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Original Article

Did sexual selection shape human music? Testing predictions from the sexual selection hypothesis of music evolution using a large genetically informative sample of over 10,000 twins

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ABSTRACT

Although music is a universal feature of human culture, little is known about its origins and functions. A prominent theory of music evolution is the sexual selection hypothesis, which proposes that music evolved as a signal of genetic quality to potential mates. The sexual selection hypothesis offers several empirically testable predictions. First, musically skilled and active individuals should have greater mating success than less-skilled individuals. Second, if musical ability functions as an indicator of genetic quality, it is expected to be associated with other traits putatively related to genetic quality. Third, associations as per the first and second predictions are expected to be at least partly due to overlapping genetic influences. We tested these predictions in a large genetically informative sample of 10,975 Swedish twin individuals aged between 27 and 54 years ($M = 40.1$, $SD = 7.7$), using musical aptitude and music achievement as measures of musical ability. To assess mating success we examined number of sex-partners, age of first intercourse, sociosexuality, and number of offspring. General intelligence, simple reaction time, and height were used to investigate relationships with traits putatively related to genetic quality. Twin modeling showed moderate genetic influences on musical aptitude for both sexes (heritability estimates were 38% for males and 51% for females). Music achievement was also moderately influenced by genetic influences in males (heritability = 57%), but the genetic influences were low and nonsignificant for females (heritability = 9%). Contrary to predictions, the majority of phenotypic associations between musical ability and music achievement with mating success were nonsignificant or significant in the other direction, with those with greater musical ability scoring lower on the measures of mating success. Genetic correlations between these measures were also nonsignificant. Most correlations of musical aptitude and music achievement with genetic quality measures were significant, including correlations with general intelligence, simple reaction time, and, in females, height (but only for aptitude). However, only the correlation between musical aptitude and general intelligence in men was significantly driven by overlapping genetic influences. Our findings provide little support for a role of sexual selection in the evolution of musical ability. Alternative explanations and limitations are discussed.

1. Introduction

Music or musicality—"a natural, spontaneously developing trait based on and constrained by our cognitive system" (p. 4; Honing & Ploeger, 2012)—is a universal feature of human culture which, in most cultures, developed independently and can be traced back more than 40,000 years (based on an old bone "flute" found in Slovenia; Kunej & Turk, 2000; McDermott & Hauser, 2005a, 2005b). Music forms part of many cultural events such as weddings and funerals, and individuals invest a considerable amount of time (and resources) in listening to music or learning to play an instrument. Further, music can evoke emotions and therefore has become a central part of the advertisement and entertainment industries (DeNora, 2001). However, despite its importance in human culture, little is known about the origins and functions of music. Why do humans make music although it appears not to aid survival? Why do humans spend resources (e.g. time, energy, money) on music which could be spent on more obvious contributions to fitness? While some argue that music may be a byproduct of more general purpose mechanisms, e.g. the auditory or language system (Pinker, 1997), others

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believe that music may be a biological adaptation (e.g. Darwin, 1871; Miller, 2000a), suggesting that music has evolved through natural or sexual selection.

1.1. Music as a biological adaption

An important criterion for an adaptationist explanation of music, apart from being universal across cultures and history, is that aspects of music (e.g. skills involved in music perception and production) are genetically based, since adaptations are necessarily encoded in the DNA. Evidence shows that some basic cognitive components underlying musicality such as relative pitch, tonal encoding of pitch, beat induction and metrical encoding of rhythm may be universal and develop spontaneously and early during child development (for a detailed review see McDermott & Hauser, 2005a). Further, a common operationalization of music ability is sensory discrimination of auditory musical stimuli of various types (Seashore, 1960). Performance on such discrimination tests shows substantial associations with music practice and is consistently better among professional musicians compared to non-musicians (Schellenberg & Weiss, 2013). It recently has been shown that such auditory discrimination abilities—rhythm, melody and pitch discrimination—are moderately heritable suggesting that 50, 59, and 12–30% of the variance, respectively, could be explained by genetic influences (Ullén, Mosing, Holm, Eriksson, & Madison, 2014). Another study reported an even higher heritability of 80% for musical discrimination using the distorted tunes test (DTT), which requires the participant to identify incorrect pitches from melodic stimuli (Drayna, Manichaikul, de Lange, Snieder, & Spector, 2001). In addition, genome-wide linkage and association studies have identified specific genetic polymorphisms apparently associated with musical aptitude (Oikkonen et al., 2014; Ukkola, Onkamo, Raijas, Karma, & Järvelä, 2009; Ukkola-Vuoti et al., 2013).

1.2. Sexual selection theory

A variety of functional hypotheses for the origins of musicality as an adaptation have been developed in recent years, such as enhancing parent and child bonding (Dissanayake, 2008), promotion of mental and social development (Cross, 2007), increasing social cohesion (Merker, 2000), or play beneficial to cognitive functions (music resulting from exaptation; Honing, 2011). The most prominent adaptationist theory of music evolution, though, is Darwin's (Darwin, 1871) sexual selection hypothesis—later refined by Miller (2000a)—suggesting that music has evolved for the purpose of signaling genetic quality to potential mates and thus increasing mating success. The theory is based on Darwin's well-established idea that bird songs function as (primarily male) courtship displays to attract sexual mates (primarily choosy females) (Darwin, 1871) and has proven the most useful hypothesis for understanding the functions of insect stridulation, bird, and whale song, and lots of other complex auditory signaling in other species. The sexual selection theory of music evolution (Miller, 2000d) proposes that genetic mutations accumulated over many generations (i.e. mutation load) have deleterious downstream effects on general functioning (Houle, 1998; Keller & Miller, 2006), and that cognitive ability is an especially sensitive indicator of mutation load because brain function depends on a very large proportion of the genome and will thus be affected by a large proportion of random mutations (Sandberg et al., 2000). As such, cognitive ability has been hypothesized to be a fundamental indicator of good genes (Miller, 2000c, 2000d). However, variation in cognitive ability (as measured by intelligence tests) is not directly observable, but can only be indirectly communicated through exhibition of complex behavior, such as music production (Miller, 2000a, 2000d). As such, the theory proposes that musical production has been used to advertize such traits and humans have evolved to utilize the information such display conveys about the performer (Miller, 2000a). Accordingly, musicality would be an indicator of high genetic quality promising indirect benefits of mate choice in the form of genetic benefits to the offspring. Based on this framework, there are several predictions which can be tested.

1.3. Predictions of sexual selection hypothesis

First, if music production evolved as a sexual display, it follows that more musically skilled individuals should have quantitatively greater mating success (e.g. more sex-partners) than less-skilled individuals (Miller, 2000a). To the extent that women have been more choosy than men (see Stewart-Williams & Thomas, 2013 and commentaries for a discussion), the link between sexual display and mating success could be expected to be stronger in men. Second, if musical ability functions as display of cognitive ability and, more generally, of genetic quality, we expect positive associations of musical ability with cognitive ability and other traits putatively reflecting genetic quality, such as reaction speed and height (specifically for males; Stulp, Buunk, & Pollet, 2013). Third, the associations between musical ability and putative genetic quality traits are expected to be genetically based (i.e. positive *genetic* correlations) because each trait is an imperfect index of the same underlying "mutation load." Further, if musical ability is causally influencing mating success because of its role as an indicator of genetic quality, a positive genetic correlation is expected between the two. This is because when a heritable trait (musical ability in this case) causally influences a second trait, the genes affecting the first trait will necessarily affect the second trait as well, resulting in a genetic correlation between the traits.

Here we test these predictions using a large genetically informative sample of Swedish twins.

2. Methods

2.1. Participants

The data were collected with two Web-based surveys from a large cohort of Swedish twins with approximately 32,000 twin individuals born between 1959 and 1985—the STAGE cohort (Lichtenstein et al., 2006). The first survey, conducted between 2005 and 2006, included questions about body height and sexuality (number of sex-partners, age at first intercourse) and had a total of 11,229 male and 14,096 female participants ($M = 33.7$ years, SD = 7.7; Långstrom, Rahman, Carlstrom, & Lichtenstein, 2010). The second survey was conducted between 2012 and 2013 (for further detail on this survey see Mosing, Madison, Pedersen, Kuja-Halkola, & Ullén, 2014; Ullén et al., 2014) and contained, among others, measures of musical ability, IQ and simple reaction time, as well as the Mini-K questionnaire and number of children (see below). Data from the first survey were matched to the participants of the second survey, i.e. participation in the second survey determined inclusion in the present study. The final sample consisted of 11,543 participants aged 27–54 at time of the second survey ($M = 40.7$, SD = 7.8) with a score for at least one of the traits studied here. Single twins were included as they contribute to the estimation of means and variances. Around 28% of the participants reported that they play or have played a musical instrument (including singing). Choir singing is commonly offered as an extra-curricular school activity in Sweden, and some schools offer in addition a basic orientation in instrumental playing. Further, 18% of the musically active reported having participated in special musical education also outside of school.

Zygosity was determined based on questions about intra-pair resemblance. In the STR, this method has been shown to be more than 98% accurate when zygosity status was confirmed using genotyping (Lichtenstein et al., 2002). For further details on the STAGE cohort and zygosity determination in the Swedish Twin Registry see Lichtenstein et al. (2002, 2006). The present study received approval from the Regional Ethics Review Board in Stockholm (Dnr 2011/570-31/5, 2012/1107/32, 2012/2172-32).