percent of individuals with congenital amusia exhibit impaired perception of rhythmic structure. However, it is possible that this deficit arises because amusic individuals lack motivation to engage in musical activities (because of their fundamental pitch deficit), and hence fail to develop normal rhythmic skills. It is currently unknown whether beat deafness is a domain-specific musical impairment, or whether it is accompanied by rhythmic impairments in other domains such as language.

Musical Hallucinations

An extremely small percentage of the population, less than 2 in 1,000 people, suffers from musical hallucinations. When they occur, they are often associated with conditions such as hearing loss (hypoacusis), brain tumors, epilepsy, stroke, and psychiatric disorders. In most cases, afflicted individuals heard familiar songs. Surprisingly, hearing loss is the most common etiology of musical hallucinations.

Imaging techniques like functional magnetic resonance imaging (fMRI) reveal that musical hallucinations are associated with activity in auditory areas, the motor cortex, visual areas, the basal ganglia, the cerebellum, hippocampi, and the amygdala, among other areas. The optimal treatment for musical hallucinations depends on the origin of the disorder, but may include drugs such as antidepressants or neuroleptics, or hearing aids.

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See Also: Atonality; Brain Specialization for Music; Hearing Damage; Language Disorders; Mental Health.

Further Readings

Evers, S. and T. Ellger. "The Clinical Spectrum of Musical Hallucinations." *Journal of the Neurological Sciences*, v.227 (2004).

Peretz, I. "The Biological Foundations of Music: Insights From Congenital Amusia." In *The Psychology of Music*, 3rd ed., Diana Deutsch, ed. New York: Elsevier, 2013.

Phillips-Silver, J., P. Toiviainen, N. Gosselin, O. Piché, S. Nozaradan, C. Palmer, and I. Peretz. "Born to Dance but Beat Deaf: A New Form of Congenital Amusia." *Neuropsychologia*, v.49/5 (2011).

Särkämö, T., M. Tervaniemi, S. Soinila, T. Autti, H. M. Silvennoinen, M. Laine, and M. Hietanen. "Cognitive Deficits Associated With Acquired Amusia After Stroke: A Neuropsychological Follow-Up Study." *Neuropsychologia*, v.47/12 (2009).

Stewart, L. "Characterizing Congenital Amusia." *Quarterly Journal of Experimental Psychology*, v.64/4 (2011).

Musical Instrument Digital Interface

Musical Instrument Digital Interface (MIDI) is an industry-standard communications protocol for electrical musical instruments. Since its introduction in 1983, MIDI has rapidly achieved prominence, revolutionizing the music world, with most musicians and manufacturers growing increasingly dependent on it; yet, some musical communities have remained critical because its use has presented numerous technical and aesthetic issues.

Historical Context

Dave Smith (founder of Sequential Circuits) and Ikutaro Kakehashi (founder and engineer of Roland) unveiled MIDI at the January 1983 NAMM Show. Several variables contributed to its almost immediate adoption by most manufacturers: The protocol was highly touted by Robert Moog in an article from October 1982 in *Keyboard* magazine; it resulted from a collaboration between competing manufacturers demonstrating its effectiveness by allowing two of their leading products to communicate in real time; the music industry was considerably smaller in terms of number of manufacturers; and it is an extremely cost-effective addition to electronic music devices. Because of the sheer scale and scope of the developments in the music world that MIDI brought about, in 2013, 30 years after its creation, the Recording Academy recognized Smith and Kakehashi with a Technical Grammy.

Impact

The current pervasiveness of MIDI is remarkable because it is rare to encounter music hardware or software (especially within PC, video game, or cell-phone platforms) that do not support or depend on its use. Because of its significance, colleges and universities provide courses on MIDI and offer state-of-the-art music facilities that utilize MIDI for numerous purposes (e.g., sequencing and notation). At the primary and secondary levels of music education, MIDI has also proven to be an educationally powerful tool, allowing young musicians with little or no formal training in traditional music to actively participate in music creation.

For instance, the typical setup (PC plus keyboard controller) eliminates the necessity of physically mastering an instrument, and minimizes the knowledge of traditional music notation. Most creation and editing of music takes place within a visually intuitive interface, the "piano-roll," a grid where note durations are represented as solid blocks on the horizontal axis, pitch is vertically organized, and other parameters (e.g., velocity and pan) are represented with the use of lines or color shades. This mode of data representation allows young musicians to shape performance characteristics with a high level of creative control.

Similarly, the advent of personal computers has brought about a shift in the expectations of musical production values that has allowed amateur musicians to realize their ideas within an industry previously dominated by professional composers and performers. Sequencing PC software has become the leading controller, synthesizer, sampler, and sequencer, with expanded capabilities to synchronize audio tracks alongside a MIDI sequence. As a result, seqûencers allow amateur musicians to develop a musical voice via intuitive interfaces and ready-made building blocks.

Because of the compositional strategies readily available through MIDI (e.g., the profusion of repetition through cut-and-paste, mechanical timings, and synthesized sounds), MIDI is most suitable for the production of popular music styles that exploit its features to musical end. MIDI is in part responsible for an aesthetic turn in popular music, allowing a new generation of popular musicians, and displacing jazz and rock and roll styles for more sequenced and looped idioms such as dance, techno, and house music.

Criticism

MIDI has been controversial in numerous regards. Its use has raised technical and aesthetic issues, which include the following: limitations because of its keyboard-centric approach, inadequacies in emulating traditional music, shortcomings attributable to its reliance on fixed-pitch temperament, the slow rate of data transmission that stems from its serial protocol, the trivializing of sound information to basic note-on/note-off messages, and the level of musicianship that results from single authorship, rather than a synergy between various musicians.

Because MIDI was initially developed for keyboards or fixed pitch instruments, it established, particularly in its incipient stages, a performance paradigm not suitable for string, wind, or percussion instrumentalists. Although there is currently a wide variety of controllers, ranging from instrument-like devices (e.g., wind controllers, mallet controllers, and drum pad controllers) to devices that do not resemble traditional musical instruments (e.g., gloves, clothing, touch-screens, and turntables), the keyboard-centric approach to music production still poses an overriding restraint in the manipulation of sound, especially for instrumentalists used to affecting the subtleties of pitch as sound unfolds, or those in which the physicality of performance dictates to a great extent the end result. For instance, the performance of a traditional instrument through an altered interface (e.g., producing drum-set or violin sounds with a keyboard controller) would distance the performer from the potential and limitations existing in the real counterpart.

MIDI is a serial communications protocol that allows a considerable amount of information to be generated and transmitted, yet presents limitations in terms of data speed, which makes it insufficient for certain performance conditions. For instance, as a response to the recognition of the limitations of MIDI inherent in its note-on/note-off basic protocol, which restricts the manipulation of dynamics characteristic of wind or string instruments, manufacturers and software designers employ continuous control functions such as pitch bend. Although a valuable solution to

circumvent this impediment, the use of continuous control functions substantially increases the amount of data transmitted, often causing malfunctions. Similarly, the equally profuse amounts of data produced by multi-instrument and/or multitimbral arrangements often push MIDI toward its operational limit, resulting in transmission delay, loss, or corruption of data.

Since its development, MIDI has transformed the nature of the working relationship between composers, performers, copyists, and orchestrators. By empowering the lone musician to simultaneously perform multiple musical tasks, it obliterated the collaborative dynamics of "jamming" while dissolving the criteria for distinguishing between the numerous roles of musicians. The vanishing divisions between multiple roles, however, might be the cause for an overabundance of MIDI productions that exhibit inferior musical craft.

Future Directions

While networking protocols undergo frequent updates or rapidly become obsolete, MIDI has endured in its original 1.0 version, with a few additions and adaptations. Current technical advances in MIDI technology do not address the protocol, but rather the transfer of information (e.g., wireless MIDI), innovative and sophisticated control devices (e.g., three-dimensional movement-recognizing interfaces, virtual instruments, and built-in accelerometers), as well as a wide variety of production settings (e.g., the manipulation of digital recordings for DJ purposes, or the manipulation of visual information). Although MIDI is still at the vanguard of music made using electronic instruments, the future prosperity of this protocol might be contingent upon its integration of advances in computational power and increased processing speeds.

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See Also: Electronic Music; Popular Music; Recording Industry; Technology.

Further Readings

Anderton, C. *MIDI For Musicians*. New York: Amsco, 1986.

Diduck, R. A. "The 30th Anniversary of MIDI: A Protocol Three Decades On." http://thequietus.com/articles/11189-midi-30th-anniversary (Accessed May 2013).

Holmes, T. *Electronic and Experimental Music: Pioneers in Technology and Composition*. New York: Routledge, 2003.

Huber, D. M. *The Midi Manual: A Practical Guide to Midi in the Project Studio*. New York: Taylor & Francis, 1999.

Manning, P. *Electronic and Computer Music*. Oxford, UK: Oxford University Press, 1994.

MIDI Manufacturers Association. "Learn About MIDI." http://www.midi.org (Accessed May 2013).

Musical Meme

A musical meme is a replicable unit of musical culture propagated by imitation. Within popular culture, musical memes have now come to be most readily associated with the Internet and transmission via social networking sites. Such is the breadth of current understandings of the term that Wagner's *leitmotifs*, the sampling by electronic artist Moby on his 1999 album *Play* of field recordings collected by Alan Lomax in 1959, the iconic four-note opening motif from the first movement of Beethoven's Symphony no. 5 in C minor, and Justin Timberlake's *Saturday Night Live* parody of Beyoncé's "Single Ladies (Put a Ring on It)" music video (Beyoncé's video itself inspired by the "Mexican Breakfast" routine Bob Fosse choreographed for *The Ed Sullivan Show* in 1969) could all be considered examples of musical memes. However, the notion of a meme predates cyberspace and current technologies and holds a more clearly parameterized meaning in relation to music than that which is encompassed by current popular usage of the term.

Ontological Basis of the Musical Meme

English evolutionary biologist Richard Dawkins invented the term *meme*, defining it as a unit of cultural transmission when the term appeared for the first time in 1976 in his seminal text *The Selfish Gene*. Tunes, ideas, catchphrases, clothes,