

# Cohesion-based theories of the evolution of human musical behaviour

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## 1 Extending cohesion-based models

There is good circumstantial evidence for the role of music in establishing social cohesion. Music is *used* by social groups in a number of contexts. Durkheim <sup>[14]</sup> discussed the cohesive nature of Western religions and their rituals, establishing a mechanical solidarity amongst people through a shared set of beliefs and an identity. Ritualized group activities such as singing are understood in these terms, not only by academics, but by the people who engage in them. One way of understanding this in psychological terms, as discussed by Mithen <sup>[23]</sup>, with reference to McNeill <sup>[22]</sup>, is the experience of *boundary loss*. Sharing in the collective production of sound, we lose awareness of the boundary between ourselves and others, and experience a feeling of becoming *one* with the group. If that sense of oneness is genuine then it is surely a powerful force in establishing collective goals and

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[14] Emile Durkheim. *The Division of Labor in Society*. The Free Press, New York, 1933.

[23] Steven Mithen. *The Singing Neanderthals*. Weidenfeld and Nicholson, London, 2005.

[22] W. H. McNeill. *Keeping Together In Time: Dance and Drill in Human History*. Harvard University Press, 1995.

shared interests in human groups.

The role of music in establishing collective bonds has been discussed by a number of theorists, focusing on different aspects of such a notion. Brown <sup>[5]</sup> considers the potential origins of music in a mode of heterophonic unsynchronized group vocalisation, which he argues ties in with music's role in group communication and solidifying social groups, and acts as a precursor to the development of human synchronisation abilities. Hagen and Bryant <sup>[17]</sup> argue that music can be seen as a means for signalling group coalition strength. Coalition strength is considered to be determined by the duration and closeness of interaction within a group, and can be successfully indicated by synchronous musical performance, which also depends on these conditions in order to become well established. Hagen and Bryant note that, for this to work, musical style would need forces that drive its divergence, otherwise all groups might converge on the same 'song', and it would become harder to establish the coalition strength of a group based on the quality of their performance. Some degree of co-evolution between performance and perception could be imagined driving this change, leading to more refined and stylized forms of performance.

Cross and Woodruff <sup>[8]</sup> have argued that music should be understood as a form of communication in which the transmission of fixed meaning is of less significance than the establishment of a sense of shared intentionality, thus serving a different and complementary function to language. This perspective accommodates the role of vocal communication in

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[5] S. Brown. Contagious heterophony: A new theory about the origins of music. *Music&Scientia*, 11(1):3–26, Spring 2007.

[17] Edward H. Hagen and Gregory A. Bryant. Music and dance as a coalition signaling system. *Human Nature*, 14(1):21–51, 2003.

[8] Ian Cross and Ghofur Eliot Woodruff. Music as a communicative medium. In Rudie Botha and Chris Knight, editors, *The Prehistory of Language*. OUP, 2008.

mother-infant interaction as a way of establishing that shared intentionality [30,11,7]. For Cross and Woodruff, rhythmic entrainment acts as a medium for establishing co-operation between individuals and is capable of doing so by virtue of its honesty as a signal. Honest signals are those which, due to practical constraints on the relationship between the signal and the meaning of that signal, cannot be faked by cheats. This is an essential requirement for the emergence of any co-operative communication system in the light of the strong likelihood of selfish cheats rapidly undermining the stability of such a system. Parncutt [26] has proposed a more specific role for sound in the process of infant development, providing a bridge between the pre- and post-natal world of the baby. In the womb, a standard associative learning process could establish a connection between patterns of sound and emotional states triggered by hormones: the baby shares the mother's hormonal world and is therefore able to directly experience the emotional meaning of the sounds she makes, and later use this to infer emotional states in others. Presumably this process could also drive the increased reliance of sound in communicating emotional states in human social interaction.

The social cohesion view of music fits well with the observed uses of music in the anthropological record, where musical behaviour is, more often than not, highly social. It

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- [30] Colwyn Trevarthen. The self born in intersubjectivity: The psychology of an infant communicating. In Ulrich Neisser, editor, *The Perceived Self*. Cambridge University Press, New York, 1993.
- [11] Ellen Dissanayake. Antecedents of the temporal arts in early mother-infant interaction. In Nils L. Wallin, Björn Merker, and Steven Brown, editors, *The Origins of Music*. MIT Press, Cambridge, MA, USA, 2000.
- [7] I Cross. Music as a biocultural phenomenon. *Annals of the New York Academy of Sciences (The Neurosciences and Music)*, 999:106–111, 2003.
- [26] Richard Parncutt. Prenatal and infant conditioning, the mother schema, and the origins of music and religion. *MusicæScientiæ*, in press, 2008.

also fits with many introspective accounts of music's effect <sup>[6]</sup>. However, these theoretical models do not as yet offer satisfactory responses to the traditional problems of co-operation in evolutionary theory <sup>[9]</sup>. If Hagen and Bryant <sup>[17]</sup> are correct, then uncertainty remains as to what evolutionary factor drives music to change in such a way that synchronized musical performance remains a good indicator of coalition strength. Whilst change is stated as a requirement for such a system to operate, it does not appear to be an evolutionary outcome of the process of successive performances and evaluations. Rather, a scenario in which one song becomes established throughout all groups, and therefore indicates less about the coalition strength of any one group, may also be a likely outcome, nullifying the utility of such a system. Furthermore, it is questionable how strong this selection pressure would be, operating on groups of individuals engaging in occasional contact (the briefness of the contact being an essential part of the model). Hagen and Bryant <sup>[17]</sup> consider a hypothetical scenario in which group A encounters groups B and C, who have an entrenched rivalry. The assertion is that it is important for group A to quickly determine the coalition strength of the other two groups. Group A could form a coalition with either one of the groups and alter the balance of dominance. In this case, then, the strength of the group may not be the most important factor that group A needs to consider, since they would be successful either way. Also, if raiding between groups is sufficiently frequent, then in what way does a ritual display come to indicate more than a genuine hostile interaction? Finally, if it is known within a group that a successful display (both novel and well coordinated) influences the effect of the group, then what does this mean for the internal dynamics of the group?

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[6] Martin Clayton. Comparing music, comparing musicology. In Martin Clayton, Trevor Herbert, and Richard Middleton, editors, *The Cultural Study of Music*, chapter 4, pages 57–68. Routledge, 2003.

[9] Richard Dawkins. *The Selfish Gene*. OUP, 1976.

[17] Edward H. Hagen and Gregory A. Bryant. Music and dance as a coalition signaling system. *Human Nature*, 14(1):21–51, 2003.

Would better singers and dancers outcompete better warriors within the group, leading to groups whose ritual skills indicate exactly the opposite of what Hagen and Bryant propose? In particular, would a successful display really indicate the coalition strength of the group, or just the success of individuals to adapt to a context in which song and dance are highly valued?

Similarly, the suggestion that rhythmic entrainment is an honest indicator of co-operation between individuals fails to establish clearly how this honesty could be evolutionarily stable. To argue that the honesty of the signal would be more firmly established if participants experienced a sense of one-ness, as Cross and Woodruff <sup>[8]</sup> do, appears circular. If a sense of one-ness is advantageous to individuals over evolutionary time, then there is no need to invoke an honest signal, and if a sense of one-ness is disadvantageous to individuals over evolutionary time, then there is no sense in which the signal can be seen as being honest. The assumption that entrainment already implicitly has an effect on an individual's perception of joint intentionality and sense of one-ness within a group nullifies the need to talk about honest signalling. Put another way, how would this role for entrainment be defended against exploitation by individuals who did not feel the social bond so strongly, but still participated in the interaction? It is hard to see, according to this explanation, what additional information rhythmic entrainment brings to the interaction. Some suggestions include the energetic expenditure of music and dance, or the time taken to learn certain sequences of action, or simply the impossibility to disassociate entrainment with social bonding.

There are many ways in which these questions can be addressed within the frame of the theories so far proposed, and the purpose of this chapter is not to try to falsify them.

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[8] Ian Cross and Ghofur Eliot Woodruff. Music as a communicative medium. In Rudie Botha and Chris Knight, editors, *The Prehistory of Language*. OUP, 2008.

However, it seems relevant to also consider what kind of an active role inter-individual competition might have played in the establishment of musical behaviour. A successful co-operative system must have structural qualities that make it robust in the face of selfish exploitation. In establishing this stability, possible avenues of exploitation are invariably present, leading to a specific structural organisation that embodies a compromise between the dynamics of co-operation and competition. In this chapter, I will explore the competitive side of musical behaviour.

## 2 Competition, co-operation and cohesion

In the above review, I raise a complaint commonly used against group selection-style theories: a situation may be beneficial to a group, but one must pay more attention to what situations allow *individuals* to be successful. If individual success and group success are in conflict, then the individual success is the driving force for evolution over the group success. However, as Sober and Wilson <sup>[29]</sup> argue, it is possible for selection to operate simultaneously on a number of different levels, which interact in more complex ways than mere reinforcement or cancellation. Accordingly, the complaint should only be raised to challenge the robustness of social cohesion theories in accounting for the interaction between these levels, not as an attempt to refute them. The complaint about social cohesion-based explanations for music is that they set up the potential for musical behaviour to be used as a means for exploitation of one individual by another. The individual is exposed to exploitation through having a high *susceptibility to enchantment* through music. By ‘susceptibility to enchantment’ I mean that musical interaction causes the individual to feel a bond to other individuals, associated with shared goals and a common interest. At least,

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[29] Elliott Sober and David Sloan Wilson. *Unto Others: The Evolution and Psychology of Unselfish Behavior*. Harvard University Press, 1998.

this bond is what social cohesion theories observe and try to explain. A convincing social cohesion theory must address the dynamics of competition and exploitation built upon cognitive susceptibilities. Treating this behavioural trait as a susceptibility shifts the focus of that interaction onto the potential for individuals to take advantage of these traits in others, rather than to take advantage in possessing the trait oneself.

Social competition may even be a starting point for an evolutionary process, with the structures that facilitate co-operation emerging from it. The individualist objection establishes why competition might emerge in the context of a social structure that facilitates co-operation. The reverse could occur if the context of competitive interaction was such that it provided a selective environment for the evolution of co-operation. This has been discussed with respect to Machiavellian intelligence <sup>[32,12,13]</sup>, but not in terms of musical behaviour. Such a view requires that, firstly, music is neither an adaptation nor an exaptation, but a spandrel <sup>[16]</sup>, secondly, that the existence of music established a context in which competition took place, and thirdly, that this competition established a context in which co-operation emerged.

Underlying this view is the observation that cohesion is not synonymous with co-operation, but can also involve the stabilisation of a set of competitive tensions. Cohesion is defined as the act of forming a united whole, but, within that whole, shifts of power may

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[32] A. Whiten and R. W. Byrne. *Machiavellian Intelligence II: Extensions and Evaluations*. CUP, Cambridge, UK, 1997.

[12] Robin Dunbar. Social brain and its implications for human social behaviour, 2006.

[13] Robin Dunbar. Evolution of the social brain. In *The Evolution of Mind: Fundamental Questions and Controversies*, pages 280–292. Guilford Press, 2007.

[16] S. J. Gould and R. C. Lewontin. The spandrels of san marco and the panglossian paradigm: a critique of the adaptationist programme. In *Proceedings of the Royal Society of London*, volume 205 of *B*, pages 581–598, 1979.

be taking place that may also contribute to the cohesive process.

### 3 Music at the interface between individuals in social learning

If musical behaviour is not a direct evolutionary adaptation then it is a consequence of other cognitive capacities. Pinker [27] argues exactly this, stating music's lack of an observed function as the primary basis for such an assumption. Pinker supports his view with a breakdown of how various cognitive aspects would contribute to musical behaviour. Music can be characterized, thus, as a technology; an aspect of human behaviour with an 'evolutionary' history, just not one that involves biological adaptation. Despite these ideas of technology and evolutionary history, Pinker's view of music remains tightly bound by a notion that individual cognition is not strongly determined by the cultural environment. Music is still a product of the individual human mind, just realized or exaggerated in some way through a cultural process. According to this point of view, musical behaviour is actually maladaptive, and its existence results in a state of affairs in which some individuals use musical techniques to exploit other individuals. In Western society, professional musicians could then be seen as harmful exploiters of their fans, who pay their upkeep in exchange for unbeneficial auditory stimulation (Huron [20], similarly, asks why Moroccan villagers would support full-time musicians in their society).

Considering the relationship between Pinker's view, and the view of cohesion theorists, two questions appear relevant. Firstly, could the apparent functional utility of music be

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[27] Steven Pinker. *How the Mind Works*. Allen Lane The Penguin Press, London, UK, 1998.

[20] David Huron. Is music an evolutionary adaptation. In *The Biological Foundations of Music*, Annals of the New York Academy of Sciences, pages 43–61. 2001.

explained away by Pinker’s view? Instead of music actually being functional, could it be an exploitative process masquerading as a functional one? There is a middle way: musical behaviour is relatively neutral, and does not massively affect evolutionary outcomes. However, when such a behaviour comes to great prominence in social life, it is reasonable to assume that it has some effect on the respective fitness outcomes of a population. The problem, as ever, is that we don’t know when music did come to prominence in social life, due to a lack of archaeological evidence <sup>[31]</sup>. Secondly, who would be the evolutionary descendants of Pinker’s musicians? On the surface, by the very mention of exploitation and maladaptation, it would appear that music is destined to become erased from human behaviour, as we slowly evolve defences against this kind of exploitation. But the complex relationship between culture and genes suggests that this is far from a foregone conclusion. This second question is the focus on an evolutionary simulation described below. Here I address the first question.

The functional utility of music is understood by social cohesion theorists in terms of its intensely social nature. However, it is also possible that the attribution of function to the social features of music is inappropriate. Boyd and Richerson <sup>[4]</sup> provide a series of mechanisms by which culture might pick up and amplify maladaptive behaviours, with the powerful adaptive function of social learning outweighing the cost of acquiring these maladaptive behaviours. With cumulative cultural learning enhancing overall fitness at a rate massively outpacing biological evolution, they argue, there is a lot of room for maladaptive baggage. Boyd and Richerson put this down to the impossibility of having

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[31] Nils L. Wallin, Björn Merker, and Steven Brown, editors. *The Origins of Music*. MIT Press, Cambridge, MA, USA, 2000.

[4] R. Boyd and Peter J. Richerson. *Culture and the Evolutionary Process*. University of Chicago Press, Chicago, IL, US, 1985.

general learning mechanisms that can successfully filter good behaviours from bad ones. Amongst the low cost heuristics that Boyd and Richerson discuss as explanations of human cultural behaviour are a frequency-dependent bias – individuals are more likely to adopt behaviours that are more common – and a prestige bias – individuals are more likely to adopt behaviours from those who appear to possess prestige. According to Richerson and Boyd <sup>[28]</sup> ‘determining *who* is a success is much easier than determining *how* to be a success’ (<sup>[28]</sup> p.124). Henrich and Gil-White <sup>[19]</sup> argue that prestige is also something that we ‘pay’ to individuals with successful behaviours from whom we wish to learn. The fact that prestige partly determines whom we learn from and what we learn, and is also partly determined by the process of individual human evaluation, sets up the conditions for a runaway evolutionary process, that Richerson and Boyd <sup>[28]</sup> liken to the runaway effects of sexual selection. Cultural behaviour, according to Boyd and Richerson, evolved to help populations adapt to changing environments. In their original conception of this process, successful behaviours are understood as those which are adaptive with respect to an external environment. However, as they point out, an individual can also be successful by exploiting other individuals in the population, and their various biases for cultural learning and evaluation, without any net fitness gain with respect to the external environment. The existence of prestige allows for the cultural evolutionary process to turn inwards and promote behaviours that satisfy the ability to gain prestige in a circular manner.

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[28] Peter J. Richerson and Robert Boyd. *Not by Genes Alone: How Cultural Transformed Human Evolution*. University of Chicago Press, Chicago, IL, US, 2005.

[19] Joseph Henrich and Francisco J. Gil-White. The evolution of prestige: Freely conferred deference as a mechanism for enhancing the benefits of cultural transmission. *Evolution and Human Behaviour*, 22:165–196, 2001.

Dawkins [9], Blackmore [2], and other followers of the memetics tradition, also support the view that it is perfectly logical, from Darwinian first principles, for cultural learning to provide the basis for a new evolutionary process. In this process, learnt behaviours are the evolutionary entities, and the process of social learning is the mechanism of replication. Just as with biological reproduction, learning entails heredity, variation and selection with respect to the units it operates on. Like Boyd and Richerson, memeticists argue that culturally evolving behaviours (memes) may develop mutualistic relationships with their hosts (humans), but may also exploit them [2]. It seems that the choice to adopt the term ‘meme’ is more a matter of taste [1] than a commitment to the belief that cultural evolution has Darwinian properties, and I opt to follow Boyd and Richerson in maintaining such a discussion without recourse to the term.

It is plausible that music emerged, first and foremost, as part of cultural evolution’s maladaptive baggage, and its social utility has evolved on top of this. Boyd and Richerson do not discuss music in the recent summary of their work [28], but they do provide many examples of the copying of style from prestigious individuals. One of the most compelling reasons for imagining this working with music is simply the fact that vocal sound, along with movement, exists at the interface between people in processes of social learning. Successfully learning behaviour from others, for example, is almost certainly likely to include the ability to learn sequences of movement. If there is any scope for the accidental exaggeration of behaviours through repeated iterations of social learning, then almost

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[9] Richard Dawkins. *The Selfish Gene*. OUP, 1976.

[2] Susan J. Blackmore. *The Meme Machine*. OUP, New York, 1999.

[1] Robert Aunger. *Darwinizing Culture*. Oxford University Press, New York, 2000.

[28] Peter J. Richerson and Robert Boyd. *Not by Genes Alone: How Cultural Transformed Human Evolution*. University of Chicago Press, Chicago, IL, US, 2005.

by definition, the behaviour to emerge is *dance*: a highly ordered, socially interactive, but otherwise non-functional movement. If the same were to happen sonically, the result could be understood as music *by definition*: that is, a socially meaningful, rather than information-bearing, organisation of sound (*c.f.* Cross [7]).

## 4 Music is reinforced through the social generation of value

Combining Pinker's [27] view of music as frivolous pleasure induction with Boyd and Richerson's [4] view of cultural evolution as having the potential to propagate and exaggerate useless behaviours, it appears possible that musical behaviour not only survived despite its maladaptiveness but became entrenched due to a cultural evolutionary process of reinforcement. The ultimate expression of culture as an autonomous system occurs when individuals are able to become more successful as a result of their social interaction, through the generation of prestige, than as a result of their abilities to exploit the physical environment. Boyd and Richerson's theory shows how cultural systems could determine the conditions under which individuals may or may not be successful, just as runaway sexual selection does, without recourse to the adaptive value of the behaviours concerned (although the *handicap principle* [33] may impose an ultimate need for these behaviours to be tied to environmental success). However, the reasons suggested by Pinker for the existence of music do not seem to go far enough to establish music as a candidate for taking on this role.

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[7] I Cross. Music as a biocultural phenomenon. *Annals of the New York Academy of Sciences (The Neurosciences and Music)*, 999:106–111, 2003.

[27] Steven Pinker. *How the Mind Works*. Allen Lane The Penguin Press, London, UK, 1998.

[4] R. Boyd and Peter J. Richerson. *Culture and the Evolutionary Process*. University of Chicago Press, Chicago, IL, US, 1985.

[33] A. Zahavi. Mate selection – a selection for a handicap. *Journal of Theoretical Biology*, 53, 1975.

Pinker glosses over the more simple qualities of vocal signals: they are salient (noticeable, one-to-many, long-distance), highly individualisable, and potentially arbitrary – as Cross [7] argues, music is typified across cultures by its *variable and transposable* meaning.

This view is not dissimilar in its scope to a social cohesion view of music: music acts as a medium for interaction between individuals, and it becomes critical to the survival of individuals in social contexts. There is also a strong equivalence between the role of music in establishing inter-individual bonds from both points of view. According to the social cohesion perspective, music establishes a mutual bond between individuals. According to the maladaptation-competition perspective, musical copying is the result of a bond between a learner and a model, both of whom potentially benefit (one from prestige and the other from acquired prestigious behaviour). Thus the maladaptation-competition view is potentially able to explain the role of music in establishing social bonds, as well as the mutual benefit of musical interaction between the individuals involved. It also does this in a strictly individualist manner. Both views predict similar features in modern musical behaviour.

In short, the maladaptation-competition perspective states that human social differentiation can turn maladaptive behaviours into prospective cultural niches.

## **5 A model demonstrating the potential for kin selection to establish co-operation in a competitive environment**

I present a computer simulation study set up to explore the possible evolutionary outcomes of a world inhabited by Pinkerian musicians. A population of artificial agents was

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[7] I Cross. Music as a biocultural phenomenon. *Annals of the New York Academy of Sciences (The Neurosciences and Music)*, 999:106–111, 2003.

designed to interact amongst themselves according to a simple competitive ‘style’ game. Their evolutionary fitness was determined entirely by the outcome of those interactions. Following Pinker’s view, the basic property of this musical behaviour was that it was of no direct benefit to individuals. Since this non-functionality is framed in terms of the fact that the brain is *mistaken* in finding pleasure in musical sound, the non-functional nature of the behaviour in the model is given as the propensity for an individual to reward other individuals as a result of their musical behaviour, without reciprocity. This is referred to above as a *susceptibility to enchantment*. The scenario that is explored, then, is one in which some individuals may be able to exploit others by inducing pleasurable musical experiences in them. To keep things simple, this exploitation is simply represented by the payment of a reward from the enchanted to the enchanter. Rewards are accumulated by successful individuals as *status*. However, a less simple detail, necessary for the *evaluation* of a style to have meaning in the model, is that individual musical judgements are considered as being entirely relativistic, depending on individual life histories, and therefore also changeable over time. For one individual to gain status rewards from another, then, the other individual must be susceptible to enchantment, and must also actually be presented with a suitably enchanting style.

The remaining details of the model are discussed in detail in Bown (2008) [3]. Individuals inhabit a two dimensional space in which they move randomly and interact only with close neighbours. Musical styles are modelled as particles in a multidimensional space and are used as the basis by which individuals evaluate the novelty of other individuals’ styles, and thus determine their level of enchantment. Individuals also adapt their styles through

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[3] Oliver Bown. *Theoretical and Computational Models of Cohesion, Competition and Maladaptation in the Evolution of Human Musical Behaviour*. PhD thesis, Department of Computing, Goldsmiths College, University of London, July 2008.

learning from their neighbours (convergence) and through individual creative exploration (undirected divergence). In one configuration of the model individuals also acquire their initial styles directly from their parents (vertical cultural transmission) whilst in an alternative configuration, styles are initialized to a default value. Survival and reproduction are determined by a simple energy model: individuals gain energy by consuming food in their local environment. Individuals with higher status (gained from enchanting other individuals) have a greater chance of obtaining food, as determined by a process of tournament competition for food with randomly selected neighbours in a local environment.

The main point is that the simulation consists of an *interaction game* and a *status game*:

- The interaction game represents the existence of a cultural process of style learning which does not have a direct adaptive function. This is the component that affects everything to do with agents' styles. It is assumed that all of the aspects of the model to do with the interaction game have no *direct* benefit to individuals' fitness; the interaction game has nothing to do with either mating or extracting resources from the environment to stay alive.
- The status game represents the existence of a social reward system that results in some individuals enjoying privileges which ultimately enhance their fitness.

When individuals' susceptibility to enchantment is treated as a genetically determined trait and allowed to evolve as the model is run, a predictable result occurs in the majority of cases: susceptibility to enchantment rapidly drops to zero across the population. This is the expected and intuitive evolutionary outcome, because having anything other than a non-zero susceptibility to enchantment means rewarding other individuals, increasing their status relative to one's own, and therefore increasing their access to food (thereby implicitly

diminishing one's own access to food). A search of the parameter space of the model was conducted to find situations in which this outcome didn't occur. This revealed that when vertical cultural transmission is used, and the rate of learning is very low, susceptibility to enchantment can be seen to increase. On closer inspection, this is best explained by the principle of inclusive fitness, that under these circumstances, close kin can pay each other high rewards, but then *avoid* being enchanted by others, despite having high susceptibilities to enchantment.

More specifically, the following occurs: an individual produces a child in its own immediate vicinity. Parent and child are therefore within each other's neighbourhood for musical interaction, and also have very similar musical styles (by virtue of the vertical cultural transmission rule). Parent and child reward each other with high status when they interact. As individuals move around randomly, the children become more likely to interact with individuals other than their parents. If these other individuals have very different musical styles then these interactions will not result in mutual rewards. However, the high status rewarded to the child, gained from interactions with its parent earlier on, means that the child does well in tournament competitions with these other individuals. If this is the basic life cycle for individuals, then, it is clear that it is advantageous to have a high susceptibility to enchantment, as long as learning is relatively weak and the individual is sufficiently different to other individuals so as not to be enchanted by them. In the model, the fact that status *sticks* to an individual is important. It is only by carrying one's acquired status into a new social context (from interactions with parents to interactions with non-kin) that this particular affordance is possible.

Inclusive fitness <sup>[18]</sup> is a well established theory for how co-operation can emerge, and by searching for a situation in which the predicted eradication of music (reduction of sus-

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[18] W. D. Hamilton. The evolution of altruistic behaviour. *American Naturalist*, 97:354–356, 1963.

ceptibility to enchantment) would be thwarted, it makes sense that inclusive fitness should provide one such mechanism. In this case, musical tendencies evolve through the emergence of co-operative interaction between close kin, but this co-operative interaction itself emerges because the competitive context is written into the simulation. This shows how co-operative musical interaction could emerge as an adaptation to a culturally maladaptive scenario. In response to a non-functional system of cultural interaction that is imposed on individuals (a non-evolutionary consequence of other, more functional, aspects of their behaviour) there exists an evolutionary pathway that involves vertical cultural transmission and applies the properties of kin selection to this new domain. This points to the possibility that pre- and post-natal mother-infant interaction could be understood as an adaptation to a non-functional cultural situation rather than being functional in establishing a cultural situation. Furthermore, the outcome of this process, that susceptibility to enchantment increases, also reinforces, in part, the original cultural phenomenon. That is, the resulting population is one in which susceptibility to enchantment is high, the potential for competitive exploitation of this susceptibility exists, but agents are defended from exploitation because they learn primarily from their parents and have low learning rates.

This model is still a model of evolution towards co-operative structures based on musical interaction, and still supports a social cohesion view of music's biological evolution. However, when the question arises as to what this is an adaptation to, in the case of this model, the answer is that the adaptation is to specific cultural competitive conditions based on an exaggerated maladaptive trait. It should be added that no such model can be taken too seriously as a simulation of human bio-cultural evolution. Demands of simplicity mean that phenomena such as 'style', 'evaluation', 'learning' and 'status' do not go very far at all in sustaining any semblance of the real world. Unlike traditional modelling that attempts to fit empirical data, such models are abstract dynamical systems experiments inspired by

reasoning about the real world, but any conclusions drawn from them can only be logical, or act as suggestive evidence <sup>[10]</sup>.

The suggestion by the model that co-operation could emerge in response to a maladaptive cultural scenario adds to a more extensive theoretical scenario, consisting of two stages. In the first stage, the adaptive success of social learning leads to the proliferation of maladaptive behaviours, activities that are not actually of use to individuals either in terms of abilities to extract resources from environments, or in terms of abilities to gain favour from other individuals. Maladaptive copying begins with surface phenomena such as sound and gesture, since these are salient and individualisable and potentially arbitrary. Successful individuals become the focus of other individuals' imitation. However, individual success is also a *product* of individual copying strategies, since having more copyers means more attention and potential for social leverage; with copying and success so closely coupled, feedback ensues, music is the emergent product of this process.

In the second stage, adaptation towards a state of music-avoidance (*i.e.*, filtering out music in the process of copying) does not occur because there simply isn't an evolutionary pathway that filters out this cost whilst maintaining the benefits of cumulative cultural evolution. Rather, over evolutionary time, individuals increasingly make social capital out of the presence of music, leading towards musically adaptive minds, and the reinforcement of musical behaviour in human society. One form that this adaptation takes is via kin selection, with mother-infant interactions adapting as much as possible to exploit social dynamics to maximize the infant's social potential. Here, the social nature of music drives the mother-infant interaction towards a bond predicated on musical interaction.

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[10] E. Di Paolo, J. Noble, and S. Bullock. Simulation models as opaque thought experiments, 2000.

## 6 Viewing culture as part of the external environment

The idea that a cultural activity forms the basis for future adaptation is not new. Niche constructionism <sup>[24,21,25]</sup> posits that the process of modifying environments through action is just as important an evolutionary process as natural selection. Laland, Odling-Smee and Feldman <sup>[21]</sup> point out that humans are the most potent of niche constructors, modifying not only their physical environment, but also their cultural environment in ways that affect themselves, their offspring, and other conspecifics. In some ways this is the closest that theoretical biology has come to absorbing the social anthropologists' maxim that 'man is an animal suspended in webs of significance that he himself has spun' (<sup>[15]</sup> pp. 4–5). By introducing a feedback cycle into standard models of evolution by natural selection alone, niche construction emphasizes the potential for emergence and autocatalysis as genuine evolutionary processes. It is also a flexible enough perspective that it allows us to view culture either as a system with evolutionary dynamics of its own, or as a somewhat passive (constructed by human action) feature of the environment, much like the abiotic environment of non-human niche construction models.

Indeed, the question of what form culture takes in human evolutionary processes is particularly relevant to the problem of music's evolution. The nature of culture as a phenomenon that transcends human generations is still hard to reconcile with a view, more

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[24] F. J. Odling-Smee. Niche construction, evolution and culture. In Tim Ingold, editor, *Companion Encyclopedia of Anthropology: Humanity, Culture and Social Life*. Routledge, Oxford, UK, 1994.

[21] Kevin N. Laland, John Odling-Smee, and Marcus W. Feldman. Niche construction, biological evolution and cultural change. *Behavioral and Brain Sciences*, 21(1), 1999.

[25] F. John Odling-Smee, Kevin N. Laland, and Marcus W. Feldman. *Niche Construction: The Neglected Process in Evolution*. Number 37 in Monographs in Population Biology. Princeton University Press, Princeton, USA, 2003.

[15] C. Geertz. *The Interpretation of Cultures*. Basic Books, New York, 1973.

popular amongst biologists, of culture as merely the product of the individuals that possess it. For many, culture is generated by human behaviour, and sits on top of it. However, it is also helpful to think not only of a social environment of real tangible conspecifics, but of a cultural environment, which is abstract and in some sense external to that population. This external cultural environment is more than just the collective behaviour of the individuals making up a population: it transcends them, and it influences their behaviour as much as they influence its structure. This notion of culture as being an ‘external environment’, equivalent to the abiotic environment, evolutionarily inert but modifiable, something beyond the immediate social environment, may be more useful than the notion of memes. Both are intangible, but the former does not get stuck attempting to identify units of behaviour, or representing cultural interaction as a process of inter-individual transmission of information. In the scenario discussed in this chapter, music has two guises. One is a cultural phenomenon that emerges from the runaway evolution of maladaptive behaviour. In this guise it exists as part of the external cultural environment, to which we have to adapt if we are to survive as successful humans. The other is the adaptive response to this scenario, which takes the form of a co-operative behaviour.

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