

The Evolution of Music: Theories, Definitions and the Nature of the Evidence

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It is nowadays uncontroversial, among scientists, that there is biological continuity between humans and other species. However, much of what humans do is not shared with other animals. Human behaviour seems to be as much motivated by acquired cultures as by inherited biology, and most musical scholarship and research has treated music solely from cultural perspectives. However, over the last fifty years cognitive scientific research has approached the *perception* of music as a capacity of the individual mind, and perhaps a fundamentally biological phenomenon. This psychology of music has either ignored - or set aside as too tough to handle - the question of how music becomes the cultural phenomenon it undoubtedly is. Indeed, only in the last ten years or so has the question of the 'nature' of culture received serious consideration, or have the operations of mind necessary for 'cultural learning' explicitly engaged the attention of many cultural researchers (D'Andrade, 1995; Shore, 1996). The problem of reconciling "cultural" and "biological" approaches to music, and indeed to the nature of mind itself, remains.

One way of tackling this problem is to view music from an evolutionary perspective. The idea that music could have evolutionary origins and selective benefits was widely speculated upon in the early part of the twentieth century in the light of increasing bodies of ethnographic research and Darwinian theory (see, for example, Wallaschek, 1893). This approach fell rapidly out of favour in the years prior to the Second World War, for political as much as for scientific reasons, with the repudiation of biological and universalist ideas in anthropological and musicological fields (Plotkin, 1997). However, evolutionary thinking has again become central in a range of sciences and in recent philosophical approaches, and music's relationship to evolutionary processes has been increasingly explored over the last twenty years (see also Dissanayake, Chapters 2 and 24; Merker, Chapter 4; Brandt, Chapter 3, this volume).

1. Music in Evolutionary Thinking

Previous writings on the evolution of musical capacities have made one of two assumptions: either music is a by-product of other cognitive and physiological adaptations, or there are benefits associated with musical behaviour in its own right. Views advocating non-adaptive roots for music itself have been prominent in the last twenty years. A widely publicised view (Pinker, 1997), proposes that the complex sound patterns of music make stimulating use of adaptations for language, emotion and fine motor-control, which evolved independently through selective pressures not associated with any functions peculiar to music.

Music may not be essential for survival, as eating or breathing are, but, like talking, may confer a selective benefit and, indeed, express a motivating principle that has great adaptive power. Music may have *developed from* functions evolved for particular life-supporting purposes as a specialisation that elaborates and strengthens those same purposes. As Huron (2001, p. 44) puts it, "If music is an evolutionary adaptation, then it is likely to have a complex genesis. Any musical adaptation is likely to be built on several other adaptations that might be described as pre-musical or proto-musical."

Let us consider the various theories that have been proposed to explain how musicality may have evolved.

1.1 Music Promotes Group Cohesion

Roederer (1984), like Papousek (1996) and Dissanayake (2000; and this volume), , proposes that music developed from mother-infant communication. The musical manner of their interaction, he suggests, *strengthens emotional bonds between mother and infant*, and *practices extraction of speech information* from musical components of talk, such as vowels, inflections, or the pitch-cues cultivated in some oriental languages. Roederer also notes that music can *transmit emotional information to many people at once*, equalising the emotional state of the group, which results in a bonding effect between the group-members. This is an effect clearly identified earlier in Blacking (1969).

Sloboda (1985) observes that all cultures require cognitive and social organisation of practices and mental techniques for survival, and that while "modern" cultures have "many complex artefacts that help us to externalise and objectify the organizations we need and value" (Sloboda, 1985, p. 267), in non-literate societies the 'organisational structures' must be evidenced and expressed primarily in terms of the expressive ways that people interact with one another. For example, music can give a mnemonic framework for the knowledge of a community, as well as a way of expressing the structure of social relations (see Dissanayake, Chapter 2 & 24, and Merker, Chapter 4, this volume).

1.2 Music Is a Product of Group Selection

The potential function of music in selection at the level of the group needs to be assessed in the light of the extensive debate within recent evolutionary thinking on the nature and existence of mechanisms of selection at the group level. Shennan (2002), in a comprehensive evaluation of models of evolutionary selection applicable to theories of human prehistory, observes that selection can occur at numerous levels, including that of the group. Group behaviours affect the social environment in which individuals live, feed and breed. As Shennan puts it, "all theoretical schools, including those that are sceptical about other levels of evolutionary process than that of individual inclusive fitness, recognise that such [individual] interests may often be served by co-operating rather than competing with other individuals of the same species" (p. 213). In consequence of frequent interaction with the same people, an individual's behaviours are likely to acquire the form of approved "pro-social norms" that emerge within a population. Adherence to these norms can benefit the members of the group by giving additional rewards for behaviours that they choose to undertake as individuals (Bowles and Gintis, 1998).

In other words, optimal behaviours for the well-being of an individual can be determined through engagement with conspecifics, as well as between each individual and their non-human environment. In a social species the likelihood of an individual surviving to procreate, or of having a high rate of procreation, depends upon their "cultural fitness", how they behave in relation to others in their social group, not just their physical fitness.

Furthermore, behaviours that contribute to "group cohesiveness" may make other co-operative behaviours more likely. Bowles and Gintis (1998) have demonstrated through their own game theory model that "populations [without a centralising control] whose interactions are structured in such a way that coordination problems are successfully overcome will tend to grow, to absorb other populations, and to be copied by others" (Shennan, 2002, p. 216).

It can be seen that the emergence of musical behaviours as a pro-social norm assisting coordination within a group could lead to the growth of such groups, and the spread of those behaviours. Furthermore, not only could musical behaviours become a behavioural norm in their own right, but, because of their foundations in powerful motives for social awareness and expressive behaviours, those individuals with well-developed capacities for musical action and perception should also be best at identifying and engaging with *other* norms of social interactive behaviour. In theory, therefore, musical behaviours fit well with the models of selection at both the individual and group level that demonstrate how development and spread of musical behaviours is possible.

1.3 Socio-Emotional Bonding Is Favoured By Evolution of Musical Signalling

Brown (2000a) proposes that music and language have common origins in a single communicative system (see also Scherer, 1991). According to Brown, both music and language can be conceived of as functioning at "phonological" and "meaning" levels. The stream of sonic events that constitutes spoken language is interpreted as lexical items by means of a 'phonological system', the output of which feeds into a 'propositional system' for production of speech, within which units have both relational (syntactical) and referential (semantic) value. Analogously, a "phonological" system can be conceived of as transforming a stream of musical sounds into discrete entities (motifs, harmonic configurations, etc.) that is, "fed into a system of pitch-blending syntax that specifies a set of relationships between sound patterns and emotions... [which] deals with the issues of sound emotion, tension and relaxation, rhythmic pulse and the like." (p. 274). In this model, systems for dealing with sound 'information' in both music and speech are identified as dissociated but employing comparable tiers of 'processing', each derived from a common set of hypothetical principles for interpreting and generating phrasing in action and experience. (see Chapter 3 by Brandt, this volume).

Brown proposes that this common set of principles arose first as a unitary vocal communicative medium, "musilanguage", and then language and music became separate capacities through a process of divergence and functional specialisation. Language came to fulfil propositional functions such as the expression of 'truth values', whereas music came to constitute a pre-eminently social or interpersonal phenomenon. He suggests that, "the principal function of music making is to promote group cooperation, coordination and cohesion" (p. 296).

Brown subsequently (2000b) adds the notion of music as reinforcing "groupishness", which he defines as a, "suite of traits that favor the formation of coalitions, promote cooperative behavior towards group members and create the potential for hostility towards those outside the group" (p252). Music supports these traits through the opportunities that it offers for the formation and manifestation of *group identity*, for the conduct of *collective thinking* (as in the transmission of group history and planning for action), for group co-ordination through *synchronisation* (the sharing of time - between members of a group), and for *group catharsis*, the collective expression and experience of emotion. Ultimately, Brown sees music becoming established in human cultures through its role as, "ritual's reward system"; music, for him, is a type of "modulatory system acting at the group level to convey the reinforcement value of these activities... for survival ." (p257). Music's survival value, for Brown, is thus not immediate and individual but lies in its ability to promote group cohesion.

A different position is adopted by Hagen and Bryant (2003), who suggest that rather than music and dance *causing* social cohesion, they *signal* social cohesion

achieved by other means. Hagen and Bryant's overall thesis is that, "for humans and human ancestors, musical displays may have... functioned, in part, to defend territory (and perhaps also to signal group identity), and that these displays may have formed the evolutionary basis for the musical behaviours of modern humans" (p. 25). They propose that music and dance act as *indicators* of group stability and the ability to carry out complex co-ordinated actions (as exemplified, perhaps, in the New Zealand All Blacks' *haka*). They propose that the amount of time needed to create and practice music and dance corresponds to the quality of the coalition performing them, indicating how much time they have devoted to preparation of their skill.

Hagen and Bryant justify their position, and reject other explanations, on the grounds that musical behaviours cannot contribute directly to the cohesion of a group because they are not a good indicator of an individual's ability to contribute to the group's survival. However, this view of group cohesion purely in terms of immediately perceived cost or benefit of group membership ignores all factors consequent on emotional bonding and the loyalty engendered by a mutual emotional experience. An individual may already have established their credibility within a group, in terms of their *ability* to contribute to its survival, but this provides no indication of their *likelihood* of doing so, or of to whom they will direct their assistance. The ability of music to act as a forum for the practice of integrated, complex, co-ordinated group activities resulting in a powerful sense of membership and 'trust' provides a coherent explanation as to why such behaviours persisted at a group level. One of the manifestations of this role may indeed have been "coalition signalling", and this may even have led to its perpetuation, but this is unlikely to have been the primary selective force for music's development.

At a psycho-biological and individual level, rather than behavioural and social level, musical experience has been linked with the release and action of various life-sustaining regulatory hormones. Freeman (1995) reports that the neuropeptide transmitter *oxytocin* aids in the formation of strong positive emotional memories, and in the supplanting of negative emotional memories, having its strongest effects during trauma or ecstasy. Oxytocin is released into the brain in females whilst lactating, and is produced by both males and females following sexual orgasm. It mediates in interpersonal bonding, both pair-bonding and mother-infant bonding. Freeman suggests that oxytocin is also likely to be released whilst a person is merely *listening* to music. If this is indeed the case, it would provide a good neurological rationale for the role of music in the formation of social bonds, both in intimate interactions between persons, and in group musical activities such as crowd chants (Huron, 2001). (See Chapters 7 by Panksepp and Trevarthen, and 25 by Osborne, this volume)

1.4 Music Promotes Sexual Selection

Charles Darwin proposed that the evolution of music in humans had its roots in courtship songs. He believed that the vocalisations with greatest pitch changes made by apes tend to be produced by males when soliciting mates (Darwin, 1874). Miller (2000a, 2000b) argues that musical behaviours can indicate 'sexual fitness', signalling status, age, physical well-being and fertility. He suggests that dancing reveals aerobic fitness, coordination, strength and health; voice control may reveal self-confidence and status; rhythmic ability may indicate the "capacity for sequencing complex movements reliably", whilst virtuosic performance *per se*, "may reveal motor coordination, capacity for automating complex learned behaviours, and having the time to practice." ; this last characteristic may also, in young adults,

signal sexual availability as it implies lack of parenting demands. These properties of musical and 'dramatic' displays could lead to aesthetic preferences for particular forms of those behaviours, which leads Miller (2000a) to propose that, "...any aspect of music that we find appealing might also have been appealing to our ancestors, and if it was, that appeal would have set up sexual selection pressures in favour of musical productions that fulfilled those preferences" (p. 342).

It should be noted, however, that this logic implies that *any* musical trait for which there is a preference will subsequently be selected for by sexual selection. In fact, an important qualifier should be applied: by definition, selection, sexual or otherwise, for a particular *trait* can only occur if that trait can arise by mutation of a gene and be *inherited*. Behaviours and skills (for example any particular language or music) can be transmitted in other ways. Also, if sexual selection was actually *responsible* for the evolution of motives that cause most humans to find features of music aesthetically appealing, then we would expect convergence in behaviours of musical expression, and in the aspects of them that give pleasure. In fact, whilst musical behaviours are found in all cultures and share dynamic features and social motivations and uses, aesthetic preferences are often culture specific.

Miller argues that, "If one can perceive the quality, creativity, virtuosity, emotional depth and spiritual vision of somebody's music, sexual selection through mate choice can notice it too." (p. 355), but he admits that such rationales are speculative. While his thesis is presented as a call for empirical testing, Miller's hypothesis of the fitness-display properties of music does intuitively make sense. It could provide a mechanism by which *musical behaviours* may have become refined, perpetuated and spread in human evolution. His theory attempts to explain how the forms of musical behaviour may have evolved in the species, rather than how musical forms became appealing. It may be that the core factor in the appreciation of the "quality" of the musical behaviour (and its creativity and virtuosity in artistically developed forms) is its "emotional depth", i.e. the extent to which its perception elicits a compelling emotional response -- and this experience of emotion might not be a product of 'sexual' selection. (See Chapter 2 by Dissanayake; and Chapter 6 by Lee and Schögler on emotional expression in movements of performance, this volume).

2. The Need for a Comprehensive Definition of Music

Clearly, theories of how music may have evolved are divergent. For Pinker, music is a technology, ultimately dispensable, with no evolutionary significance. For Roederer, Sloboda, Brown and Hagen and Bryant, music may have had significant adaptive roles in selection at the group level, while for Miller music may well have played a part in sexual selection. Nevertheless, all these theories rely on what Huron (2001, p. 44) has described as "the nebulous rubric *music*". They provide no clear demarcation of what is intended by the term "music".

It seems that something approximating to a "standard dictionary definition" of music is being employed, such as, "the art of combining sounds of voices or instruments so as to achieve beauty of form and expression of emotion", a "pleasant sound" (both Concise Oxford Dictionary, 7th edn.) or "the art or science of arranging sounds in notes and rhythms to give a desired pattern or effect" (Penguin Dictionary of Music, 1972).

For contemporary musicologists and ethnomusicologists, these definitions are seriously unsatisfactory. They could apply to, say, a CD recording of a Beethoven string quartet, or a live performance by a rock band such as *Coldplay*. It is not so clear

that the dictionary definition would embrace either the musical intentions of a contemporary composer such as Brian Ferneyhough, or the sonic surface of contemporary popular forms such as electronic dance music, nor that of the drum and dance music of a shamanic ritual in Borneo. To the musicologist and ethnomusicologist, all these phenomena are indubitably musical; but, "sounds combined so as to produce beauty of form and expression of emotion." scarcely captures what can be considered to be "musical" in them. Several of the scientific conceptions of how musical behaviours and appreciations arose in evolution (e. g. that of Miller, 2000a & b) appear implicitly to define music as according to current western musical practices, where music is produced by few and consumed by many.

All these notions of music reveal themselves to be ideological constructs rooted in the workings of broader socio-economic and political forces, which change. As Magrini (2000) notes, changes in the ways in which music is manifested result in the discouragement of alternative and often older ways of engaging with music, particularly as an *active* element in everyday life. An "inhibition" of musical practices may occur through processes of reification of elements in cultural models of engagement with music as the role of the *music consumer*, as opposed to that of a *participant* or *everyday practitioner* in musical activity is created, then enhanced and eventually enforced -- by institutionalising or 'commodifying' the processes of knowledge acquisition. *Music making* may thus be "inhibited" through the loss of roles, contexts, situations and practices and the "impoverished" models of music and its social roles that result may all too easily be taken by scholars of music to represent all possible kinds of music. Before assessing the relationship between music and evolution it is essential to frame the object of study in a different way - to perceive music in all its manifestations.

2.1. Music Across Cultures and Times

All cultures of which we have knowledge have or have had something that can be regarded as "music". To be more precise, in the words of John Blacking (1995, p224), "every known human society has what *trained musicologists* would recognise as music" [our emphasis]. Across cultures and through historical time, the forms and significances of music are extremely diverse. In many, perhaps most, non-western cultures music requires *overt action* and active *group engagement*; the differentiation and specialisation of the roles of 'performer' and 'audience' might almost be considered a minority practice. In most cultures music is employed not just in entertainment and courtship, but also as an essential component of ritual, often marking transitions between different stages of life (e.g., from adolescence to adulthood), as well as consequential events such as funerary rituals and seasonal festivals. It may function in the maintenance of oral traditions by virtue of its mnemonic powers. And it seems that in most - if not all - cultures, interactions between caregivers and infants have features that can be interpreted as musical.

Music appears to be something of a universal social fact. However, as the continuation of the above quotation from Blacking (ibid.) makes clear, "there are some societies [not confined to the African continent] that have no word for music or whose concept of music has a significance quite different from that generally associated with the word 'music'". It is notable, moreover, that where a term exists in a non-western society that embraces the activities that a western musicologist might conceive of as musical, for example the Igbo *nkwa* (see Waterman, 1991), that meaning tends not to differentiate between music and dance.

In general, it seems that practices that are recognisable as "musical" in societies outwith contemporary global western culture are characterised by their use

of sound *and* movement together. They tend to involve *collective performance*: that is, they are characterised in terms not only of sound and action, but also of *interaction* between the makers of music. They are marked by both an apparent 'non-efficaciousness', in that their immediate and evident consequences are not observable in any material change in the local environment or in the subsequent behaviours of the participants, and by 'embeddedness' in a wide range of everyday and special practices. And in most if not all cases they also manifest significant hedonic value (see Chapter 7 by Panksepp & Trevarthen, this volume).

Accepting that something like "music" (even if not discretely identified as such by its practitioners) is in all human cultures, the definitions in our dictionaries seem clearly unsatisfactory. "Music" as a universal human behaviour is marked by *sound, action, interaction, non-efficacy, and a multiplicity of social functions and emotional effects*. These characteristics will now be assessed in more detail, with a view to arriving at an operational definition of music that might enable its relationship (if any) to evolutionary processes to be comprehensively addressed.

2.2. Music as Embodied Expressive Movement

Since the advent of sound recording, listening, with no overt and observable behaviour on the part of the listener, has been the paradigmatic mode of engagement with music in western societies. However, prior to the advent of sound recording the notion of music as involving action would have seemed self-evident. While it may seem trivial to suggest that music entails activity in its making, there are many instances where music's sonic patterns are not just caused by actions, but have a structure and identity that is inseparable from the 'doing' and regulation of the actions themselves. This is evident in the studies by Blacking (1961) of southern African *kalimba* (thumb-piano) music, where he showed that the melodies can on occasion depend more on the sequence of movements involved in production of the melody than on the pitch patterns produced. Similar findings are reported by Baily (1985) in respect of the repertoires performed on Afghani *dutars*, and Nelson (2002) in respect of melodic patterns found in blues guitar solos.

In these three instances, *action* on the part of a performer is an integral component of the identity of the music. Moreover, several instances can be cited where actions by participants, in situations where the performer-audience distinction is absent, constitute a framework essential for the intelligibility of musical sound patterning (see, e.g., Stobart and Cross, 2000). Indeed, a recent meta-analysis of neuroscientific studies of music perception (Janata and Grafton, 2003) demonstrates that "passive" musical perception appears to involve areas of the brain associated with motor behaviour, perhaps elicited by the sound sequences of music 'mirroring' aspects of physical movement (see Scherer and Zentner, 2001, pp. 377-378; Benzon, 2001). Music seems better understood, not as abstract patterns of sound contemplated in immobility, but as a thoroughly *embodied activity of human agents*. (see Chapter 6 by Lee and Schögler, and Chapter 8 by Turner and Ioannides, this volume)

2.3. Music as Entraining Others, and Engaging Them in Movement

Most of the contexts in which music occurs are not only active but *participatory*, involving overt and active engagement of persons in musical activities of the group. An intrinsic component of such participation is 'entrainment' (Clayton *et al.*, 2004), which involves the co-ordination in time of one participant's musical behaviours with those of others. This process appears to involve the perceptual 'inference' or 'abstraction' of a regular periodic pulse or beat from a sequence of

rhythmic events and the intuitive or cognitive organisation of the timing of actions and sounds around the motivating pulse. It also orientates attention prospectively to the timepoints presented in the pulse, with a concomitant periodic modulation of the amount of attentional resources devoted to tracking the temporal flow of the music, again orientated around the pulse (Drake *et al.*, 2000).

According to a cognitive interpretation, pulse 'abstraction' facilitates an optimal use of attentional resources over time. Experiments show that events occurring in temporal alignment with the inferred pulse are detected and identified more easily than events that occur out of phase with the pulse (Jones & Yee, 1993). What is conceived as the 'attentional load' is modulated in time in accordance with the pulse the subject infers. At a neurophysiological level, the experience of pulse seems intimately related to the different ranges of timing in co-ordination of gross and fine movements (Thaut, 2005). Entrainment to an external pulse may be either volitional (under conscious control) or pre-conscious (Stephan *et al.*, 2002).

We conclude that musical interaction between human subjects is rooted in intuitive, mind-generated, processes of pulse abstraction/generation within the individuals. These processes implement the optimal allocation (modulation in time) of attentional resources and may focus experience in hierarchical structures in time. The perceptual processes are integral to the prospective temporal control of periodic motor behaviour. Music as an interactive *social behaviour* thus affords the means for synchronising the deployment of a participant's experience of moving with that of other participants, facilitating the individual and the collective - 'intersubjective' - focus on specific moments and sequential patterns in the temporal unfolding of the music.

2.4 The Ambiguity of Musical Intentions and a Definition of Musical Meaning.

A broad interpretation of these 'entrainment' processes, or the prospective perceptual control of socially engaged musical movements might impute similar characteristics to language. Conversational language also relies on features that co-ordinate the timing of an individual's behaviours with those of others as well as synchronising the deployment of participants' attention (Auer, Couper-Kuhlen & Muller, 1999). But, in language the meaning of an utterance with reference to some object in the world can be specified with some precision, and this is not the case for music.

The "outside" meaning or denotational significance of music can rarely be pinned down unambiguously. As John Blacking noted (1995) "the 'same' sound patterns... can ...have different meanings within the same society because of different social contexts" (p. 237); in Langer's (1942) words, in music, "The actual function of meaning, which calls for permanent contents, is not fulfilled; for the *assignment* of one rather than another possible meaning to each form is never explicitly made" (p. 195). In effect, one and the same piece of music can bear quite different meanings for performer and listener; it might even bear multiple disparate simultaneous meanings for a single participant. Music, to a much greater degree than language, appears to have a "floating intentionality" (Cross, 1999), gathering meaning from the contexts *when* it happens, or *where* and *how* it is remembered to have happened, and in turn contributing meaning to those contexts.

While language can articulate complex propositions that can be interpreted as referring exclusively to particular states of affairs in the world, which may have 'truth value' in respect of these, this is not the case for music. Though possessing a similar potential to that of language for the articulation of complex syntactic

structures in action and awareness of action, music never seems to achieve direct or unequivocally interpretable reference to things beyond itself -- outside its moving. Indeed, while music can be interpreted as referring both to itself and beyond itself (as possessing both *sense* and *reference*, after Frege, 1952), it is only in respect of its perceived reference to itself (its *sense*) that its ambiguity may be minimised or entirely resolved (Cross, 2005). (See Brandt, Chapter 3, this volume).

As music flows in time it presents rhythmic and melodic patterns that may give rise to expectations for listeners or participants as to how, and when, it will continue. In the rhythmic flow of the music, those expectations may be realised or abrogated. Music thus generates, for participants, allusion to future possibilities of unfolding; when those future possibilities become actualities the significance of those earlier musical events may become clear, their sense (at least partially) disambiguated, giving rise to what Leonard Meyer (1956) has called music's 'evident meanings'.

Those patterns of evident meaning, together with the music's sonic and gestural qualities as it unfolds, may also yield a degree of reference, this time beyond the music itself. They may result in the elicitation of emotion or evocation of specific conceptual-intentional complexes in the mind, complexes of 'ideas' with which aspects of the music have become associated through individual experience or cultural convention, or because of bio-social predispositions (see Cross, 2005; Lavy, 2001; Morley, 2003, pp. 150-162). But while those conceptual-intentional complexes may themselves be complex, they are neither propositional nor decomposable in relation to definite objects of human thought and action. Their experience is also likely to vary from participant to participant, taking form in what Meyer (*ibid.*) referred to as "connotative complexes". Their sense and reference is not bound to a specific situation or set of circumstances but rather to a range of situations, as a particular emotional or affective mind-brain-body state may be relevant to a range of circumstances for any one individual (see Oatley and Johnson-Laird, 1998). Hence while aspects of music's sense may (retrospectively) be disambiguated, its objective reference cannot.

In certain circumstances, however, music can appear to bear meanings in much the same way as language. Results from functional brain imaging studies support this conclusion. A recent study by Koelsch *et al.* (2004) demonstrated that music can elicit brain responses similar to those elicited by language in respect of 'semantic mismatches', though the responses following a musical context were somewhat less consistent, than those following a linguistic context. Music and language both mean; they can both function in the conceptual-intentional domain as 'acts of meaning'. Nevertheless, in the limit language, can express more semantically decomposable propositions; it can refer unambiguously to complex states of affairs *in the world*. Music embodies, and exploits, an essential ambiguity, and in this respect it can be suggested that language and music are at complementary poles of a communicative continuum, meeting somewhere near poetry (Cross, 2003c). This inherent ambiguity, together with the quality of the actions and interactions that were noted earlier as being integral to music, suffices to differentiate music from language, enabling it to be efficacious for individuals and for groups in contexts where language would be unproductive or impotent, precisely because of the need for language to be interpreted unambiguously (see Brandt, Chapter 3, this volume).

Hence music might be defined broadly and operationally as *embodying*, *entraining*, and *transposably intentionalising* time in sound and action (see Cross, 2003a), typically being expressed by means of voices and instruments that articulate patterns in pitch, rhythm and timbre, and involving correlated gestural patterns of

movement that may or may not be oriented towards sound production. This definition is not intended as an alternative to the more conventional dictionary definitions; such definitions effectively delimit those aspects of music that appear significant within recent western culture. The broad definition is intended to delineate those attributes that, in every community, appear to distinguish music from other spheres of human activity, in a way that might enable its relationships to cultural and biological processes to be evaluated. It is not intended to be either constitutive or essentialist.

3 The Communal Functions of Musical Actions

Music as broadly defined above is capable of engaging and rewarding groups or communities and individuals. In collective musical behaviour, individuals act, and experience what they do, in shared, purposeful time. The experience of the co-ordinated nature of the collective activity is likely to engender a strong sense of group identity with the communication of pleasure. Music both entrains movement and experience, and allows each participant to interpret its significances for him or her self, independently, without the integrity of the collective musical behaviour being undermined. Music's ambiguity or 'floating intentionality', in the self and for or with others, may thus be highly advantageous for groups, serving as a medium for participation and contributing to the maintenance of social flexibility.

A clue to music's efficacy for the individual might be found in Meyer's (1956) suggestion that music does not merely embody metaphors, but is a 'metaphorising medium' through which seemingly disparate concepts may be experienced as related, and become part of a transforming experience of the self. Music appears to constitute a medium that facilitates access to, and the formation of, conceptual-intentional complexes and metaphorical representations that may apply to many individual and social circumstances. As Meyer puts it, "Music does not [for example] present the concept or image of death itself. Rather it connotes that rich realm of experience in which death and darkness, night and cold, winter and sleep and silence are all combined and consolidated into a single connotative complex. ... What music presents is not any one of these metaphorical events but rather that which is common to all of them, that which enables them to become metaphors for one another. Music presents a generic event, a "connotative complex", which then becomes particularised in the experience of the individual listener" (Mayer, 1956, p. 265). Thus music can be interpreted as facilitating the formation of conceptual-intentional complexes across multiple domains of experience, providing a synthetic medium that can bind together the experiences of disparate situations and concepts in whole forms that cannot be decomposed into sets of discrete propositions. This may be of particular significance where two or more domains of experience with fundamentally irreconcilable characteristics appear to coexist, as may be encountered in ritual or religious contexts (see Cross, 2003c).

3.1 The Developmental Value of Music (see Chapters in Sections II and IV)

While music can function as a concept-linking medium for mature members of a culture, we would suggest that it is also powerfully effective in infancy and in childhood, for the individual and for pairs or groups. "Proto-musical behaviours" (see H. Papousek, 1996) have been identified as the foundation of the ability infants have to interact with others predictively so as to exercise the capacity for Trevarthen's (1979; 1980) "primary intersubjectivity" (and see Dissanayake, Chapter 2, this volume). For older children and adults, musical behaviours can be interpreted as providing ways of interacting that, by virtue of their ambiguity, or flexible significance, are likely to minimise social conflict. As a group of children play

together musically, for each child the significance of their own and others' musical behaviour can be quite different and individual, yet the integrity of the overall musical interaction, and the pleasure gained, need not be compromised. Music's ambiguity allows for the exploration and rehearsal of skills in interacting with others, minimising risks of engaging in conflict or misunderstanding, risks that would be more likely were the medium linguistic with unambiguous reference. Musical play can be a way to exercise and acquire social competence and confidence in cost-free and mutually rewarding interaction.

In human early childhood proto-musical and proto-linguistic abilities are intimately interlinked, sharing many features and indeed relying on common systems in the child's cognitions and behaviours. As the child develops the capacity for ostensive-inferential communication, the extent to which vocal and gestural behaviours can substitute one for another in the linguistic contexts that they encounter is increasingly constrained. Utterances become more fixed and unambiguous in their significance and meaning. In contrast, proto-musical and musical behaviours retain a degree of ambiguity or transposability in their "aboutness", particularly in the "babbling" stage (see Elowson *et al.*, 1998). This ambiguity is evident in the capacity of pre-linguistic utterances to reflect, or to engage with the temporal dynamics of, the joint actions, physical events, experienced affective states and changes of affective state that can be shared in social exchanges. The elements of proto-musical behaviour can be associated, for the infant or child, with any or all of a wide range of types of event in their experience of the world and with other people.

In what is still the only large-scale study of children's music and musicality in a non-western context, Blacking (1967) notes that music subserves primarily social functions for the children of the Venda society in southern Africa. As he states "Most Venda children are competent musicians... and yet they have no formal musical training. They learn music by imitating the performances of adults and other children..." (p29). In a society where music is mainly manifested as interactive behaviour that plays an especially significant role in structuring social relations in both ritual and everyday contexts (Blacking, 1976), the musicality that emerges from enculturative processes has profound effects on children's socialisation. Blacking's findings relate directly to research on how children learn all manner of knowledge and skills in different cultures, and specifically to the prevalence of 'intent participation learning' in the majority of societies (Rogoff *et al.*, 2003), especially where there is little or no institutionalised schooling (and see Section IV, this volume). While the Venda culture that Blacking studied might be thought to be exceptional in the importance that it accords to music in structuring social relations, music seems equally socially significant in many other non-western societies, such as those of the rural Andes (Stobart, 1996), or the partially urbanised and heteroglot cultures of north-west China (in the form of *hua'er* songs, see Yang, 1994). Music and activities exhibiting musicality in infancy and childhood can be conceived of as providing a medium through which social flexibility may be acquired and sustained.

Music may also aid development of the individual's cognitive flexibility. Over the last twenty years or so (see Spelke, 1999), cognitive psychologists have found that infants do not come into the world as 'blank slates'; neonates are predisposed to pick up and to process experience in quite specific ways. Capacities for consciousness of events and objects emerge too rapidly to be explained by the operation of a general-purpose learning mechanism, and their adaptive purpose is now abundantly evident. It has been shown, moreover, that infants assimilate information pertaining to the use of *physical objects and events* in a manner that is

quite different from how they acquire and manage their intentions toward *persons and social events*. For example, a very young child may show a highly developed capacity to reason about the social world at a level that may not be manifested in their reasoning about physical objects (Donaldson, 1992; Cummins, 1998). It could be said that infants come primed for 'physics' and primed for 'psychology', each in domain-specific ways. Yet infants and children ultimately acquire what can be thought of as a domain-general competence useful to grasp meanings in any kind of cultural context. We suggest that music, or rather proto-musical behaviour, is efficacious in the emergence of this domain-general cultural competence by virtue of its ambiguity, its transposability or floating intentionality. After all, infants not only emerge into the world primed for investigation of what a psychological scientist might identify as 'physics' and 'psychology', but also predisposed to engage in music-like activities in their interactions with caregivers, which are neither or both of these. Thus, the foci and significances of these proto-musical activities or inherent musicality can lie equally in either domain (Cross, 1999), and it seems probable that they operate at a more fundamental motivating level, enhancing the likelihood of integration of information across physical and social experience, and facilitating the formation of a general competence not tied to any cognitively specialised domain (Cross, 2005).

Tentative evidence exists for the above suggestion in the positive correlations between IQ and engagement in musical activities found in studies reviewed by Schellenberg (2003). His own more rigorously conducted study (Schellenberg, 2004) shows that engaging in music lessons leads to a small but statistically significant enhancement of IQ. While this evidence might suggest that music has 'limited' effect on the intellectual capacities of some individuals, it is also possible that, for subjects of this particular investigation, the "formal" western music lesson (which tend to take forms very similar to "school" lessons) provides a highly culture-specific learning context, one that minimises the extent to which the apparent social efficacy of music can be explored and exercised.

We conclude that music and language, while different parts of the human communicative toolkit, both provide purposeful syntactic frameworks that serve human needs of joint action and interaction. Similar capacities underlie their use, including the capacity to produce complex and hierarchically structured sequences of events (sounds, actions) and to abstract structure from such patterns produced by others. Where language and music diverge, however, is in the ways in which the structures of those patterns are endowed with significance. In language, considerations of reference and of relevance with regard to states of affairs in the world (see Sperber & Wilson, 1986) are paramount. In music, unambiguous reference, and relevance, are much less significant; the primary determinant of musical experience might well be how the perceived sounds fit with the temporal structures experienced in a moving human body.

3.2 Is Musicality a Universal Human Talent, and If So, What Kind of Talent?

Our account of the functions of music presumes that music is not only culturally but humanly universal, i.e., that not only do all known cultures engage in practices that are recognisable as "musical", but that all individuals of those cultures have the capacity for musicality. This assumption would be seriously undermined were evidence to be found that a significant proportion of normally developing

individuals in any human population were incapable of displaying musical behaviours. On the basis of current evidence, we believe that this is not the case.

Within many a traditional society a capacity to engage in musical activities appears to be expected of all its members (Blacking, 1995; Arom, 1991). While it is accepted that some persons will be more adept or creative than others, some capacity for music is expected of all, just as is a capacity for speech. In contemporary western societies a similar situation prevails; even those individuals who feel that they have no capacity to engage in overt musical behaviours are generally expected to have the capacity to listen to music with some degree of appreciation.

There are, nevertheless, persons who are classified as "amusical", who appear, when tested, to lack the capacity to engage with or comprehend the sounds produced by musical behaviours. This deficit may be consequent on a brain trauma, but some individuals with no identifiable neurological damage also appear to lack musical capacities, as defined by certain tests (Peretz, 2003). These individuals typically show dissociation between their capacities to deal with information in the pitch and time domains, frequently exhibiting more profound deficits in the processing of melody than of rhythm. Peretz suggests that an inability to process fine-grained pitch differences inhibits the development of a capacity to engage in musical activities, and she defines this condition as *amusia*. While earlier studies (e.g., Kalmus and Fry, 1980) suggested that some 5% of the "normal" population were 'amusical', evidence from the application of a more sophisticated test instrument, the Montréal Battery of Evaluation of Amusia (MBEA) suggests that amusia is extremely rare; only 2% of those tested had scores less than two standard deviations below the mean, but even here performance was at around 70% correct (Peretz *et al.*, 2003).

It appears that there is no good evidence that musicality is not a universal human attribute. However, very little scientific research into the possession of musical capacities has been conducted outside the confines of contemporary western society, and for a wider picture one must rely on the ethnographic record. From the evidence presented in the ethnographic and scientific literature taken together we conclude that, as with language, all humans (with a very few rare exceptions) have the capacity to engage in musical behaviours.

In view of the extent to which music appears entwined with other domains of human behaviour it seems feasible to suggest that this human capacity for music may be comprise a number of components, which may have come about under the influence of a range of different evolutionary pressures. The integrated suite of behavioural capacities that constitutes modern human musicality might have a variety of sources in prehistoric adaptive changes.

Pinker's (1997) description of music as a "technology" with no evolutionarily adaptive value, a view apparently predicated on the notion that music consists simply of sonic patterns, is unacceptable. As we have seen, music cannot be reduced to patterns of sound, and its effects appear more far-reaching than simple and immediate hedonic response in individuals. Miller's (2000) sexual selection theory, which focuses on music as display, may well describe some of the ways in which musicality was adaptive in human evolution. However, as should be evident from the foregoing, music is more than display, usually involving co-ordinated *interaction* rather than display in individual performance. It seems highly likely, indeed, that music plays a significant role in forming and maintaining group cohesion among humans as Brown (2000b) suggests, by virtue of its capacity to entrain activity, and its 'floating intentionality'. Finally, despite differences, there appear to be close

functional correspondences between music and language, which support Brown's (2000a) suggestion that they share a common and deeply-rooted evolutionary origin.

3.3 Altriciality and Play

Music, considered as a universal human behaviour, does appear to have significant *proximate* effects. However, proximate effects are not necessarily equatable with ultimate causes. To evaluate music's status in processes of human evolution it is also necessary to consider how musical behaviours might have become part of the human behavioural repertoire. It can be proposed that processes of progressive juvenilization evident in the later hominin lineage would have spurred the emergence of behaviours that are central to the modern human faculty for music. Within the hominin lineage each successive species appears to be more altricial than its predecessors, a progressively longer proportion of the total life-span being spent in increasingly differentiated juvenile states (Bogin, 1999).

Joffe (1997) has shown that primate species with complex social organisations are more likely to be altricial, and she proposes that a complex social organisation is enabled by an extension of the learning period in which members of a species manage their social interaction in more flexible ways. A significant feature of the behaviour of juvenile animals, particularly of predatory or social species, is play, which can be identified as action and interaction that "appears to be purposeless" (Bekoff, 1998) in a world largely constructed by the participants.

Play usually involves functional behaviours being employed in modified forms, and when used among individuals it requires the "negotiation of co-operative agreement" (*ibid.*). Play enables juveniles to learn to deal with their environment by testing features of it through action, and to acquire the skills necessary to engage with conspecifics when rehearsing and elaborating skills of social interaction. It is also self-stimulating "fun" in its own right (Panksepp and Burgdorf, 2003). Play thus has many "musical" features and comparable individual and social efficacy. Indeed, Hanus Papousek (1996, p.46-7) describes infant and early childhood musical behaviours as forms of play involving higher-level integrative processes that act to nurture "exploratory competence". Vocal play (in the form of babbling) does not appear to be unique to humans; Elowson et al. (1998) note that this behaviour occurs in juvenile pygmy marmosets, that response from a caregiving adult is more likely when the juvenile is vocalising, and suggest that pygmy marmoset babbling has relevance to understanding the evolutionary processes of human vocal development. It may be that an association between vocal play and a positive caregiving response privilege the social function of such types of play.

We suggest that in an increasingly altricial lineage, the need to accommodate to population structures with an increasing proportion of members with access to juvenile modes of cognition, motivation and behaviour (other factors being equal) may have favoured the emergence of something like musicality as a means of assimilating the value of those juvenile modes of exploratory cognition into the adult behavioural repertoire while regulating its modes of expression. Given that play is particularly a feature of the behaviour of juveniles in social mammals, and given that it is likely to have positive survival value for members of those species who engage in it, it is probable that group behaviours that enable yet regulate it so as to co-opt its utility into the adult repertoire are likely to have some adaptive - or exaptive - value. Music can be interpreted as one such mechanism, emerging under the selection pressures of the progressive extension and stage-differentiation of the juvenile period in the later hominid lineage.

4 The Archaeological Record

Archaeological evidence is clear -- musical behaviours have been a part of human life for many millennia. Modern humans in Europe were manufacturing musical pipes from the bones of birds at least 36,000 years ago, and the sophistication of these instruments exceeds that of many mediaeval and contemporary examples of such pipes (Scothern, 1992). It seems likely that when modern humans arrived in Europe around 40,000 years ago, they had already developed instrumental musical behaviours; it is likely that instruments were in use far earlier, and that musical behaviours that made use of the voice and body movements had a long history prior to the development of musical artefacts.

From 30,000 years ago, however, there is a marked increase in evidence for musical activities, including rasps, percussion instruments, many more bone pipes, and evidence that rocks and caves were exploited for their acoustic properties (Cross and Watson, 2006; Morley, 2003). These musical activities seem widespread, often occurring in what appear to be loci of intense human activity, which includes the making of graphical "art". Such evidence as there is suggests that musical performance was a group activity, rather than one involving a select few.

Available evidence is, of course, fragmentary. The differential preservation of bone over other organic materials is likely to bias the record, and with the focus of archaeological research on Europe, the rest of the old world that was occupied by anatomically modern humans has been neglected. There is also the possibility that objects used for sound-production have yet to be identified as such. Increased sophistication in analysis (e.g. d'Errico *et al.*, 2003) and in methods of excavation, as well as experimental work on the potential sound-producing properties of archaeological materials (c.f. Cross, Zubrow and Cowan, 2002) should help fill out the record of musical activities in prehistory. However, we do know enough to assert that musical behaviours are extremely ancient, probably dating at least to the emergence of behavioural complexity in anatomically modern *Homo sapiens*.

While a fully integrated capacity for musicality is evident in early modern humans, musicality appears to be made up of a number of psychological capacities, including those for production and perception of complex sequences of sounds and actions, for social entrainment, and for creatively engaging with patterns of sounds and actions, all manifestations of multiple intentionalities. The palaeo-anatomical and archaeological records suggest that these different capacities arose at different times in the hominid lineage that leads to modern humans (Morley, 2002; 2003).

Available evidence would suggest that our nearest primate relatives have few capacities that could be interpreted as "musical". Chimps and bonobos lack the phonational capacity for the production of complex vocal signals, in part because of their very different physiques (Morley, 2002), and there is no evidence that either chimps or bonobos can entrain to regular patterns of visual or sonic stimuli (however, see Fitch, 2006, forthcoming). A recent survey of systems of animal communication (Seyfarth & Cheney, 1999) concludes that even among primates the interpretability of vocal signals by conspecifics is generally bound so tightly to awareness of present circumstances that they cannot be regarded as "referential". Calls that might be conceived of as conveying 'disembedded' information to conspecifics are better thought of as expressing an individual's affective state, without any reference or intention to inform others. As the authors note (*ibid.*, p. 159) "In sum, a variety of results argue that, in marked contrast to humans,

nonhuman primates do not produce vocalizations in response to their perception of another individual's ignorance or need for information." It would appear that although some non-human primates (notably, gibbons) can produce complex and long sequences of sound and action, a key element of musicality - engagement with the intentionalities of such sequences - is absent. (see Chapter 4 by Merker).

The likelihood of significant continuities between the lifeways of other primates and of australopithecines (currently the oldest known ancestor genus leading to modern humans) suggests that no significant components of a human faculty for music emerged with this latter group of species, although it might be hypothesised that the move to bipedalism laid some of the foundations for a capacity for entrainment in rhythmic stepping and gesturing. Although recent evolutionary thinking (see Wood & Collard, 1999) interprets the very early humans *Homo habilis* (and possibly *Homo rudolfensis*) (from 2 myr BP) as manifesting a high degree of continuity with australopithecine lifeways and capacities, the archaeology associated with the species shows significant changes in the evidence for toolmaking and the transmission of traditions of tool manufacture. While *H. habilis* and *rudolfensis* remains are fragmentary and their interpretation is debated, it can reasonably be conjectured that manufacture and use of tools suggests that the species had more muscularly developed hands (with perhaps a relatively longer thumb) than did their predecessor species, as well as a greater degree of refinement in control of manual movement (see Wilson, 1998). These capacities are likely to have allowed for the beginnings of finely controlled expressive manual gesture, an intrinsic component of all modern human communicative systems.

With *Homo ergaster* and *Homo erectus* (from about 1.8 myr BP) major changes take place; brain size reaches around 1000cc and body size and configuration approximates the modern human. *H. ergaster* and *H. erectus* exhibit more complex lifeways and toolkits than their precursors as well as a vast increase in geographical range. The capacity for much enhanced control of phonation conferred by a barrel-shaped chest together with the enhanced articulatory capacities of the vocal system and the presence of an ear canal of modern proportions, suggests that the sounds of the voice were increasingly significant for this species. This may be taken to indicate significant changes in the nature of social life, perhaps marking the emergence of a rich vocal repertoire to replace other forms of interpersonal interaction (in conformance with Dunbar's (1993) "grooming-to-gossip" model). The evidence also suggests that some foundational components of musicality were in place, most likely expressed in the use of vocal sounds to articulate complex emotion states in the regulation of social relations, and possibly to convey referential information.

However, not until the appearance of *Homo heidelbergensis* (ca 700 to 500 kyr BP) do we find the fully modern vocal tract, together with an auditory system that is maximally sensitive to speech frequencies (Martinez et al., 2004). This co-adaptation suggests that vocal sounds were crucially significant for this species, more so than other environmental sounds. This can be construed as a refinement of earlier *H. ergaster* capacities, which is supported by evidence for the production and use of an expanded range of artefacts. This advance in creativity is likely to have manifested in the capacity to produce and perceive increasingly complex vocal sounds and sequences, including behaviours that we might identify as singing.

Finally, following the emergence of anatomically modern *Homo sapiens*, which date back some 150 kyr BP, we ultimately find evidence for symbolic intelligence or "fully modern *sapiens* behaviour" (Henshilwood & Marean, 2003), and unambiguous evidence of musical behaviours. Such behaviours are built upon cognitive, physiological and behavioural foundations that emerged in the various preceding

hominid species, as outlined above. At what point such behaviours can be considered *symbolic*, in the sense of having the capacity to indicate meaning through an arbitrary coupling of sign and referent, is very much open to debate, but the capabilities probably emergent in *H. ergaster*, and then developed in *H. heidelbergensis*, would have featured strong associations between emotional content, and vocal and physical gesture. *Symbolic culture*, in which signs enter into a web of inter-relationships that come to constitute a significant feature of the ecology of the human mind (see Chase, 1999), emerged with modern *Homo sapiens*.

Thus, we suggest that the emergence and development of complex manual and vocal gesture under the conditions of greater social complexity associated with *H. ergaster* and *H. erectus* constituted the foundations of what would come to be melodic vocalisation, or singing. It seems likely that the production and perception of complex sequences of sounds with the voice was very important by the time of *H. heidelbergensis*, and that the social roles of such vocalisations, including the potential to rehearse and refine social interactions, were built upon subsequently, to become a part of music and language in the fully symbolic culture that emerged in modern humans.

5 Conclusions

The evolutionary story can be read as indicating that a version of Brown's (2000a) "musilanguage" may have emerged with *H. ergaster*, perhaps restricted to the exchange of social information, with a further development of a capacity for more general reference with *H. heidelbergensis*. It seems likely that divergence between music and language arose first with modern humans, with language emerging to fulfil communicative, ostensive, and propositional functions with immediate efficacy. Music, operating over longer time-scales, emerged to sustain (and perhaps also foster) the capacity to manage social interactions while providing a matrix for the integration of information across domains of human experience. We propose that music and language enabled the emergence of modern human social and individual cognitive flexibility (Cross, 1999). We think of both music and language as subcomponents of the human communicative toolkit: as two complementary mechanisms for the achievement of productivity in human interaction though working over different timescales and in different ways.

While the selection pressures for the emergence of language have been taken to be self-evident (Pinker, 1994), those for music appear less well understood, perhaps because effects of music appear less immediate and direct, or obvious, than do those of language (Mithen, 2005). However, we suggest that a degree of adaptation to changes in the rate of individual maturation evident in the later hominid lineage may be a factor that led to the human capacity for musicality, distinct from and perhaps foundational in respect of, language (Cross, 2003b).

Musical capacities are built on fundamentally important social and physiological mechanisms and, at an essential level, are processed as such. Music uses capacities crucial in situations of social complexity: the vocal, facial and interactive foundations of these capabilities are evident in other higher primates, and such capacities would have become increasingly important and sophisticated as group size and complexity increased. Vocal emotional expression, interaction, sensitivity to others' emotional state and empathic ability would have been selectively important abilities; those individuals in which such capabilities were more developed would have been selectively favoured. Fundamentally integrated

into the planning and control of complex sequences of vocalisations, and related to the prosodic rhythm inherent in such sequences, is rhythmic motor coordination. The motor system is primed in the instigation of such vocal behaviours, and corporeal gesture is consequently incorporated into the execution of the vocal behaviour.

In terms of potential selective advantages associated with carrying out developed musical behaviours, they could confer an advantage on individuals in terms of sexual selection – because of their foundations in the capacities to communicate emotionally and effectively, to empathise, bond and elicit loyalty, musical abilities have the potential to be a proxy for an individual's likelihood of having strong social networks and loyalties, and of contributing to a group. Musical behaviour also has the potential for being a mechanism for actually stimulating and maintaining those networks and loyalties; because of the stimulation of shared emotional experience as a consequence of participation in musical activities, it has the potential to engender strong feelings of empathic association and group membership.

Musical or proto-musical behaviour also has the potential to make use of several cognitive capacities at once, relying on the integration and control of biological, psychological, social and physical systems; furthermore it gives the opportunity to practise and develop these integrated skills in a context of limited risk.

In terms of the emergence of full (specialised, as opposed to proto-) musical behaviours, their foundations in social interaction, emotional expression, and fine control and planning of corporeal and vocal muscular control lends them extremely well to exercising the integration of important cognitive skills. The execution of musical activities could become increasingly important, and beneficial, on both an individual and group level, with increasing social complexity within and between groups.

Because music production and perception is handled by the brain in ways that are complex and related to interpersonal interaction and the formation of social bonds, it stimulates many functions thus associated. It seems musical participation, even without lyrics or symbolic associations, can act on the brain in ways that are appealing to humans, because of their vicarious stimulation of fundamentally important human interactive capacities

While this model for the emergence of musicality appears to fit well with the evidence available from ethnographic, cognitive, comparative, palaeo-anatomical and archaeological sources, other ecologically observable behaviours suggest there are further facets to the evolutionary story requiring consideration. Investigation of the origins, emergence and nature of musical behaviours in humans is in its early stages, and has plenty more to reveal. It concerns, after all, an element of human behaviour that, in contrast to Pinker's (1997) opinion, the vast majority of people would miss very much if we were suddenly bereft of it. In fact, it would be impossible to remove music without removing many of the abilities of social cognition that are fundamental to being human.

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