Before Words.
Music and Its Natural History

Domenica Bruni, Fabio Esposito

Abstract

The paper investigates the evolutionary origins of music, focusing on its adaptive function and phylogeny. We compare theories such as Steven Pinker's, who sees music as a non-adaptive by-product, Charles Darwin's ideas that music evolved through sexual selection as a signal of intelligence and fitness, and Herbert Spencer's, who argued that music evolved from emotional expression rather than reproduction. Other perspectives highlight the role of music in social cohesion and emotional expression. The paper also examines modern research that questions whether sexual selection is the sole driver of evolution, suggesting a complex and multidisciplinary understanding of the role of music in human evolution.

Keywords: Music Evolution; Sexual Selection; Emotional Expression; Phylogeny; Adaptive Function.

Sommario

Il saggio esplora le origini evolutive della musica, concentrandosi sulla sua funzione adattativa e sulla filogenesi. Il saggio contrappone teorie come quella di Steven Pinker, che vede la musica come un sottoprodotto non adattivo, le idee di Charles Darwin, secondo cui la musica si è evoluta attraverso la selezione sessuale come segnale di intelligenza e fitness, e quelle di Herbert Spencer, che sosteneva che la musica si è evoluta dall'espressione emotiva piuttosto che dalla riproduzione. Altre prospettive evidenziano il ruolo della musica nella coesione sociale e nell'espressione emotiva. Il saggio esamina anche le ricerche moderne che mettono in dubbio che la selezione sessuale sia l'unico motore dell'evoluzione, suggerendo una comprensione complessa e multidisciplinare del ruolo della musica nell'evoluzione umana.

Parole chiave: Evoluzione della musica; Selezione sessuale; Espressione emotiva; Filogenesi; Funzione adattativa.

1. Music, partners & cheesecake

Reconstructing and investigating the evolutionary history of music means addressing two main issues: the adaptive function of music and its phylogeny. Regarding the adaptive function, there are several perspectives. Cognitive scientist Steven Pinker's 'Music as Cheesecake' theory (1997) proposes that music is simply a form of extemporaneous pleasure, an evolutionary by-product with no specific adaptive function; it exploits other mechanisms of the brain developed for different evolutionary purposes, such as language and motor co-ordination. According to this view, music would be similar to a culinary treat that gratifies us without having a direct impact on our survival or reproduction. In the words of Steven Pinker:

> As far as biological cause and effect are concerned, music is useless. It could vanish from our species and the rest of our lifestyle would be virtually unchanged. Music appears to be a pure pleasure technology, a

> cocktail of recreational drugs that we ingest through the ear to stimulate a mass of pleasure circuits at once (Pinker, 1997, p. 528).

In contrast, the theory of sexual selection, advocated by Charles Darwin in 1871 and further developed by scholars such as biologist Benjamin D. Charlton (2014) and evolutionary psychologist Geoffrey Miller (2000), suggests that music might have played a crucial role in mate selection. In this perspective, the ability to produce and enjoy music might have been selected as a signal of fitness and intelligence, useful for attracting partners.

Another theory, proposed by Altenmüller et al. (2013), suggests that music might have more complex origins. According to this view, music could be derived from ancient emotional signaling systems shared by many social mammals. From these roots, music would have evolved to elicit aesthetic emotions, facilitate auditory learning, promote social cohesion, and enhance psychological and physiological well-being.

On the phylogeny front, there are two main hypotheses. One theory proposes that music evolved concurrently with language or as an extension of cognitive abilities associated with language (Patel 2008; Brown 2000). In this case, music might not be an isolated phenomenon, but rather an aspect of the evolution of language itself.

Another possibility is that music emerged as an extension of emotional communication, evolving from the musical components of speech (Juslin and Västfjäll, 2008; Levitin, 2008). According to this theory, music may have originated as a means to express and communicate emotions in a more complex and refined way.

Two main questions emerge from these theories. The first is about adaptation: are there specific benefits of music that are not found with other types of sounds? If there are no clear adaptive benefits, music might just be a side effect of the evolution of a complex auditory system. The second question concerns phylogeny: is music a uniquely human trait, recently developed, or is it an ancestral trait shared with other mammals? During the

19th century, a debate developed between Charles Darwin and Herbert Spencer concerning the evolutionary origins of music and its role in the natural world. In the following paragraphs we will try to summarize this debate by highlighting how Herbert Spencer's theoretical contributions on this issue were sometimes sidelined in favour of Darwinian hypotheses (cf. Miriam Piilonen's *Theorising Music Evolution*, 2024).

We will highlight how in recent times empirical research has put Darwin's and Spencer's intuitions to an experimental test level. The hypothesis that sexual selection actually influenced musicality in our ancestors and its strong link to emotions still remains a subject of debate and uncertainty within the scientific community. Despite numerous theories and historical insights, the link between musicality, sexual selection and emotions has not been conclusively proven.

2. Darwin's intuition

Charles Darwin was one of the first scientists to offer an evolutionary perspective on the origin of music, seeking to understand how it had developed in human beings, even though it did not show an immediately obvious adaptive function. In particular, in his works, and especially in *The Origin of Man* (1871), Darwin linked music to the principles of his theory of natural and sexual selection, proposing that it played an important role in the biological and social dynamics of humans. A central element in the Darwinian view is the link between music and sexual selection.

Darwin hypothesized that, like birdsong, human music emerged as a tool to attract potential partners. Within sexual selection, traits that increase the chances of reproductive success are selected for even if they do not improve direct survival. Darwin observed that, in many species, males use complex sounds, such as singing, to woo females, suggesting that human music may have had a similar function. In Darwin's words, 'Music arose as a means of courtship and as a way of expressing emotions before the development of complex language' (Darwin 1871, §19).

Darwin proposed that competition between males to impress females might have led to the development of a taste for music, similar to what happens in birds that elaborate songs to signal their genetic fitness. Humans would have used music to demonstrate cognitive qualities such as intelligence and creativity, qualities that could be appreciated by females when choosing a mate. This phenomenon also involved dance and rhythmic coordination, skills that required motor dexterity and synchronisation, further favourable elements in mate selection. Another interesting observation by Darwin concerns the analogy between human music and birdsong. He noted how males of many bird species sing to attract females, interpreting these behaviors as manifestations of sexual selection.

Darwin suggested that our ancestors had developed similar musical behaviors before the emergence of articulate language. Early forms of human communication may have been closer to music than to verbal language, with melodic vocalizations used to express emotions and attract mates. In this sense, music would not only derive from sexual selection, but would also be a precursor to language itself, a theory often referred to as the 'musical hypothesis' or the 'protomusic hypothesis'. According to this idea, the ability to produce and appreciate music would have preceded the development of language, paving the way for the evolution of human communication.

Another important aspect of Darwinian theory is the role of music in the expression of emotions. Darwin believed, in fact, that music had a profound capacity to express and arouse emotions and that this was one of the main reasons for its widespread use in all cultures. Darwin writes in one of his correspondences:

> I envy you very much in going to the Opera, for I have at last got a very decided taste for Music; When Roper was here we had a concert from morning to night: his visit here was very pleasant as it is quite delightful to hear anyone sing with such spirit, & excellent good taste. (Darwin,

> Letter To W. D. Fox [30 June 1828] from Darwin Correspondence Project, University of Cambridge).

In the groundbreaking text *The Expression of Emotions in Man and Animals* (1872), Darwin explores how humans and animals manifest emotions through sounds and vocalizations, linking these expressions to the evolution of music.

Man's ancestors may have used melodic vocalizations to communicate emotional states such as joy, sadness or sexual desire. This ability to express emotions through non-verbal sounds would have laid the foundation for the development of music as a complex and culturally significant art form. Darwin manifested an ambivalent position regarding the function of music in human evolution. On the one hand, he recognized its potential to evoke emotional states, but on the other he was skeptical about its ability to induce primary and intense emotions such as terror or anger. In his view, music was more likely to generate more subtle and refined emotions, such as affection or romantic love, which could in turn foster the development of feelings of devotion or attachment.

In this context, Darwin saw music not so much as a catalyst for violent or immediate emotional reactions, but rather as a tool for promoting emotions that facilitate social cohesion and interpersonal bonds, crucial aspects in the evolution of human relationships.

Finally, Darwin also recognised an important social role for music. While emphasizing sexual selection, he argued that music could have an adaptive function for social cohesion purposes. Indeed, music is often a collective activity that strengthens social bonds and promotes cooperation, as can be observed in tribal dances or ritual songs. Darwin suggested that this ability to synchronize and coordinate human behavior through music may have had adaptive value in early human communities, facilitating social interaction and the strengthening of bonds within the group. In short, according to Darwin,

music contributed to the survival of the species not only as a tool of sexual selection, but also as a means to foster cooperation and social cohesion.

In the last years of his life, Charles Darwin gradually moved away from the study of music. Although in his youth he had nurtured a deep appreciation for it, recognizing how much pleasure it gave him, this connection faded with time. In later life, Darwin came to state that he no longer had any interest in music, as if he had lost the taste and fascination that it had previously exerted on him, a fascination that had led him to trace its natural origin.

This transformation was not only a change in his personal preferences, but also reflected a broader mutation in his intellectual interests. During much of his career, Darwin had focused on scientific questions of enormous scope, such as the evolution of species and natural selection, areas that required a deep immersion in the rigour of empirical observation and theoretical reflection. The complexity and breadth of such studies may have gradually distanced him from an appreciation for more immediate and instinctive forms of artistic expression, such as music. Moreover, the decline of his interest in music can be seen as part of a more general change in his aesthetic and sensory inclinations. Darwin himself recognized that, with age, many of the things that once excited him had lost their appeal. This process, sometimes described as a kind of ‘waning of the emotions’, is common with advancing years and may explain why music, an art closely linked to emotions and immediate pleasure, no longer appealed to him as it had in the past.

Finally, the cooling of Darwin's relationship with music could be linked to his ongoing questioning of human nature and the biological functions of emotions and the arts. If Darwin had initially attempted to understand music within his evolutionary theory - perhaps seeing it as a primitive form of communication or a means of expressing deep emotions - the complexity of this issue may have led him to shift his attention to other more pressing issues for his research. The loss of interest in music, then, would not simply have been a conscious choice, but the result of an inner and intellectual evolution

that reflected the direction of his studies and reflections at that stage of his life.

Darwin's theories on the origin of music, although innovative, were not without criticism. Some scholars pointed out that music seems to have much broader functions than those proposed by Darwin, such as cultural transmission and learning. Moreover, his hypothesis on sexual selection did not fully explain why music was practised by both sexes and at all stages of life, not only during the reproductive period. However, despite its limitations, Darwin's ideas paved the way for an evolutionary approach to music that has inspired subsequent research and remains a benchmark for understanding the role of music in human evolution.

3. Herbert Spencer, the origin of music and the link with the emotions

The British philosopher Herbert Spencer approached the subject of music from a decidedly more psychological and philosophical perspective than his contemporaries, particularly in comparison to Charles Darwin. His interpretation of music was deeply rooted in his broader evolutionary theory, formulated in works such as *Principles of Psychology* (1855). Spencer did not see music as a simple result of biological processes related to reproduction and sexual selection, as Darwin proposed. Rather, he attributed music an advanced role in emotional and cognitive expression, considering it a unique and distinctive capacity of human beings.

For Spencer, music represented one of the highest forms of human communication. In his vision, it had originally developed as vocal expression, evolving from ‘passionate speech’, a mode of communication in which emotions and cognition were closely intertwined. This type of expression involved the interaction between body and mind, reflecting how evolution not only impacted on the physical aspects of the human species, but also on emotional and intellectual development. Music, therefore, according to

Spencer, was not just an artistic manifestation, but a window into the evolution of human cognitive and affective capacities.

His essay *The Origin and Function of Music* (1857) represents a milestone in his analysis of this topic. In it, Spencer proposed that the emotional effects of music were the direct result of physiological reactions. Music, according to this view, acted not only on a psychological level, but produced physical responses in the body, such as muscle contractions, changes in respiration and changes in heart rate. These reactions were associated with feelings of pleasure or pain, showing how music was intimately linked to human physiology. This connection between the physiological and emotional dimensions was fundamental to understanding how music evolved: it was not just a product of culture, but had deep biological roots, capable of touching the most primitive and authentic emotions of the individual.

Spencer interpreted music as a sign of human emotional progress. In his vision, evolution was not only physical, but also emotional and intellectual.

As human society evolved and became more complex, music became more refined, reflecting the growth of cognitive abilities and the maturation of human emotions. This idea opposed the evolutionary model proposed by Darwin, who saw music as a primordial form of communication, originating primarily from impulses related to sexual selection and mating. Darwin considered music to be a proto-language used to attract partners and demonstrate physical and mental qualities, thus associated with instinctive and primal dynamics.

Spencer, on the contrary, saw music as a manifestation of more sophisticated and advanced evolution. He believed that the human ability to produce and understand music reflected a higher level of emotional and cognitive development.

Music, in its complexity and richness, represented a hallmark of human progress, an indicator of how humans had managed to develop a system of emotional expression and communication that went beyond the basic necessities of existence. In this vision, music was not only linked to biology,

but also to culture and psychology, embodying the perfecting of the human being as a whole.

Spencer's vision was connected to a broader conception of human evolution that included not only the physical, but also the moral and intellectual aspects. Music, for him, was not simply a product of instinct, but a symbol of man's elevation, of his development as a thinking and sensitive being. Through music, man expressed his ability to feel and understand complex emotions, giving voice to the feelings that formed the basis of his existential experience. In this sense, music was not just an art form, but tangible evidence of the evolutionary progress and differentiation of human beings from other animal species.

In short, Spencer's evolutionary model placed music in a broader context of emotional and intellectual refinement, positioning it as an indicator of the human capacity to process and communicate complex emotions. This higher interpretation of music reflected his conviction that human evolution should be analysed not only from a biological perspective, but also through the lens of psychology and philosophy, disciplines that revealed the complexity and richness of human nature.

4. Post-Darwinian perspectives and the contemporary debate

In recent years, research has begun to investigate the possibility that musicality is indeed a sexually selected trait. Genetic and psychological studies have been conducted to test the hypotheses that musicality might be related to certain genes, such as those related to music perception and production, memory and motor behavior. Some research has found a correlation between musicality and reproductive success, suggesting that musical abilities may have influenced mating choices. However, results are often conflicting. While some evidence suggests that music may have a genetic basis and influence reproductive success, other research indicates that musical ability does not appear to have a significant impact on mating choices

in modern Western societies. These findings raise questions about the validity of the sexual selection hypothesis to explain the origin of music, and suggest that musicality may not have been shaped solely by sexual pressures. A crucial aspect of contemporary research is the division of musicality into distinct components that can be analyzed separately. Musicality is not considered a single monolithic trait, but rather a set of distinct abilities, each of which may have different evolutionary origins. For example, the ability to synchronize with a rhythm, the preference for consonant intervals and the ability to reproduce complex melodies may have evolved through different evolutionary paths. This multi-component perspective allows each aspect of musicality to be examined separately, testing specific hypotheses about the genetic, neurological and behavioral basis of each musical ability. Another interesting concept explored by some authors, such as psychologist Andrea Ravignani, is that of sensory bias.

In his *Darwin, Sexual Selection, and the Origins of Music*, Ravignani hypothesizes that some musical preferences may not have been directly selected for, but may be the result of innate sensory biases that exist as by-products of other evolutionary processes. For example, the preference for rhythms based on integer ratios might be a sensory bias not directly related to sexual or natural selection, but nevertheless present in many musical cultures. This hypothesis suggests that musicality could be the result of a complex interaction between natural selection, sexual selection and sensory bias. Despite Darwin's and Spencer's insights and recent advances in empirical research, it remains uncertain whether sexual selection actually shaped musicality in our ancestors. Studies of modern populations, especially in Western contexts, may not accurately reflect the selective conditions present in primitive societies. Furthermore, cultural and environmental factors may have altered or removed some of the selective pressures that could have influenced the evolution of music. Another point raised is that although sexual selection is a plausible explanation for the origin of music, it may not be the only one. Other evolutionary hypotheses suggest that music may have

evolved as a tool for social cohesion, fostering group bonding and collective coordination, or as a by-product of the evolution of language.

5. Toward a deeper understanding of the evolution of music

Charles Darwin and Herbert Spencer, two of the most influential minds of the 19th century, used music as a theoretical tool to explore the complex process of human evolution. However, although both saw music as an important key to understanding humans and their development, their approaches differed significantly, reflecting different perspectives on the nature and functions of music itself within the evolutionary framework.

Darwin regarded music as one of the oldest and most primitive manifestations of human communication, closely linked to the mechanisms of sexual selection. In his view, singing and early forms of musical expression would have played a fundamental role in courtship, acting as a means of attracting potential partners. According to Darwin, the ability to produce pleasant or fascinating sounds would have increased the chances of reproductive success, becoming a selected trait in the course of evolution. For him, therefore, music was not simply an artistic expression, but an adaptive strategy born of deep-rooted biological impulses.

On the other hand, Herbert Spencer adopted a different perspective, focusing not so much on the biological and sexual aspects of music, but on its emotional potential. He saw music as a product of evolution that had been refined as human society became more complex. According to Spencer, music reflected human emotions in a unique and profound way, offering a medium through which humans could express complex and articulate states of mind. Unlike Darwin, Spencer considers music as a hallmark of the advanced human condition and an emotional language able of conveying the nuances of inner life and subjective experience.

These different interpretations reflect the respective theoretical priorities of Darwin and Spencer. While Darwin focused on the biological aspects of evolution, attempting to explain how physical and behavioral characteristics

developed through natural and sexual selection, Spencer was more interested in the social and cultural evolution of humans, viewing music as a form of expression that evolved in parallel with the emotional and psychological development of the human species.

Despite their differences, both Darwin and Spencer used music as a model to address fundamental questions about the essence of human beings. For Darwin, music represents a link to the deeper roots of evolution, linking humans to other animals through courtship behavior. For Spencer, on the other hand, music was a testament to human progress, a medium that showed how humans had distanced themselves from other species through the elaboration of a sophisticated emotional language.

Although Darwin and Spencer had different starting points and theoretical goals, both recognized the value of music as a key element in understanding what it means to be human. Darwin saw it as evidence of natural instinct and the evolutionary forces that shape behavior, while Spencer interpreted it as a sign of the high emotional and psychological capacity that distinguishes humans in the animal kingdom. Thus, while starting from different perspectives, both used music to question the deeper dimensions of human experience and the role of evolution in shaping our cognitive and affective capacities.

Charles Darwin’s and Herbert Spencer’s hypotheses on the evolution of music certainly opened an important avenue for understanding the origin of human musicality. However, it must be recognised that the issue remains complex and requires further empirical studies.

The renaissance of interest in evolutionary musicology at the end of the 20th century is a significant moment for music studies and the understanding of the role of music in human evolutionary history. After decades of relative inactivity on this front, during which evolutionary theories had been largely neglected by music scholars, this field returned to the core of academic attention thanks to the attempt to integrate music into a broader evolutionary framework. For much of the 20th century, musicology had viewed

evolutionary theories with suspicion, considering them too speculative and insufficiently grounded in empirical evidence. There were several reasons for the initial reluctance of musicologists to confront evolutionary theories. Firstly, the intangible nature of music - often considered a highly abstract and cultural art - seemed ill-suited to the scientific paradigms of biological evolution, which focus primarily on concrete and measurable traits. Moreover, the field of human evolution had traditionally focused on aspects such as anatomy, language and social behavior, leaving little room to discuss artistic and cultural expressions, such as music, which were seen as secondary by-products of human development, not central factors.

However, in the 1990s and 2000s, a decisive turning point occurred. Scholars such as Steven Mithen, David Huron and W. Tecumseh Fitch revived the field of evolutionary musicology, adopting an interdisciplinary approach that combined evolutionary biology with cognitive psychology and neuroscience. These modern scholars sought to understand music not only as a cultural phenomenon, but as a behavior that had evolved over millions of years in response to selective pressures related to communication, social interactions and emotional expression. Steven Mithen, for example, in his influential book The Singing Neanderthals (2005), hypothesized that music and language had common roots in an ancient prelinguistic form of communication, which he called 'Hmmmmm' (Holistic, Multi-modal, Manipulative, Musical, and Mimetic). Mithen suggests that the ability to produce organized, melodic sounds played a crucial role in the social cohesion of prehistoric groups and the development of human cognitive abilities. Music, in this perspective, would not have been a mere by-product of the evolution of language, but a fundamental component of the evolution of the species.

In his work, psychologist David Huron (2001) explored how music affects the human brain and how it has been selected through evolutionary mechanisms to meet cognitive and social needs. His research focused on analysing the emotions aroused by music, proposing that music acts as an

emotional regulation mechanism, useful in fostering cohesion and cooperation within social groups. In this view, music would have an adaptive function that contributed to the survival and evolutionary success of human groups.

Evolutionary biologist William Tecumseh Fitch, a leading figure in this field, focuses on animal language and communication as they relate to the evolution of music, attempting to draw parallels between the sound behavior of humans and that of other species (Fitch 2009, 2005). Fitch explored how some aspects of musicality, such as rhythm and melody, might have deep biological roots that are not exclusively human, but shared with other primates or mammals.

Despite the renewed interest and progress made in understanding music from an evolutionary perspective, scholars such as music theorist Miriam Piilonen (2024) warn against over-reliance on evolutionary biology to explain all aspects of music. Piilonen argues that, although biological evolution can certainly offer valuable insights into the history and functions of music, it should not be regarded as the only key. Music is a complex phenomenon that cannot be fully understood through the prism of natural selection or selective pressures alone, but cultural, historical and individual factors that influence musical production and experience must also be taken into account.

In other words, while evolutionary musicology provides a useful framework for exploring the origins of music and its role in human development, it must not obscure the importance of the other factors that contribute to its complexity. The exclusively biological approach risks reducing music to a mere evolutionary product, ignoring its symbolic, social and cultural dimensions, which have played a crucial role in its transformation throughout human history.

The resurgence of evolutionary musicology in recent decades has brought exciting new perspectives on the study of music, thanks to the integration of scientific disciplines such as biology, psychology and neuroscience. However, it is essential to keep a balanced approach that acknowledges both

the evolutionary roots of music and its complexity as a cultural and symbolic phenomenon. Only through an interdisciplinary and holistic view can we hope to fully understand the profound significance of music in human life. Contemporary research has begun to test these hypotheses in a systematic way, using interdisciplinary approaches that combine genetics, neuroscience, psychology and anthropology. Although not all questions are yet definitively answered, it is clear that the evolution of musicality is a field of study that is moving from theoretical speculation to evidence-based debate, opening up new perspectives on how and why humans developed the unique ability to make and appreciate music.

In recent years, there has been a growing interest to empirical research aimed at testing these evolutionary hypotheses. This renewed focus translates into a more systematic and rigorous approach to the question, with the intention of providing more concrete answers and scientific foundations to questions concerning the origin and function of music and musicality.

A key aspect of this empirical approach is the need to include comparative studies between different animal species. These studies can reveal whether and how musicality manifests itself in other species and whether there are significant similarities or differences to humans. Such comparisons may provide important clues as to the evolutionary pressures that may have influenced the development of musicality. In addition, the analysis of human population genetics offers another relevant perspective. Understanding which genes are associated with musical ability may help us identify the biological mechanisms that support this ability, clarifying whether it may have been subject to sexual selection during evolution.

In addition, paleo-anthropology, studying the fossil remains and traces of our ancestors' behavior, can provide further evidence. By analyzing how the earliest forms of musical expression might have developed and been used in social contexts, it is possible to gain a more comprehensive view of the evolutionary pressures that shaped our predisposition to music.

Although the idea that music and musicality may be the result of influences related to sexual selection is fascinating, it is crucial that research continues to explore this topic with an empirical approach. This means moving away from speculative theories that often rely on mere anecdotes, and towards a more scientific and rigorous understanding. Only through the systematic analysis of concrete data and the nurturing of an ongoing dialogue between biological, anthropological and psychological sciences will it be possible to obtain a clearer picture of the origins and functions of music in human beings.

The journey towards understanding human musicality is certainly still in its infancy and developmental stage, but the interest in empirical research promises to shed new light on this fundamental aspect of our species.

References

ALTERNMÜLLER E., SCHMIDT S., ZIMMERMANN E. (Eds.) (2013), *The evolution of emotional communication: From sounds in nonhuman mammals to speech and music in man*, OUP Oxford.

BROWN S. (2000), *The musilanguage model of music evolution*, in WALLIN C., MERKER B., BROWN S. (Eds.), *The origins of music*, MIT Press, Cambridge, MA, pp. 271-300.

CHARLTON B. (2014), *Menstrual cycle phase alters women's sexual preferences for composers of more complex music*, «Proceedings of the Royal Society B», 281, pp. 1-6.

DARWIN C. (1859), *On the origin of species by means of natural selection, or the preservation of favoured races in the struggle for life*, 1st ed., John Murray, London.

DARWIN C. (1871), *The descent of man, and selection in relation to sex*, 1st ed., 2 vols., John Murray, London.

DARWIN C. (1872), *The expression of the emotions in man and animals*, John Murray, London.

FITCH W.T. (2005), *The evolution of music in comparative perspective*, in AVANZINI G., LOPEZ L., KOELSCH S., MAJNO M. (Eds.), The neurosciences and music II: From perception to performance, New York Academy of Sciences, New York, pp. 29-49.

FITCH W.T. (2009), *Biology of music: Another one bites the dust*, «Current Biology», 19, no. 10, pp. 403-404.

HURON D. (2001), *Is music an evolutionary adaptation*?, «Annals of the New York Academy of Sciences», 930, no. 1, pp. 43-61.

JUSLIN P.N., LILJESTRÖM S., VÄSTFJÄLL D., BARRADAS G., SILVA A. (2008), *An experience sampling study of emotional reactions to music: listener, music, and situation*, «Emotion», 8(5), pp. 668.

LEVITIN D.J. (2008), *The world in six songs: How the musical brain created human nature*, Penguin Plume, New York.

MILLER G. (2000), *Evolution of human music through sexual selection*, in WALLIN C., MERKER B., BROWN S. (Eds.), *The origins of music*, MIT Press, Cambridge, MA, pp. 329-360.

MITHEN S. (2006), *The singing Neanderthals: The origins of music, language, mind, and body*, Harvard University Press, Cambridge, MA.

PATEL A.D. (2008), *Music, language, and the brain*, Oxford University Press, Oxford and New York.

PIILONEN M. (2024), *Theorizing music evolution: Darwin, Spencer, and the limits of the human,* Oxford University Press.

PINKER S. (1997), *How the mind works*, Allen Lane, London.

RAVIGNANI A. (2018), *Darwin, sexual selection, and the origins of music*, «Trends in Ecology & Evolution», 33(10), pp. 716-719.

RUGGIERO G., BRUNI D. (2015), *Il ritmo della mente. La musica tra scienza cognitiva e psicoterapia*, Mimesis Edizioni, Milano.

SPENCER H. (1855), *Principles of psychology*, 1st ed., Longman, Brown, Green, and Longmans, London.

SPENCER H. (1857), *The origin and function of music*, «Fraser's Magazine», October, pp. 396-408.