite formalizzazione, ripetizione, esagerazione ed elaborazione, con ciò attirando attenzione e suscitando e modellando emozione. La sensibilità universale di infanti di appena 8 settimane a

tali alterazioni di (ovvero operazioni su) voce, espressione facciale e movimenti corporei, quando vengono presentati loro da adulti con i quali hanno intime relazioni diadiche entro una cornice temporale condivisa, suggerisce un'evoluta capacità adattativa che permette e rinforza i legami emotivi. Tali operazioni proto-estetiche (proto-musicali) esistevano come una riserva alla quale le singole culture potevano attingere per l'invenzione di cerimonie rituali artistiche che univano i gruppi temporalmente ed emotivamente come facevano le coppie madre-infante. Nelle sue origini e nella sua evoluzione, si presume che la musica sia un'attività multimodale (visuale e cinetica, come pure uditiva) e sociale — ossia non solitaria. Un'appendice descrive importanti somiglianze strutturali e funzionali tra musica, interazione madre-infante, cerimonie rituali, e corteggiamento e atto amoroso (inteso in senso diverso dalla copulazione) degli adulti. Tali somiglianze suggeriscono non solo una relazione evolutiva fra questi comportamenti, ma depongono anche a favore dell'esistenza, nella specie umana, di un'evoluta propensione neurale amodale a rispondere — cognitivamente ed emotivamente — a modelli temporali dinamici prodotti da altri umani in contesti di affiliazione.

• Si la musique est nourriture d'amour, qu'en est-il de la survie et du succès reproductif?

Cet article se démarque de plusieurs autres discussions sur l'origine, l'évolution et la fonction adaptative de la musique en traitant la musique non comme un ensemble de qualités perceptives (hauteur, timbre, mètre), d'éléments formels (prosodie, mélodie, harmonie, rythme), non comme une activité mise en scène (chanter, battre des rythmes) ou un genre (berceuse, chant, danse). La musique est plutôt conçue comme une *capacité comportementale et motivationnelle*: ce qui est fait aux sons et aux pulsations lorsqu'ils sont « musifiés » — transformé en musique — et pourquoi. Dans cette nouvelle perspective, j'emploie la notion éthologique de *ritualisation,* selon laquelle les comportements communicatifs ordinaires (les sons, les mouvements) sont modifiés à travers leur formalisation, répétition, exagération et élaboration, attirant ainsi l'attention, donnant lieu et forme à l'émotion. La sensibilité universelle du bébé, aussi jeune que de 8 semaines, à de telles modifications de (ou opérations sur) la voix, l'expression faciale et les mouvements du corps, lorsque que ceux-ci lui sont présentés par un adulte au cours d'interactions dyadiques intimes dans un cadre temporel partagé, suggère l'existence d'une capacité adaptative ayant évolué pour permettre et renforcer la mise en lien affective. De telles opérations proto-esthétiques (ou proto-musicales) constituent un réservoir d'où les cultures individuelles vont puiser leur inspiration lorsqu'elles inventent les cérémonies rituelles saturées d'art qui réunissent les personnes et les groupes dans le temps et l'émotion, comme elles l'ont fait pour les couples mères-bébés.

La musique, à son origine et au cours de son évolution, est considérée comme multimodale (visuelle et kinésique ainsi qu'aurale) et comme une activité sociale — et non solitaire. Dans un appendice, je décris des ressemblances structurelles et fonctionnelles importantes entre la musique, l'interaction mère-bébé, la cérémonie

rituelle et la cour et la relation sexuelle amoureuse (à distinguer de la copulation). Ces ressemblances non seulement suggèrent une relation évolutionnaire entre ces comportements mais aussi défendent l'existence d'une propension neurale amodale ayant évolué chez l'humain pour répondre — sur le plan cognitif et affectif — aux expressions temporelles dynamiques organisées produites par d'autres humains dans des contextes d'affiliation.

• Wenn Musik die Nahrung der Liebe ist, was ist dann mit dem Überleben und dem reproduktiven Erfolg?

Dieser Artikel unterscheidet sich von vielen Diskussionen über Ursprung, Evolution und adaptive Funktion(en) von Musik, weil Musik hier nicht im Sinne wahrnehmbarer Qualitäten (Tonhöhe, Timbre, Metrum), formaler Elemente (Prosodie, Melodie, Harmonie, Rhythmus), dargebotener Aktivität (Singen, Trommeln) oder Genre (Wiegenlied, Lied, Tanz) behandelt wird. Vielmehr wird Musik als *handlungs- und motivationale Fähigkeit* verstanden: was und warum etwas mit Tönen und Pulsierungen getan wird, wenn sie zu Musik werden. Für diese neue Sichtweise verwende ich den ökologischen Begriff der *Ritualisierung:* Gewöhnliche kommunikative Verhaltensweisen (z. B. Klänge, Bewegungen) werden durch Formalisierungen, Wiederholungen, Übertreibungen und Ausarbeitungen verändert, wodurch sie Aufmerksamkeit erregen und Emotionen hervorrufen und prägen. Die universelle Sensibilität von Kindern bereits ab einem Alter von acht Wochen hinsichtlich solcher Veränderungen von Stimme, Gesichtsausdruck und Körperbewegungen — wenn sie von Erwachsenen in engen dyadischen Interaktionen innerhalb eines gemeinsamen zeitlichen Rahmens angeboten werden — verweist auf eine entwickelte adaptive Fähigkeit, die emotionale Bindungen ermöglicht und verstärkt. Solche proto-ästhetischen (proto-musikalischen) Prozesse sind wie ein Reservoir, aus dem individuelle Kulturen schöpfen konnten, als sie kunstreiche rituelle Zeremonien erfanden, die in der Folge Gruppen — ähnlich wie bei Mutter-Kind-Paaren — zeitlich und emotional verbanden. Musik scheint in Ursprung und Evolution multimodal (visuell und kinästhetisch ebenso wie auditiv) zu sein und ist eine soziale und keine einzelgängerische Aktivität. In einem Anhang werden wichtige strukturelle und funktionale Ähnlichkeiten zwischen Musik, Mutter-Kind-Interaktion, zeremoniellem Ritual sowie dem Liebeswerben und dem Liebesakt (im Gegensatz zu Kopulation) von Erwachsenen beschrieben. Diese Ähnlichkeiten lassen nicht nur eine evolutionäre Beziehung zwischen diesen Verhaltensweisen vermuten, sondern bieten auch Argumente für die Existenz einer entwickelten, amodalen neuralen Prädisposition der menschlichen Spezies, sowohl kognitiv als auch emotional auf dynamische, zeitliche Muster zu reagieren, die von anderen Menschen in Beziehungskontexten produziert werden.