Primary

1. Chakraborty, S., Dutta, S., & Timoney, J. (2021). The Cyborg Philharmonic: Synchronizing interactive musical performances between humans and machines. Humanities and Social Sciences Communications, 8(1), 1–9. https://doi.org/10.1057/s41599-021-00751-8
    a. It is here that we seek to investigate how real-time cooperation between machines and humans could be achieved through technologies and models from synchronization and learning, with their exact configuration for the generation of melody alongside each other, to achieve the vision of human–robot symphonic orchestra. (p. 2)
    b. "Robotic Musicianship" has always been a challenging domain and has garnered significant interest among researchers over recent years for the generation of musical pieces. Along with sonic features like beats and chords, time plays a crucial role in terms of the rhythmic aspect of musical performance. (p. 3)
    c. The work of Bishop and Goebl (2018) demonstrated the importance of gestural communication, such as head nods or foot taps, and the leader–follower model as useful features in an ensemble environment. They found that gestural communications helped in establishing early synchronization, sometimes even from the very first chord, and that the identification of the leader had a very high impact on maintaining the beat and timing in-sync with the others. (p. 4)
    d. In such real-time music systems even a small latency could initiate a butterfly effect (Lorenz, 2000), potentially throwing the system out-of-sync. In this regard, MIDI information is beneficial for reducing the time delay over a data transmission (Moog, 1986; Yuan et al., 2010), with the use of 'MidiScore', a score-aligning model based on a bootleg score synthesis, for alignment (Tanprasert et al., 2020). This would help in tracking the portion of the song being played and detect the tempo, as well as provide a global overview of the sonic properties. (p. 5)

2. Kaipainen, M., Ravaja, N., Tikka, P., Vuori, R., Pugliese, R., Rapino, M., & Takala, T. (2011). Enactive Systems and Enactive Media: Embodied Human-Machine Coupling beyond Interfaces. *Leonardo (Oxford)*, *44*(5), 433–438. https://doi.org/10.1162/LEON_a_00244
    a. The core concept, an enactive system, is constituted by dynamically coupled human and technological processes, that is, a dynamic mind-technology embodiment. An enactive system does not assume a standard interface with goal-targeted conscious interaction; rather the function of interfacing is driven by bodily involvement and spatial presence of the human agent without the assumption of conscious control of the system (p. 433)

b. As a contrast to the standard conceptualization of human computer interaction, the enactive relationship conceives the underlying technology as continuous, ubiquitous and “intelligent” accompaniment to the human actor, or a direct extension of the user’s perceptual and cognitive apparatus involved in participation in the system—living and acting with the system instead of just using it. (p. 433)
c. This discussion also has to do with modeling creativity in general. Creativity can be seen as an enactive process where pattern synthesis and recognition work in tight reciprocal interaction. For example, hand motion and visual perception form an enactive loop in the activity of drawing. (p. 434)
d. The challenges lie on the side of mapping of the measured psycho-physiological data to meaningful behavioral, semantic or emotional entities that can be applied to control enactive systems. (p. 435)

3. Zioga, P., Pollick, F., Ma, M., Chapman, P., & Stefanov, K. (2018). "Enheduanna—A Manifesto of Falling" Live Brain-Computer Cinema Performance: Performer and Audience Participation, Cognition and Emotional Engagement Using Multi-Brain BCI Interaction. *Frontiers in Neuroscience*, *12*, 191–191. https://doi.org/10.3389/fnins.2018.00191
    a. It enables for the first time the simultaneous real-time multi-brain interaction of more than two participants, including a performer and members of the audience, using a passive EEG-based BCI system in the context of a mixed-media performance. (s. intro)
    b. The methodology focuses on the oscillatory processes of the brain activity, which occur when large neural populations are not engaged with a specific task and synchronise following an oscillatory pattern. While, with the use of temporal band-pass filters, the 4–40 Hz frequencies are processed and sent to the MAX MSP Jitter software. (s. EEG Data Acquisition)
    c. More specifically, the majority of the audience participants and the performer participant across the majority of the events were able to successfully identify whether their brain-activity was interacting with the live visuals or not, and highlighted as main factors the changing colours of the visuals, part 2 “You/We” of the performance, the explanatory vignettes and the dramaturgical use of lights. (s. summary)
    d. As in the study by Jola et al. (2011), the currently discussed live brain-computer cinema performance makes a claim about live experiences and experiments outside the laboratory and contributes on new hypotheses about the effects of the length of time, but also the role of the directing strategy, dramaturgy and narrative structure on the audience's perception, cognitive state, and engagement. (s. The Live-Brain computer..)

4. Cook, P. R. (1999). *Music, cognition, and computerized sound : an introduction to psychoacoustics* . MIT Press.
https://mitpress.mit.edu/books/music-cognition-and-computerized-sound
    a. Sound moves through the air as a travelling wave with a velocity of 1128 feet (344 meters) per second. The wavelengths of sinusoidal sound waves of various frequencies and musical notes are shown in table 1.1. Middle C on the piano keyboard (traditionally located closest to the first letter of the brand name above the keyboard) is C4 and has a frequency of 261.6 hertz (Hz; cycles per second). Each doubling or halving of frequency is called an "octave," and causes the index number to go up or down by 1. Thus the C above middle C is C5, and has a frequency of 523.2 Hz. (p. 2)
    b. What happens when a sound consists of two frequencies that aren't widely separated, so that some hair cells are excited by both sinusoids? We hear beats. If the two frequencies are a few cycles apart, what we hear is like a single sine wave of rising and falling intensity. As we increase the frequency difference, we hear a vibrating, somewhat harsh sound. If we make the frequency difference large enough, we hear the two sinusoidal sounds clearly and separately. (p. 8)
    c. Figure 3.1 demonstrates that internal representation can indeed be quite different from the physical stimulus on the retina. Two tables are depicted as if in different orientations in space, but stating that there are two tables already makes a cognitive interpretation. The figure actually consists only of a pattern of lines (or dots) on a two-dimensional surface. Still, humans tend to interpret the patterns of lines as three-dimensional objects, as two differently oriented tables with one larger than the other. (p. 22)
    d. Another fundamental principle of perception is called perceptual completion. Sometimes we have incomplete information coming into our sensory systems. To infer what is going on, we have to do some amount of top-down processing in addition to the normal bottom-up processing. We must complete the information to determine the most probable explanation for what is occurring in the real world that is consistent with the information presented to our senses. (p. 30)

5. Ehrlich, S. K., Agres, K. R., Guan, C., & Cheng, G. (2019). A closed-loop, music-based brain-computer interface for emotion mediation. *PloS One*, *14*(3), e0213516–e0213516.
https://doi.org/10.1371/journal.pone.0213516
    a. In addition, the majority of neuroscientific research on affective responses has investigated brain processes involved in mere recognition of emotional content, while the brain processes involved in the induction and mediation of affective states by emotionally-evocative stimuli are not yet well understood, due in part to the difficulty of carefully controlling these types of studies. (s. intro)

    b. Any desired ‘trajectory’ through the valence-arousal-space is therefore possible, e.g. going continuously from happy over sad towards angry musical expressiveness (see exemplary trajectory in Fig 2B). This principle allows the integration of the algorithm into an online BCI architecture according to our initially proposed concept (Fig 1). (s. Materials and methods)
    c. After the experiment, participants were asked to describe their strategies verbally and in the form of a short written text. All participants reported strategies based on retrieval of emotional mental images or episodes from the past as well as events they look forward to in the future. In addition, for the ‘modulation towards sad’ task, participant P01 reported in the second session to have successfully used the strategy of self-inducing a “meditative state of mind”, rather than retrieving memories. (s. Modulation performance results)
    d. The results, however, indicated that ionian mode was rated with higher valence on average than lydian mode, suggesting that swapping these two modes in a future version of the automatic music generation system could result in a better match with perceptual valence ratings. (s. Discussion)

6. Holland, S. (2013). *Music and human-computer interaction* . Springer. https://www.springer.com/gp/book/9781447129899

7. Lefford, M. N., & Thompson, P. (2018). Naturalistic artistic decision-making and metacognition in the music studio. *Cognition, Technology & Work*, *20*(4), 543–554. https://doi.org/10.1007/s10111-018-0497-8
    a. As a result, participants can often feel that their unique talents and thus reputations (and thus careers) are determined by the amount of agency they have within the process and by the decisions that are taken during a production. All of these factors contribute to the intense working environment of the recording studio. (s. intro)
    b. The numerous and varying demands of this macrocognitive setting require contributors inside the recording studio to regulate their thinking using metacognitive skills. Metacognition involves evaluating one’s own cognition (Flavell 1987) or thinking processes. During a studio production, individuals can use metacognition as a way of managing the multiple cognitive demands placed upon them during collaboration and the multiple forms of information available for decision-making. (s. Macrocognitive work and metacognition)
    c. With all that could go wrong, framing the producer’s decision-making is the understanding that ultimately the producer is accountable for the completion and quality of a recording, and ensuring its commercial viability. The producer’s problem detection is linked to (personal) risk. (s. The record producer)

d. The producers' prior experiences are influences on decisions, including knowledge of recorded music history, specific genres and culture and art generally; awareness of existing social pressures at large, outside the production; and formal training (if any). (s. Work goals production decisions)

8. Johnson, D., Damian, D., & Tzanetakis, G. (2020). Evaluating the effectiveness of mixed reality music instrument learning with the theremin. *Virtual Reality : the Journal of the Virtual Reality Society*, *24*(2), 303–317. https://doi.org/10.1007/s10055-019-00388-8
    a. Current systems, however, typically display real-time visual cues and feedback on standard computer displays. This requires that a student transfer their focus from the music instrument to the computer display to view the information. Furthermore, there is an inherent transfer function that a student must perform to map the visual cues overlaying a graphical representation of the instrument to the physical instrument they are interacting with. These challenges increase demand on the student's cognitive processing abilities. (p. 304)
    b. Furthermore, some instruments that lack signifers of discrete notes, like the violin, require precise ear training for assessment of sound quality. Adding a visual layer to the music learning process makes this already difcult task more complex as students must process multimodal visual and auditory feedback simultaneously (p. 304)
    c. The authors found that real-world training and XR training resulted in equivalent performance on the steadiness test and both outperformed the group that received no training. This work provides strong evidence in support of positive learning transfer with XR training environments but in a contrived scenario. Research in surgical training provides some practical results on the use of XR training for psychomotor skills. (p. 305)
    d. In addition to creating standalone music instruments, XR can be used to augment traditional instruments with new capabilities. In the feld of new interfaces for musical expression (NIME), it is common to augment traditional instruments through the addition of sensors which allows for realtime processing of performance data (Machover and Chung 1989). These hyperinstruments enable the type of control and music generation provided by digital instruments that is typically not available to performers of acoustic instruments. (p. 306)

Secondary

1. Brown, Oliver. (2021). *Beyond the Creative Species: Making Machines That Make Art and Music* . MIT Media Press, https://mitpress.mit.edu/books/beyond-creative-species.

2. Luca, M., & Bazerman, M. H. (2020). *The power of experiments : decision making in a data-driven world* . The MIT Press. https://mitpress.mit.edu/books/power-experiments

3. Kao, J. (2021). Another Perspective: Music Education in the Age of Innovation. *Music Educators Journal*, *107*(3), 63–69. https://doi.org/10.1177/0027432121994079

    a. We live in an era of digital music streaming, online experiences, and intelligent instruments that also shape new patterns of music creation and consumption. And the pandemic of 2020–2021, despite all its challenges, has been a powerful spur to innovation. Virtual performance, new collaborative technologies such as JackTrip,2 online music instruction, new kinds of software, and novel business models have all made their appearance during this period. In short, we live in a time in which the urgent need and the opportunity to innovate music teaching and to support young musicians have never been greater. (s. Age of innovation)
    b. This is an era in which to be employable means to have the improvisational ability to quickly learn new skills—or, better yet, have the skills to create your own job. It is an era that favors the innovator and the entrepreneur. Individuals are empowered as never before with new technology-based capabilities to learn, collaborate, publish, and influence. The implications for careers in music are clear. (s. Age of innovation)
    c. Most of us in senior positions grew up in an era of analog media and verbal literacy in which writing essays, penmanship, and manipulating words were considered to be core skills. These days, many students have a new concept of literacy. Some even actively avoid the effort of learning to write in cursive, preferring instead to work on keyboards. This is an era in which new artificial intelligence capabilities can enable a student to write a perfectly composed ten-page paper instantaneously when a topic is typed into a search bar.16 Perhaps it is “search and curation” rather than composition that should be seen as the new literacy. And in the context of music education, one wonders whether notation is becoming the equivalent of cursive while new graphical user interfaces enable new approaches to musical learning and performance. (s. From Symbols to Experiences)
    d. Music education today faces an innovator’s dilemma. It cannot keep simply improving the existing model in an environment in which economics, talent preferences, and pedagogical methods are shifting dramatically. As formal education and learning continue to diverge under the influence of disruptive

technology, music education institutions are challenged to figure out new strategies. (s. So what)

4. Glinsky, A. (2000). *Theremin: Ether music and espionage*. Urbana: University of Illinois Press. https://www.press.uillinois.edu/books/catalog/98mgt7tm9780252072758.html