Music Psychology: How Sound Shapes the Human Mind

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Music psychology, or the psychology of music, may be regarded as a branch of both psychology and musicology. It aims to explain and understand musical behavior and experience, including the processes through which music is perceived, created, responded to, and incorporated into everyday life. Modern music psychology is primarily empirical; its knowledge tends to advance on the basis of interpretations of data collected by systematic observation of and interaction with human participants. Music psychology is a field of research with practical relevance for many areas, including music performance, composition, education, criticism, and therapy, as well as investigations of human attitude, skill, performance, intelligence, creativity, and social behavior.

Music psychology can shed light on non-psychological aspects of musicology and musical practice. For example, it contributes to music theory through investigations of the perception and computational modelling of musical structures such as melody, harmony, tonality, rhythm, meter, and form. Research in music history can benefit from systematic study of the history of musical syntax, or from psychological analyses of composers and compositions in relation to perceptual, affective, and social responses to their music. Ethnomusicology can benefit from psychological approaches to the study of music cognition in different cultures.

History

Early history (pre-1860)

The study of sound and musical phenomenon prior to the 19th century was focused primarily on the mathematical modelling of pitch and tone. The earliest recorded experiments date from the 6th century BCE, most notably in the work of Pythagoras and his establishment of the simple string length ratios that formed the consonances of the octave. This view that sound and music could be understood from a purely physical standpoint was echoed by such theorists as Anaxagoras and Boethius. An important early dissenter was Aristoxenus, who foreshadowed modern music psychology in his view that music could only be understood through human perception and its relation to human memory. Despite his views, the majority of musical education through the Middle Ages and Renaissance remained rooted in the Pythagorean tradition, particularly through the quadrivium of astronomy, geometry, arithmetic, and music.

Research by Vincenzo Galilei (father of Galileo) demonstrated that, when string length was held constant, varying its tension, thickness, or composition could alter perceived pitch. From this he argued that simple ratios were not enough to account for musical phenomenon and that a perceptual approach was necessary. He also claimed that the differences between various tuning systems were not perceivable, thus the disputes were unnecessary. Study of topics including vibration, consonance, the harmonic series, and resonance were furthered through the scientific revolution, including work by Galileo, Kepler, Mersenne, and Descartes. This included further speculation concerning the nature of the sense organs and higher-order processes, particularly by Savart, Helmholtz, and Koenig.

Rise of empirical (1860-1960)

A brass, spherical Helmholtz resonator based on his original design, circa 1890-1900.

The latter 19th century saw the development of modern music psychology alongside the emergence of a general empirical psychology, one which passed through similar stages of development. The first was structuralist psychology, led by Wilhelm Wundt, which sought to break down experience into its smallest definable parts. This expanded upon previous centuries of acoustic study, and included Helmholtz developing the resonator to isolate and understand pure and complex tones and their perception, the philosopher Carl Stumpf using church organs and his own musical experience to explore timbre and absolute pitch, and Wundt himself associating the experience of rhythm with kinesthetic tension and relaxation.

As structuralism gave way to Gestalt psychology and behaviorism at the turn of the century, music psychology moved beyond the study of isolated tones and elements to the perception of their inter-relationships and human reactions to them, though work languished behind that of visual perception. In Europe Géza Révész and Albert Wellek developed a more complex understanding of musical pitch, and in the US the focus shifted to that of music education and the training and development of musical skill. Carl Seashore led this work, producing his The Measurement of Musical Talents and The Psychology of Musical Talent. Seashore used bespoke equipment and standardized tests to measure how performance deviated from indicated markings and how musical aptitude differed between students.

Modern (1960-present)

Music psychology in the second half of the 20th century has expanded to cover a wide array of theoretical and applied areas. From the 1960s the field grew along with cognitive science, including such research areas as music perception (particularly of pitch, rhythm, harmony, and melody), musical development and aptitude, music performance, and affective responses to music.

This period has also seen the founding of music psychology-specific journals, societies, conferences, research groups, centers, and degrees, a trend that has brought research toward specific applications for music education, performance, and therapy. While the techniques of cognitive psychology allowed for more objective examinations of musical behavior and experience, the theoretical and technological advancements of neuroscience have greatly shaped the direction of music psychology into the 21st century.

While the majority of music psychology research has focused on music in a Western context, the field has expanded along with ethnomusicology to examine how the perception and practice of music differs between cultures. It has also emerged into the public sphere. In recent years several bestselling popular science books have helped bring the field into public discussion, notably Daniel Levitin's This Is Your Brain On Music (2006) and The World in Six Songs (2008), Oliver Sacks' Musicophilia (2007), and Gary Marcus' Guitar Zero (2012). In addition, the controversial "Mozart effect" sparked lengthy debate among researchers, educators, politicians, and the public regarding the relationship between classical music listening, education, and intelligence.

Research areas

Perception and cognition

Much work within music psychology seeks to understand the cognitive processes that support musical behaviors, including perception, comprehension, memory, attention, and performance. Originally arising in fields of psychoacoustics and sensation, cognitive theories of how people understand music more recently encompass neuroscience, cognitive science, music theory, music therapy, computer science, psychology, philosophy, and linguistics.

Affective response

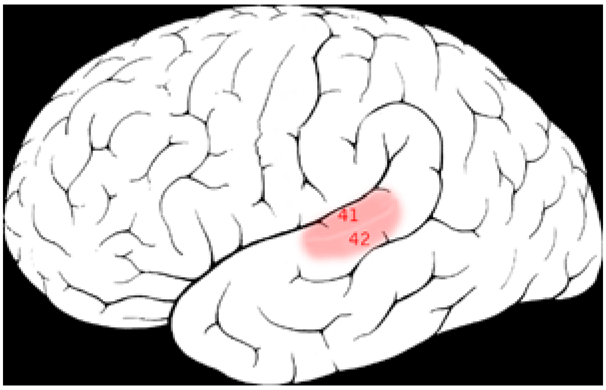
Music has been shown to consistently elicit emotional responses in its listeners, and this relationship between human affect and music has been studied in depth. This includes isolating which specific features of a musical work or performance convey or elicit certain reactions, the nature of the reactions themselves, and how characteristics of the listener may determine which emotions are felt. The field draws upon and has significant implications for such areas as philosophy, musicology, and aesthetics, as well the acts of musical composition and performance. The implications for casual listeners are also great; research has shown that the pleasurable feelings associated with emotional music are the result of dopamine release in the striatum--the same anatomical areas that underpin the anticipatory and rewarding aspects of drug addiction.

Neuropsychology

A significant amount of research concerns brain-based mechanisms involved in the cognitive processes underlying music perception and performance. These behaviours include music listening, performing, composing, reading, writing, and ancillary activities. It also is increasingly concerned with the brain basis for musical aesthetics and musical emotion. Scientists working in this field may have training in cognitive neuroscience, neurology, neuroanatomy, psychology, music theory, computer science, and other allied fields, and use such techniques as functional magnetic resonance imaging (fMRI), transcranial magnetic stimulation (TMS), magnetoencephalography (MEG), electroencephalography (EEG), and positron emission tomography (PET).

The cognitive process of performing music requires the interaction of neural mechanisms in both motor and auditory systems. Since every action expressed in a performance produces a sound that influences subsequent expression, this leads to impressive sensorimotor interplay.

Processing pitch



The primary auditory cortex is one of the main areas associated with superior pitch resolution.

Perceived pitch typically depends on the fundamental frequency, though the dependence could be mediated solely by the presence of harmonics corresponding to that fundamental frequency. The perception of a pitch without the corresponding fundamental frequency in the physical stimulus is called the pitch of the missing fundamental. Neurons lateral to A1 in marmoset monkeys were found to be sensitive specifically to the fundamental frequency of a complex tone, suggesting that pitch constancy may be enabled by such a neural mechanism.

Pitch constancy refers to the ability to perceive pitch identity across changes in acoustical properties, such as loudness, temporal envelope, or timbre. The importance of cortical regions lateral to A1 for pitch coding is also supported by studies of human cortical lesions and functional magnetic resonance imaging (fMRI) of the brain. These data suggest a hierarchical system for pitch processing, with more abstract properties of sound stimulus processed further along the processing pathways.

Absolute pitch

Absolute pitch (AP) is defined as the ability to identify the pitch of a musical tone or to produce a musical tone at a given pitch without the use of an external reference pitch. Researchers estimate the occurrence of AP to be 1 in 10,000 people. The extent to which this ability is innate or learned is debated, with evidence for both a genetic basis and for a "critical period" in which the ability can be learned, especially in conjunction with early musical training.

Processing rhythm

Behavioural studies demonstrate that rhythm and pitch can be perceived separately, but that they also interact in creating a musical perception. Studies of auditory rhythm discrimination and reproduction in patients with brain injury have linked these functions to the auditory regions of the temporal lobe, but have shown no consistent localization or lateralization. Neuropsychological and neuroimaging studies have shown that the motor regions of the brain contribute to both perception and production of rhythms.

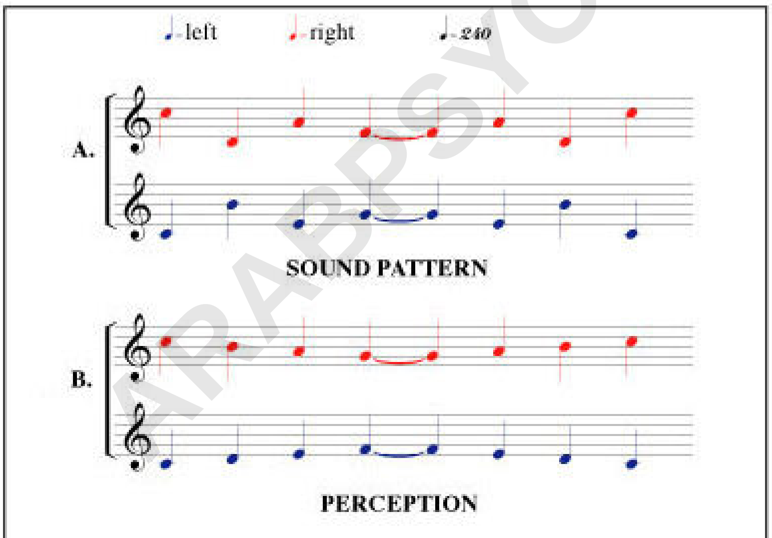
Even in studies where subjects only listen to rhythms, the basal ganglia, cerebellum, dPMC and SMA are often implicated. The analysis of rhythm may depend on interactions between the auditory and motor systems.

Neural correlates of musical training

Although auditory-motor interactions can be observed in people without formal musical training, musicians are an excellent population to study because of their long-established and rich associations between auditory and motor systems. Musicians have been shown to have anatomical adaptations that correlate with their training. Some neuroimaging studies have observed that musicians show lower levels of activity in motor regions than non-musicians during the performance of simple motor tasks, which may suggest a more efficient pattern of neural recruitment.

Motor imagery

Previous neuroimaging studies have consistently reported activity in the SMA and premotor areas, as well as in auditory cortices, when non-musicians imagine hearing musical excerpts. Recruitment of the SMA and premotor areas is also reported when musicians are asked to imagine performing.



The pattern that produces the scale illusion (A), and a way that it is often perceived (B)

Deutsch's scale illusion: an auditory illusion in which two scales are presented with successive tones alternating between each ear but are perceived as simultaneous, unbroken scales.

Psychoacoustics

Psychoacoustics is the scientific study of sound perception. More specifically, it is the branch of science studying the psychological and physiological responses associated with sound (including speech and music). Topics of study include perception of the pitch, timbre, loudness and duration of musical sounds and the relevance of such studies for music cognition or the perceived structure of music; and auditory illusions and how humans localize sound, which can have relevance for musical composition and the design of venues for music performance. Psychoacoustics is a branch of psychophysics.

Cognitive musicology

Cognitive musicology is a branch of cognitive science concerned with computationally modeling musical knowledge with the goal of understanding both music and cognition.

Cognitive musicology can be differentiated from the fields of music cognition and cognitive neuroscience of music by a difference in methodological emphasis. Cognitive musicology uses computer modeling to study music-related knowledge representation and has roots in artificial intelligence and cognitive science. The use of computer models provides an exacting, interactive medium in which to formulate and test theories.

This interdisciplinary field investigates topics such as the parallels between language and music in the brain. Biologically inspired models of computation are often included in research, such as neural networks and evolutionary programs. This field seeks to model how musical knowledge is represented, stored, perceived, performed, and generated. By using a well-structured computer environment, the systematic structures of these cognitive phenomena can be investigated.

Evolutionary musicology

Evolutionary musicology concerns the "origins of music, the question of animal song, selection pressures underlying music evolution", and "music evolution and human evolution". It seeks to understand music perception and activity in the context of evolutionary theory. Charles Darwin speculated that music may have held an adaptive advantage and functioned as a protolanguage, a view which has spawned several competing theories of music evolution. An alternate view sees music as a by-product of linguistic evolution; a type of "auditory cheesecake" that pleases the senses without providing any adaptive function. This view has been directly countered by numerous music researchers.

Cultural differences

An individual's culture or ethnicity plays a role in their music cognition, including their preferences, emotional reaction, and musical memory. Musical preferences are biased toward culturally familiar musical traditions beginning in infancy, and adults' classification of the emotion of a musical piece depends on both culturally specific and universal structural features. Additionally, individuals' musical memory abilities are greater for culturally familiar music than for culturally unfamiliar music.

Applied research areas

Many areas of music psychology research focus on the application of music in everyday life as well as the practices and experiences of the amateur and professional musician. Each topic may utilize knowledge and techniques derived from one or more of the areas described above. Such areas include:

Music in society

Including:

everyday music listening
musical rituals and gatherings (e.g. religious, festive, sporting, political, etc.)
the role of music in forming personal and group identities
the relation between music and dancing
social influences on musical preference (peers, family, experts, social background, etc.)

Musical preference

Consumers' choices in music have been studied as they relate to the Big Five personality traits: openness to experience, agreeableness, extraversion, neuroticism, and conscientiousness. In general, the plasticity traits (openness to experience and extraversion) affect music preference more than the stability traits (agreeableness, neuroticism, and conscientiousness). Gender has been shown to influence preference, with men choosing music for primarily cognitive reasons and women for emotional reasons. Relationships with music preference have also been found with mood and nostalgic association.

Background music

The study of background music focuses on the impact of music with non-musical tasks, including changes in behavior in the presence of different types, settings, or styles of music. In laboratory settings, music can affect performance on cognitive tasks (memory, attention, and comprehension), both positively and negatively. Used extensively as an advertising aid, music may also affect marketing strategies, ad comprehension, and consumer choices. Background music can influence learning, working memory and recall, performance while working on tests, and attention in cognitive monitoring tasks. Background music can also be used as a way to relieve boredom, create positive moods, and maintain a private space. Background music has been shown to put a restless mind at ease by presenting the listener with various melodies and tones.

Music in marketing

In both radio and television advertisements, music plays an integral role in content recall, intentions to buy the product, and attitudes toward the advertisement and brand itself. Music's effect on marketing has been studied in radio ads, TV ads, and physical retail settings.

One of the most important aspects of an advertisement's music is the "musical fit", or the degree of congruity between cues in the ad and song content. Advertisements and music can be congruous or incongruous for both lyrical and instrumental music. The timbre, tempo, lyrics, genre, mood, as well as any positive or negative associations elicited by certain music should fit the nature of the advertisement and product.

Music education

A primary focus of music psychology research concerns how best to teach music and the effects this has on childhood development.

Including:

optimizing music education
development of musical behaviors and abilities throughout the lifespan

the specific skills and processes involved in learning a musical instrument or singing
activities and practices within a music school
individual versus group learning of a musical instrument
the effects of musical education on intelligence
optimizing practice

Musical aptitude

Musical aptitude refers to a person's innate ability to acquire skills and knowledge required for musical activity, and may influence the speed at which learning can take place and the level that may be achieved. Study in this area focuses on whether aptitude can be broken into subsets or represented as a single construct, whether aptitude can be measured prior to significant achievement, whether high aptitude can predict achievement, to what extent aptitude is inherited, and what implications questions of aptitude have on educational principles.

It is an issue closely related to that of intelligence and IQ, and was pioneered by the work of Carl Seashore. While early tests of aptitude, such as Seashore's The Measurement of Musical Talent, sought to measure innate musical talent through discrimination tests of pitch, interval, rhythm, consonance, memory, etc., later research found these approaches to have little predictive power and to be influenced greatly by the test-taker's mood, motivation, confidence, fatigue, and boredom when taking the test.

Music performance

Including:

the physiology of performance
music reading and sight-reading, including eye movement
performing from memory and music-related memory
acts of improvisation and composition
flow experiences
the interpersonal/social aspects of group performance
music performance quality evaluation by an audience or evaluator(s) (e.g. audition or competition), including:
influence of musical and non-musical factors
the audience's positive evaluation shift as a result of an audio-visual presentation mode

Music and health

Including:

the effectiveness of music in healthcare and therapeutic settings

music-specific disorders
musicians' physical and mental health and well-being
music performance anxiety (MPA, or stage fright)
motivation, burnout, and depression among musicians
noise-induced hearing loss among musicians

Music and audio engineering

Gestalt theory is also used as a perceptual model to discuss the psychophysical impressions established by those who mix audio (i.e., mix engineers). As with other design-based activities, such as user-interface design, Gestalt constructions provide a useful guide for creative technologists.