# Music and Mental Imagery

**Edited by Mats B. Küssner,
Liila Taruffi and Georgia A. Floridou**

## Introduction and Overview

*Mats B. Küssner, Liila Taruffi, and
Georgia A. Floridou*

Routledge
Taylor & Francis Group
LONDON AND NEW YORK

# Introduction and Overview

*Mats B. Küssner, Liila Taruffi, and*
*Georgia A. Floridou*

Most of us would have experienced a piece of music stuck in our head (a so-called "earworm"; Floridou et al., 2015; Liikkanen & Jakubowski, 2020), playing over and over in our mind for days if not weeks. Perhaps, it is a song that we first heard at a concert some days earlier and that our mind seems to automatically and spontaneously recreate for us—whether we like it or not. Our capacity to "hear" music in the absence of the corresponding external sound waves is a prime example of auditory, or indeed, musical imagery, and belongs to the broader category of mental imagery. In most general terms, *mental imagery* is a sensory-like experience in a modality in the absence of an actual corresponding sensory input in that modality. This definition is in line with others from the cognitive sciences such as the one provided by Kosslyn et al. (1995, p. 1335):

> [v]isual mental imagery is 'seeing' in the absence of the appropriate immediate sensory input, auditory mental imagery is 'hearing' in the absence of the immediate sensory input, and so on. Imagery is distinct from perception, which is the registration of physically present stimuli.

However, scholars from other (applied) disciplines have different connotations with, and perspectives on, the term *mental imagery*. The following definition from the realm of music education stresses the practical function of mental imagery in a typical rehearsal context: mental imagery is characterized as

> cognitive or imaginary rehearsal of a physical skill without overt muscular movement. The basic idea is that the senses—predominantly aural, visual, and kinesthetic for the musician—should be used to create or recreate an experience that is similar to a given physical event.
>
> (Connolly & Williamon, 2004, p. 224)

To carve out the subtle (or not-so-subtle) differences of scholars' perspectives on mental imagery, we asked each contributor of this volume to provide their own definitions—resulting in 24 nuanced and multifaceted versions from fields such as psychology, philosophy, musicology, music therapy, and music education.

## Mental Imagery: Ordinary or Originary?

While some forms of mental imagery, as in the case of earworms, may be based on past experiences and mechanisms of memory retrieval (Liptak et al., 2022) and maintenance (Killingly et al., 2021), our mind is capable of much more: humans—especially trained musicians—can voluntarily imagine a melody in various timbres and turn, for example, a piano tune into a full-blown orchestra version. Or we can create new sounds in our mind's ear that have never been instantiated in physical sound waves, which is a typical mental practice of both composers and musical performers. However, some might argue that all personal musical imagery must be based on, or related to, one's previous listening experiences. This refers to the broader philosophical question of "whether imagination is autonomous and originary or rather is derivative of other psychological processes and hence ordinary" (Waller et al., 2012, p. 298) and whether creative imagination can be measured with scientific methods at all (Thomas, 1999). The separation of mental imagery based on memory and creative processes has a long tradition in the literature and comes with various terms and definitions. For instance, already James (1890) distinguished between *reproductive* and *productive imagination*; more recent accounts use the terms *memory imagery* and *imagination imagery* (Gracyk, 2019). As further discussed in Waller et al. (2012), contemporary scientific endeavours treat mental imagery mostly as "memory images," that is, as based on previous experiences, whereas imaginative, originary accounts had been ignored. The chapters offered in this volume do not support such a view. Many accounts and research reports provided throughout this volume testify to the power of music to create genuinely new mental images that are not simply reinstantiations of previous external sensory input in the mind's eye or ear. Music may, in that sense, reveal itself as one key to unlock the gate to originary mental processes that engage one or several modalities. Indeed, the fact that mental imagery in musical contexts occurs not only in the auditory but also in visual, kinaesthetic, or even tactile modalities implies that a multimodal perspective is needed for a comprehensive understanding of mental imagery (Nanay, 2018).

## Multimodality

The importance of multimodality has been discussed by Godøy and Jørgensen (2001) some 20 years ago and is taken up again in this volume. Conceived by various music scholars in the late 1990s, Godøy and Jørgensen's volume *Musical Imagery* aimed to (at least partially) rectify cognitive scientists' bias towards visual imagery in their pursuit of shedding light on the mechanisms underlying mental imagery. However, as the editors of that volume soon noted while organizing the structure of the book, a narrow focus on auditory mental imagery could not possibly account for the complex mental processes involved in music listening and making. Indeed, when we listen to music, we may conjure up visual images of, for instance, performing musicians or of natural landscapes in our mind's eye (visual mental imagery); feel a sense of movement that corresponds to the

temporal unfolding of a piece (kinaesthetic mental imagery); or may even imagine a distinct smell (olfactory mental imagery) that we associate with the emotional character of the music or that has been triggered by an episodic memory. Although a recent study (Wilain et al., 2021) has shown that visual and kinaesthetic mental imagery are the two modalities most often involved during music listening, other modalities such as olfactory, gustatory, and tactile do occur as well. When mental images in two or more modalities are formed and experienced simultaneously or in succession, this is what we refer to as *multimodal mental imagery*. For instance, when we hear *and* see a musical performance in our mind, this is multimodal mental imagery—regardless of whether an external stimulus (such as music) is present or not. This definition differs from Nanay's definition (this volume) and highlights why it is so important to define terms and concepts precisely. Nanay argues that music-evoked visual mental imagery *in itself* is a case of multimodal mental imagery, because two modalities are involved: auditory (perception) and visual (imagery). If Nanay (2021) is right that some forms of mental imagery are unconscious, it will be challenging to ascertain which modalities are involved during music listening. What seems clear, though, is that all these mental images, stemming from various modalities, are an integral part of musical experience, highlighting that multimodality is a central feature of music-related mental imagery.

## From Basic to Applied Research in Mental Imagery

Although Küssner and Orlandatou (this volume) briefly touch on the history of mental imagery research and Taruffi and Küssner (this volume) describe the basic points of the "imagery debate" that captured cognitive science for many years (Kosslyn et al., 2006), most chapters are concerned with the recent academic discourse. For an excellent summary of the beginnings of empirical research on mental imagery at the end of the 19th century—when Carl Stumpf and his contemporaries paved the way for much of the experimental music research as we know it today—and all the philosophical writings on mental imagery that preceded it, we refer the reader to Schneider and Godøy (2001). Suffice it to say that, in his essay "On Gestalt Qualities" in 1890, Christian von Ehrenfels, the philosopher and early protagonist of Gestalt psychology, already emphasized the importance of multimodal mental imagery for musical works. He stressed that, when thinking about an orchestral piece, one should imagine a scene with the entire orchestra, the concert setting, the lighting, the movements of the conductor and musicians, and so forth. Some of the questions and issues discussed in this volume therefore have a long history and engaged generations of scholars interested in the fundamental mechanisms of how music plays (in) our mind and their relation to cognitive and affective processes. It is with this historical awareness that we present the current volume and hope that a fresh approach to the topic with new interconnections between related psychological phenomena and a glimpse into areas of applied, music-related mental imagery research will provide a useful resource for students, scholars, and music practitioners. Testimony

to the applicability of music and mental imagery research already comes from translational research developed in this area. For instance, recent years have seen a rise of studies on auditory imagery (Halpern & Overy, 2019; Schaefer, 2017; Watanabe et al., 2020) including applications of how imagined sound and music can aid in pedagogy, clinical contexts, and rehabilitation. While each individual chapter is self-contained and can be enjoyed on its own, we expect the number of revelatory insights into music-related mental imagery to correlate positively with the number of chapters read.

## Part I: Modalities of Mental Imagery

The first part of the present volume provides an overview of the most commonly experienced types of modalities of mental imagery in musical contexts (see Wilain et al., 2021), namely auditory, visual, and kinaesthetic. As we perceive music holistically, a division into separate sense modalities is somewhat artificial, but it helps to delineate basic concepts and theories. It also reflects the different research strands that are usually concerned with one specific type of mental imagery. The last chapter of Part I provides one account of how multimodal mental imagery may work in musical contexts.

Introducing the reader to the most commonly studied form of mental imagery in relation to music, that is, musical imagery, Floridou develops, in Chapter 1, a rich conceptual framework of its multifaceted forms ranging from voluntary musical imagery during mental rehearsal over anticipatory imagery during music listening to spontaneously occurring musical mind-pops and earworms. She critically reviews literature on musical imagery occurring before, during, and after musical activities and shows how its various forms are intricately linked with everyday cognitive processes such as mind-wandering, memory, or future thinking. Above all, her analysis reveals that musical imagery is an umbrella term for many different concepts that musically trained and untrained individuals alike regularly encounter in everyday life.

In Chapter 2, Taruffi and Küssner address visual mental imagery (VMI) in various musical contexts, ranging from shamanic rituals to music therapy, and emphasize the individuality of VMI experiences during music listening. Music-related VMI can be associated with a number of related cognitive phenomena such as mind-wandering, absorption, or trance, which will be dealt with in depth in Part III of this volume. The first main section of this chapter is devoted to the format of mental representations underlying VMI, as Taruffi and Küssner re-visit the "imagery debate" (Kosslyn et al., 2006). The basic question of the imagery debate is whether mental representations are depictive or propositional, that is, whether information is encoded image-like or with abstract, linguistic symbols. There is now a substantial amount of neuroscientific evidence in favour of the depictive account, demonstrating that topographic areas of the visual cortex are activated during both perception and imagery. The role of affect in music-related VMI is the focus of the second main section. Taruffi and Küssner introduce Juslin and Västfjäll's framework of emotion induction during music listening

(Juslin & Västfjäll, 2008) and report several recent empirical studies which have begun to shed light on the relationship among VMI, music, and emotion. The last section is concerned with various clinical applications—from music therapy to chemotherapy—in which VMI already plays a prominent role and which could be further enhanced by music-based interventions. As well as highlighting the manifold forms and functions of music-related VMI, the chapter anticipates some of the topics that are discussed in more detail in Parts III and IV of this volume.

In Chapter 3, Godøy illuminates musical imagery—similar to Floridou in Chapter 1—but with a focus on the connection between actions and sounds, building on his extensive work on sound-motion objects. *Sound-motion objects* have a duration of 0.3–3 seconds and "are perceived and conceived holistically as coherent units, and notably so, as units combining sensations of sound and body motion" (Godøy, 2019, p. 161). Heavily influenced by the theoretical work of Husserl and Schaeffer, Godøy argues that musical imagery—as well as music perception in general—is shaped by constraints of our motor system and that mental imagery of sound-producing actions can trigger mental imagery of musical sounds. His central theoretical framework is *intermittent motor control*, that is, the idea that actions are planned, executed, and monitored in chunks of variable length. These can then, in turn, be found in our perception of musical shapes which are similarly organized in sound-motion objects at different timescales. Employing a combination of music theory, phenomenology, and cognitive science, Godøy situates volitional musical imagery within broader processes of musical creativity and provides robust empirical evidence for his thesis that sound-motion objects are central ingredients of our musical listening and mental imagery experiences.

Drawing on the work of Godøy, Cox, Lipps, and Stern among others, Kim develops, in Chapter 4, an intricate account of kinaesthetic musical imagery that is distinct from commonly encountered concepts such as kinaesthetic imagery and motor imagery, which are often used synonymously in the music literature and refer to first- or third-person perspectives of human body movements. Disentangling those terms, she puts her finger on various inconsistencies in the literature and delineates her own concept that is informed by historical discourses—for instance, Lipps' discussion of the term "Einfühlung" (i.e., empathy)—as well as her own empirical work using micro-phenomenological interview techniques with musicians to carve out second-person perspectives of music cognition. Because kinaesthesia and kinaesthetic imagery have so many different connotations in the literature, Kim feels obliged to outline first what her concept of kinaesthetic imagery does *not* involve. For instance, it is not the simulation of motor actions that are necessary for sound-producing gestures and it is also not the conscious imagination of (imitated) motor actions. Rather, according to Kim, "*kinaesthetic musical imagery* can be understood as a category of mental imagery that could be best characterized as the (quasi-)perceptual conscious experience of dynamic self-movement that mental representations of musical dynamic properties give rise to." She contextualizes her approach within theories of consciousness and draws connections to Stern's psychodynamic forms of vitality, offering a new

perspective on a concept—kinaesthetic imagery—which, on close inspection, proves to be rather thorny and theoretically challenging.

In Chapter 5, Nanay draws on philosophy, psychology, and neuroscience to provide his account of *multimodal mental imagery* in musical contexts. While mental imagery may be triggered top-down (e.g., by voluntarily imagining a national anthem), multimodal mental imagery, according to Nanay, is triggered laterally by sensory input from a modality (e.g., vision) that is different from the relevant modality (e.g., audition) in which mental imagery occurs. Nanay outlines some general features of mental imagery: it can be voluntary or involuntary, conscious or unconscious, and the location of its object can be internal (e.g., before the mind's eye) or external (e.g., on the desk or the wall in front of us). He discusses the role of (musical) expectations and how some belong to the category of *auditory temporal mental imagery*, that is, perceptual processing that comes either too late or too early, but does not correspond to the relevant sensory input. Nanay reports some neuroscientific evidence showing that our brain is able to process perceptual information of highly familiar stimuli before the corresponding sensory input has occurred. A convincing musical example is the installation *Earth-Moon-Earth (Moonlight Sonata Reflected From The Surface of The Moon)*, a piece of sound art where our expectations fill in missing notes of the Moonlight Sonata. In the remainder of the chapter, Nanay draws on various illustrative examples of music and dance performances to argue that multimodal perception of music is the norm and can have—enabled by multimodal mental imagery— lasting effects on our musical experience. For instance, he shows how dancers' gestures can trick us into hearing altered time signatures, and how this mode of listening to the musical metre may persist—due to (unconscious) visual mental imagery of those gestures—when being presented with an audio-only version of that performance some weeks later.

## Part II: Measurement

The second part is concerned with the tricky question of how to measure and analyse experiences of music-related mental imagery. Experts in their respective fields reveal advantages and disadvantages of state-of-the-art tools and methods ranging from verbal self-report to neuroimaging approaches and deep neural networks. All measurements are discussed with respect to relevant empirical findings from research on music-related mental imagery. The last chapter of this part encompasses a broader, cross-cultural perspective and emphasizes some important ethical questions (e.g., power relations) relevant not only to field work in remote areas of the world but also to the daily work in music psychological laboratories.

In Chapter 6, Gelding, Day, and Thompson introduce subjective and behavioural measures of music-evoked visual imagery and auditory imagery for music, highlighting a number of imagery-related dimensions that researchers usually assess with self-reports. Dimensions of music-evoked visual imagery include, for instance, prevalence, nature, content, quality, vividness, intensity, timing, and duration. Gelding and colleagues focus on temporal dynamics of visual imagery

and report one of their own studies (Day & Thompson, 2019) that used chrono-metric measures (i.e., reaction times) to investigate when people experience emotional responses and visual imagery during music listening. Chronometry offers a promising way to study the causal relationship between visual imagery and felt emotions, but a variety of methods (e.g., supressing visual imagery, see Hashim et al., 2020) are needed before more solid conclusions about causality can be drawn. The second part of their chapter is concerned with auditory imagery for music, both during and after listening. The authors emphasize the need to develop more robust, adaptable behavioural methods that take into account interindividual differences and ensure that people actually use musical imagery to solve a given task. Two novel methods developed by the authors—the Pitch Imagery Arrow Task (PIAT) and the Rhythm Imagery Task (RIT)—are described to address the aforementioned issues. Interestingly, Gelding and colleagues' use of the term *anticipatory imagery* (i.e., auditory imagery during music listening) seems to largely overlap with Nanay's concept of *auditory temporal mental imagery*, as both deal with the brain's anticipated continuation of musical stimuli. The authors close their chapter with a plea to make use of more neuroscientific methods (see Belfi, this volume) to corroborate subjective and behavioural measures.

In Chapter 7, Hubbard provides a systematic overview of, and critical reflection on, self-report measures of mental imagery in musical contexts, not only emphasizing some of the points made by Gelding et al. (this volume) but also introducing a number of novel aspects. Under the term *self-report measures*, Hubbard subsumes both verbal questionnaire data and non-verbal behavioural responses. He discusses in detail the advantages and disadvantages of verbal self-report and pays attention to disadvantages that are specific to music and imagery research such as the insensitivity of questionnaires to transient episodes of visual imagery, the blurring of imagery and non-imagery information, and the issue of participants reporting their interpretation of visual imagery (rather than the visual images themselves). Notable behavioural measures include key presses (judgements and selections), drawing lines, adjusting metronomes, and finger tapping. In the second part of his chapter, Hubbard outlines musical and non-musical dimensions of musical imagery, where *musical imagery* denotes a broad spectrum of different types (usually visual and auditory) of mental imagery. Musical dimensions include pitch, timbre, contour, tempo, loudness, expressive timing, tonality, and lyrical content; non-musical dimensions encompass vividness, clarity, valence, ability to control or transform (auditory) images, and voluntariness. He emphasizes that self-reports not only complement neuroscientific methods and form an integral part of recent methodological developments (e.g., neuro- or het-erophenomenology) but also allow researchers to track emergent properties of mental imagery.

Belfi focuses on neuroscientific measures in Chapter 8, aiming to provide practical guidance in choosing the appropriate method for identifying neural correlates of music-related mental imagery. The first approach discussed is lesion studies with patients suffering from focal brain damage due to strokes, removal of brain tissue, or infections. For instance, one such neuropsychological study

revealed that musical hallucinations—a form of musical imagery where people imagine music coming from the external world—are associated with damage to the (left) temporal lobes. A method more commonly used in mental imagery research is functional magnetic resonance imaging (fMRI). A typical question that can be addressed in fMRI studies is whether perception and mental imagery of music (or other stimuli) rely on the same neural structures. Findings have revealed that there is substantial overlap, but mental imagery does not necessarily activate primary sensory regions such as the primary auditory cortex for musical imagery. Belfi also discusses electroencephalography (EEG), which has some advantages in comparison with fMRI (cheaper, silent, mobile devices available), and reports a couple of findings from musical imagery studies. For instance, Schaefer et al. (2011) showed that musical imagery compared to perception gives rise to more activation in the alpha frequency range (8–12 Hz) over occipito-parietal areas, indicating that musical imagery involves working memory processes. The last method covered is magnetoencephalography (MEG). Belfi discusses one MEG study (Gelding et al., 2019) utilizing the Pitch Imagery Arrow Task, which revealed that beta activity (13–30 Hz) in auditory and sensorimotor areas is associated with mental imagery for musical pitch. To close her chapter, she cautions against using neuroscientific measures without accompanying self-reports or behavioural methods, thereby echoing arguments made by Hubbard (this volume) and Gelding et al. (this volume).

In Chapter 9, Ofner and Stober delve deeper into neuroimaging data and provide an overview of the latest machine learning techniques (i.e., extracting knowledge from raw data) to make sense of EEG and fMRI data collected during music listening. Machine learning algorithms are used to find patterns and trends in raw data that are not visible to the naked eye, with the aim to understand the data better or to make predictions based on the detected patterns. In the realm of music research, one of the main goals is to classify or even reconstruct auditory stimuli based on brain signals of sound perception. Machine learning algorithms work relatively well for speech segments, but perceived—let alone imagined—complex musical stimuli pose a severe challenge. The main focus of this chapter is on deep neural networks—a machine learning technique that uses supervised (i.e., examples of input–output pairs are provided) or unsupervised learning to represent information. The authors discuss two classes of deep neural networks in more detail: convolutional neural networks (CNNs) and recurrent neural networks (RNNs). CNNs show similarities with the actual brain structure of the visual cortex and are good at spatial processing; on the other hand, RNNs are often used to process sequential data. Both classes have been used to estimate musical tempo or classify imagined musical excerpts. In the last section, Ofner and Stober discuss deep generative models, which have the advantage of using unsupervised learning. Although training and analysis of such models are complicated—small deviations (e.g., a shift in tempo) can lead to large mathematical errors—these models are regularly used in real-time applications or interactive settings. One future challenge identified by the authors is to collect more multimodal data, for instance by combining neuroimaging data with physiological, (facial) motor,

or behavioural data. This request is in line with Belfi's (this volume) suggestion to make reverse inference—that is, inferring cognitive processes from brain signals—less speculative. Another request is to pair deep neural networks with predictive coding (Clark, 2013) to construct models that are even more similar to the biological brain and that are able to explain internally generated, sensory-like experiences such as mental imagery. All the approaches and methods discussed in this and previous chapters have not only the potential to transform basic research questions related to music and mental imagery but also wide-reaching ethical implications. Some of these will be addressed in the last chapter of Part II.

Informed by his own research in Japan, Papua New Guinea, and Pakistan, Athanasopoulos reflects, in Chapter 10, on methodological and ethical issues in cross-cultural studies of music-related mental imagery. When conducting research in a foreign culture, every concept needs to be revisited before formulating meaningful research questions. Since language is often a barrier, researchers should present images or videos and use non-verbal responses (e.g., free drawings) in their studies. Due to complex (digital) interconnections and dependencies between cultures and societies, researchers should also carefully check their hypotheses and assumptions when doing field work. Ethical considerations should always proceed any research questions, and great attention should be paid to power relations as well as concepts and ideas researchers bring to the field. Athanasopoulos also weaves in findings from his own cross-cultural research, speculating that there may be innate associations between sound and imagery concepts. For data to be interpreted in light of cultural particularities, it is important to form interdisciplinary research teams, including anthropologists, ethnomusicologists, psychologists, and cognitive scientists. Some concrete factors to be taken into account when testing individuals from a different culture encompass formal school experience, musical training, literacy, physical aspects of the experimental setup, familiarity with the type of data collection, and scale construction. Crucially, Athanasopoulos reminds music and mental imagery researchers that "there is no objective quality to the perception of musical imagery; instead, each participant group is likely utilising approaches which maximally facilitate communication between themselves and their peers."

## Part III: Mental Imagery and Related States of Consciousness

The third part of this volume explores imagery-based states of consciousness (ordinary or altered) that are evoked during music listening or making. Imaginative thought is remarkably diverse, and beyond the modalities in which it can occur (described in detail in Part I), there are several mental states or states of consciousness that strongly rely on mental imagery (e.g., autobiographical memory, mind-wandering, daydreaming, and absorption) and that can also be relevant to musical contexts. Experts from diverse fields, including psychology, musicology, and music therapy, discuss how music can shape such mental states and underlying processes. The reader may witness consistent overlaps among the different

states of consciousness examined here, and the chapters highlight the lack of defi-nite conceptual boundaries among them. In this regard, an outstanding issue for future research on mental imagery and music consists of stimulating conceptual work to provide a holistic framework that can effectively account for the variety of music-related, imagery-based states of consciousness.

In Chapter 11, Jakubowski deals with music-evoked autobiographical memo-ries (MEAMs), which are often listed among the most intense and moving expe-riences one can have with music. After providing a brief picture of the crucial role of mental imagery in autobiographical memory, Jakubowski specifically focuses on how music can act as an effective cue for spontaneously eliciting posi-tive and vivid lifetime memories. When looking at the peculiarities of MEAMs compared with autobiographical memories evoked by other cues, such as photo-graphs of famous faces and TV programmes, it is striking that the imaginal con-tent of MEAMs exhibits increased motor, spatial, and social elements along with a greater proportion of perceptual details. These findings stress the social nature of music and the important role it plays in creating and nurturing social bonds and the embodied nature of musical experiences. In the last part of her chapter, Jakubowski identifies tasks for future research, including an in-depth investiga-tion of the imagery modalities through which MEAMs occur (given, e.g., the conflicting findings regarding the role of visual imagery), and an exploration of the potential for using music to elicit memories in people with dementia and other memory impairments.

Konishi provides, in Chapter 12, a state-of-the-art review of research on mind-wandering—a ubiquitous mental phenomenon that has long been studied in experimental psychology under a range of different terminologies, such as "daydreaming," "task-unrelated thought," or "stimulus-independent thought." Mind-wandering episodes, which are characterized by a shift of attention away from the task at hand or the external environment, can be investigated in terms of their phenomenological content (very often people mind-wander to current concerns or goals) and can be modulated by the characteristics of the context (mind-wandering increases with fatigue). After reviewing mind-wandering's benefits (e.g., increased creativity) and costs (e.g., decreased task performance), Konishi examines its relationship with music from a two-sided perspective, by addressing the following questions: How can music influence mind-wandering, and can mind-wandering occur in the form of musical imagery? While music seems capable of modulating the content (and to some extent also the frequency) of mind-wandering episodes via emotion, mind-wandering can also occur in the auditory modality, for example, as in the case of *earworms* when a catchy tune plays again and again in our minds. The integration of music into mind-wandering research may provide novel insights into our understanding of conscious mental experiences in relationship to tasks that do not require much focused attention (such as music listening).

In Chapter 13, Gritten offers a theoretical reading of a mental phenomenon closely related to mind-wandering: distraction. Distraction is one mechanism underlying the evocation of mind-wandering that disrupts the focus of the

listener's attention, possibly leading to "failed listening." By retrieving a personal anecdote of attending the UK premiere of Goehr's orchestral work *Colossos or Panic*, Gritten unpacks the complex relationship between traction and distraction. Although, at first, distraction may appear as a "drag" on the listener, by triggering mind-wandering and leading away from focused listening, it ultimately challenges the listener. This challenge consists of drawing the listener back to their body and adapting to the materiality of musical sound and to what happens in the external environment. In summary, Gritten's chapter sheds positive light on distraction, showing the functionality it may fulfil and how it consequently amplifies indeterminacy within the listening context.

In Chapter 14, Herbert covers *musical daydreaming*—a heteronomous, multimodal mode of listening marked by fluctuations between internal mentation and awareness of the external sensory environment, which largely overlaps with the concept of mind-wandering. As Herbert explains, heteronomous listening differs from autonomous listening (where music is the sole focus of attention), allowing more space for the unfolding of mental imagery. The chapter is centred around an examination of subjective reports of music listening experiences, which illuminates the phenomenology of musical daydreams as well as how visual imagery contributes to the overall experience by shaping specific content, partly via enculturation through repeated exposure to film. It also clearly emerges that multimodality is a key characteristic of such mental experiences, which are modulated by a rich network of internal/external variables, including age, musical training, context, personality, and intention. Although musical daydreams may strongly rely on biological rhythms, chronobiological explanations remain at present merely speculative, and empirical data are needed to shed more light on this. However, Herbert suggests that this is a highly promising direction for future work, since musical daydreams "may function as a self-regulatory process affording respite from the vicissitudes of daily life—a space for simply 'being.'"

Küssner and Orlandatou (Chapter 15) explore synaesthesia—a condition observed in a small subset of the general population, in which a stimulus not only is processed by its corresponding sense but also activates another sensory modality. The chapter examines synaesthesia's relationship to mental imagery, looking in particular at the comparison of sound-colour synaesthesia and music-induced visual mental imagery. After a brief historical overview of synaesthesia research, the authors put forward the argument that music-induced visual mental imagery can be regarded as a weak form of sound-colour synaesthesia, given the large overlap between their conceptual and experiential features. However, some significant differences also emerge. For example, synaesthesia tends to feature stronger vividness and less control on the experience than music-induced visual mental imagery. The authors underscore three key areas—emotion, creativity, and memory—where synaesthetes' and non-synaesthetes' responses to music-induced visual mental imagery may differ. The chapter ends with the encouragement for future researchers investigating music-induced visual imagery to assess whether their participants are synaesthetes to avoid potential confounds.

With Vroegh's contribution (Chapter 16), we slightly move away from ordinary consciousness and focus on *absorption*, which has often been defined as a trance-like state of consciousness. Aiming to make progress on theoretical debates by adopting an empirical-oriented approach, Vroegh uses a probabilistic graphical approach to unveil how multiple dimensions of consciousness relate to each other in the context of an absorbed listening state, with a particular focus on the dimension of visual imagery. Specifically, he applies Bayesian network analysis on a novel dataset gathered by 193 participants, who, after listening to a 5-minute piece of favourite music, had to fill in the Phenomenology of Consciousness Inventory (Pekala, 1991), which taps onto a number of consciousness dimensions such as attention, self-awareness, short-term memory, self-control, and altered experience. The results show that an absorbed state of mind is linked to a high probability (74%) of experiencing *visual imagery*. Moreover, *altered experience* represents a central "hub" of the network, whereas *mixed affect*, *short-term memory*, and *reflective thoughts* are outcome attributes. Overall, this chapter contributes to uncover the main dimensions characterizing the experience of absorption in music, underscoring its close relationship with visual imagery. It provides intriguing insights into the structure of absorption from a multidimensional perspective on consciousness and puts forward a promising analytic method that could be applied to the study of other music-related and imagery-based states of consciousness.

By combining perspectives from music therapy, shamanic healing, and psychedelic therapy, Fachner explores, in Chapter 17, music-evoked imagery in altered states of consciousness (ASC). The author puts forward the thesis that a recumbent body posture during an ecstatic ASC induces a process of downregulation of arousal that in turn allows to free up energy for focusing on the imagery evoked during music listening. To support his argument, Fachner showcases a range of ASC induction settings including, for example, shamanic journeys and monotonous drumming. The common denominator is that inwardly tuned attention and less movement are used to save up energy, which in turn will be released to boost inner imagery related to the various ASC. Music featuring monotonous structures seems ideal to retreat from the "here and now"; however, the choice of music is culturally mediated, and complex structures may also be relevant in triggering more articulated mental images and narratives. Importantly, Fachner points out that, besides the induction settings, performance rites, suggestibility traits, and personal willingness to enter an altered state play a crucial role in enhancing overall imagery.

## Part IV: Applied Mental Imagery

How can mental imagery, which is intangible, only existing in the mind of the person who imagines, have practical applications? Part IV of the current volume addresses this question and, in six chapters, the authors present their research and perspectives on the application of mental imagery. Scholars and practitioners explore a range of domains in applied mental imagery, from motor

rehabilitation and coping with music performance anxiety to music therapy and piano performance. Drawing on data from multiple research methods such as interviews, subjective observations, and empirical testing, the authors interpret their findings and the literature while developing reviews and theoretical frameworks. The chapters in Part IV touch on issues which relate back to the previous parts of the volume, underlie our understanding of imagery, and inform the volitional and spontaneous uses of imagery not only in musical settings but also in non-musical settings, thereby responding to calls for translational research in the field.

The first three chapters discuss applications of mental imagery in rehabilitation, therapeutic, and pedagogical settings. In Chapter 18, Schaefer delivers an overview of how imagery is and could be harnessed in motor rehabilitation for movement-related purposes (e.g., in Parkinson's disease) and in music pedagogy for memorization and expressiveness. First, the author explores past research and provides an account of imagery and its intricate link to movement. She touches on issues regarding imagery, its phenomenological aspects, cognitive, behavioural, and neural correlates, and individual imagery abilities. Moreover, she discusses how understanding imagery's underlying processes can improve applications in both rehabilitation and pedagogy. She offers an explanation of how musical imagery (voluntary and spontaneous), similar to music processing, can act as an endogenous auditory cue for movement and could potentially supplement or even replace music in motor rehabilitation. Next, Schaefer reviews research on the use of multimodal imagery in music pedagogy and how various imagery modalities interact with motor-related processes to support memorization of music, reduce cognitive load while performing, enhance communication and expressiveness, and benefit music performance. The commonalities between imagery processes and motor aspects for movement recovery and music pedagogy open up exciting prospects not only for understanding imagery in more depth but also for creating applicable protocols and teaching methods.

Next, moving away from the physical and cognitive benefits of imagery, Finch and Oakman (Chapter 19) present a comprehensive review of the literature on how voluntary imagery is used by musicians to manage affective-related aspects of performance and, more specifically, music performance anxiety (MPA). The authors review intervention studies and provide a categorization of the existing imagery techniques that have been tested with musicians to help them cope with MPA. They employ the superordinate term *mental preparation imagery* comprising four techniques—metaphorical imagery, relaxation imagery, systematic desensitization, and imagery in mental skills training—which are used for general performance reasons, when preparing for specific performances, or for specific performance-related goals. In addition, the authors use the term *mental rehearsal* for certain imagery-related performance tasks. The techniques and the details offered draw on methods from music therapy to cognitive behavioural therapy aimed at reducing anxiety, easing the cognitive and motor demands of the performance, or both. In view of future developments, the authors highlight the strengths and limitations (e.g., small sample size) of the reviewed studies while also making

suggestions, based on research results and practices from other disciplines such as sports psychology, about what musical imagery aspects and individual differences to be studied and how.

Imagery techniques for MPA, covered in the previous chapter, adopt aspects from the music therapy form of Guided Imagery and Music (GIM), which is presented in Chapter 20 by Dukić. Although GIM therapy sessions are explained and used as the departure point in this first empirical chapter of Part IV, the reported study utilizes the GIM context as a stimulus to explore one of the hypothesized meanings of music, that is, to offer a narrative. According to Dukić, a *narrative* is a sequence of meaningful events that present a serial order of setup, confrontation, and resolution. This order is realized through active and passive exchanges as expressed in tension and relaxation conveyed by specific features of music acting as a scaffold for imagery to emerge in the same manner. In Dukić's study, participants underwent a standard GIM session and listened to music that was intended to induce (or not) a narrative plot while reporting on spontaneous visual imagery experiences the moment they occurred. The analysis focused on categorization of imagery as passive or active. The results showed that specific musical pieces in the GIM programme, such as Britten's *Sentimental Sarabande*, followed the narrative order as predicted, while others did not. The author offers explanations for these differences, for example, specific musical features that could trigger these responses, and makes suggestions for future studies, for instance, looking at the specific music features, which contribute to the emergence of active and passive imagery. Research on GIM seems promising not only for further understanding imagery and the meaning of music but also, more importantly, for developing tailored music therapy sessions according to the needs of the clients.

The last three chapters cast light on the experience of imagery in skilled music performance. Two chapters deal with accounts of imagery in typical and visually impaired professional pianists and their performances in Western classical music contexts in the UK and South Africa, adapting existing or developing novel theoretical frameworks. In Chapter 21, Presicce presents a brief review of music performers' experiences with visual imagery and provides a system of categories building on a framework of music listening and visual imagery by Taruffi and Küssner (2019). The framework is based on cognitive control constraints on the occurrence of visual and other forms of imagery but this time adapted for performing music. Presicce divides visual imagery during music performance into three categories—*spontaneous*, *heuristic*, and *strategic*—which serve different aspects of performing. She describes how these forms of imagery can enhance the performance, its expressiveness, or its preparation, echoing some of Finch and Oakman's techniques on coping with MPA. In the second part of the chapter, Presicce presents an insider's view and outlines her first-hand experiences as a pianist and member of a piano duo as examples not only to confirm some of the imagery categories of the framework but also to showcase the power of imagery as a performative tool for memorization and expressivity.

In a similar manner, Herbst and van Zyl explore, in Chapter 22, the experience of piano performance and learning but this time by offering a unique window into the inner world of visually impaired (VI) pianists. The sample of four VI pianists (congenitally blind, partially sighted) and one sighted piano teacher with experience in teaching VI pianists provides an insight into a population that has been minimally studied in relation to mental imagery and music. The authors conducted open-ended semi-structured interviews focusing on experiences of listening, performing, and learning music in relation to, for example, the appearance of non-musical associations with music theoretical concepts and mental imagery linked to music notation systems. The identified themes reflect aspects related to VI pianists and how their external experience (e.g., braille notation) could hamper access to music and how their internal experience (e.g., use of metaphors and mind-wandering occurrence) can facilitate their musical understanding and compensate for their visual impairment. Finally, the authors develop a conceptual framework by compiling their findings and interpreting them through the lens of embodied cognition and dynamic system theories. This multimodal framework showcases the synergy of various imagery modalities, affective aspects, music structure, and bodily processes and the practical implications which are relevant for VI and sighted musicians alike.

In Chapter 23, Black presents an intriguingly different view of imagery from what we have seen so far. The chapter provides an examination of how, in the context of an observational study using video recording and interviews, 21 directors of amateur choirs employ verbal content, coined as *verbalized imagery*, to alter the vocal responses of the singers. The definition of verbalized imagery used by the author is distinct from definitions of auditory verbal imagery or musical imagery that have been presented so far in this volume. *Verbalized imagery*, as adopted by Black, refers to the words used orally by the choir directors, which describe images, metaphors, similes, or other figurative language, to elicit or alter singers' vocal responses. Through a very rich dataset and a qualitative analysis, the author identifies several categories of verbalized imagery such as visual, auditory, kinaesthetic, emotional, conceptual-musical, conceptual non-musical, and multimodal. Focusing on visual and emotional verbalized imagery, Black observes tone quality and expression to be the most frequent vocal effects. Given the plethora of types of verbalized imagery and vocal responses, the author encourages choir directors to use verbalized imagery as a strategy in their practice. The use of the term imagery in this chapter is an apt reminder to always ask people what they mean when they talk about "imagery." A clarification of the term will help to avoid misunderstandings not only between scholarly fields concerned with imagery research but also between academia, the arts, and the general public.

## Part V: Outlook

As mentioned in the beginning of this introductory chapter, the different definitions of mental imagery provided in this volume are intended to sensitize the reader to the diversity of approaches one may take when studying music and

mental imagery, with a view to stimulating more collaborative research on this topic. The issue of defining mental imagery is also taken up by Eerola in the last chapter of this volume. Besides offering his own diagnostic take on the problems to be solved in the near future to make progress in this field such as theoretical integration, analytical reviews, and innovative studies, he re-visits the problem of assessing and measuring mental imagery in musical contexts and proffers an embodied account of mental imagery to integrate existing findings and to be able to deal with complex features such as multimodality.

We envisage that this volume will bring loose ends of mental imagery research together and reveal interconnections between topics and areas of music research that will produce synergistic effects for novel studies. Progress will depend on taking aboard all the theoretical, conceptual, historical, methodological, episte-mological, and ethical issues related to music and mental imagery discussed in this volume and elsewhere. It is not an easy task, but one that—if achieved in an interdisciplinary research environment—will potentially transform our knowl-edge of musical experience and provide a new window onto mental imagery more generally.

## References

Clark, A. (2013). Whatever next? Predictive brains, situated agents, and the future of cogni-tive science. *Behavioral and Brain Sciences*, *36*(3), 181–204. https://doi.org/10.1017/S0140525X12000477

Connolly, C., & Williamon, A. (2004). Mental skills training. In A. Williamon (Ed.), *Musi-cal excellence: Strategies and techniques to enhance performance* (pp. 221–245). Oxford: Oxford University Press.

Day, R. A., & Thompson, W. F. (2019). Measuring the onset of experiences of emotion and imagery in response to music. *Psychomusicology: Music, Mind, and Brain*, *29*(2–3), 75–89. https://doi.org/10.1037/pmu0000220

Floridou, G. A., Williamson, V. J., Stewart, L., & Müllensiefen, D. (2015). The Involuntary Musical Imagery Scale (IMIS). *Psychomusicology: Music, Mind, and Brain*, *25*(1), 28–36. https://doi.org/10.1037/pmu0000067

Gelding, R. W., Thompson, W. F., & Johnson, B. W. (2019). Musical imagery depends upon coordination of auditory and sensorimotor brain activity. *Scientific Reports*, *9*(1), 16823. https://doi.org/10.1038/s41598-019-53260-9

Godøy, R. I. (2019). Thinking sound-motion objects. In M. Filimowicz (Ed.), *Foundations in sound design for interactive media* (pp. 161–178). New York: Routledge.

Godøy, R. I., & Jørgensen, H. (Eds.). (2001). *Musical imagery*. New York: Taylor & Francis.

Gracyk, T. (2019). Imaginative listening to music. In M. Grimshaw-Aagaard & M. Walther-Hansen (Eds.), *The Oxford handbook of sound and imagination* (Vol. 2). Oxford: Oxford University Press. https://doi.org/10.1093/oxfordhb/9780190460242.013.11

Halpern, A. A., & Overy, K. (2019). Voluntary auditory imagery and music pedagogy. In M. Grimshaw-Aagaard, M. Walther-Hansen, & M. Knakkergaard (Eds.), *The Oxford handbook of sound and imagination* (Vol. 2, pp. 390–407). Oxford: Oxford University Press. https://doi.org/10.1093/oxfordhb/9780190460242.013.49

Hashim, S., Stewart, L., & Küssner, M. B. (2020). Saccadic eye-movements suppress visual mental imagery and partly reduce emotional response during music listening. *Music & Science*, *3*, 2059204320959580. https://doi.org/10.1177/2059204320959580

James, W. (1890). *The principles of psychology*. New York: Henry Holt and Co.

Juslin, P. N., & Västfjäll, D. (2008). Emotional responses to music: The need to consider underlying mechanisms. *Behavioral and Brain Sciences*, *31*(5), 559–575. https://doi.org/10.1017/S0140525X08005293

Killingly, C., Lacherez, P., & Meuter, R. (2021). Singing in the brain: Investigating the cognitive basis of earworms. *Music Perception*, *38*(5), 456–472. https://doi.org/10.1525/mp.2021.38.5.456

Kosslyn, S. M., Behrmann, M., & Jeannerod, M. (1995). The cognitive neuroscience of mental imagery. *Neuropsychologia*, *33*(11), 1335–1344. https://doi.org/10.1016/0028-3932(95)00067-D

Kosslyn, S. M., Thompson, W. L., & Ganis, G. (2006). *The case for mental imagery*. Oxford: Oxford University Press.

Liikkanen, L. A., & Jakubowski, K. (2020). Involuntary musical imagery as a component of ordinary music cognition: A review of empirical evidence. *Psychonomic Bulletin & Review, 27*(6), 1195–1217. https://doi.org/10.3758/s13423-020-01750-7

Liptak, T. A., Omigie, D., & Floridou, G. A. (2022). The idiosyncrasy of Involuntary Musical Imagery Repetition (IMIR) experiences: The role of tempo and lyrics. *Music Perception: An Interdisciplinary Journal*, *39*(3), 320–338. https://doi.org/10.1525/mp.2022.39.3.320

Nanay, B. (2018). Multimodal mental imagery. *Cortex*, *105*, 125–134. https://doi.org/10.1016/j.cortex.2017.07.006

Nanay, B. (2021). Unconscious mental imagery. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *376*(1817), 20190689. https://doi.org/10.1098/rstb.2019.0689

Pekala, R. J. (1991). *Quantifying consciousness: An empirical approach*. New York: Plenum Press.

Schaefer, R. S. (2017). Music in the brain: Imagery and memory. In R. Ashley & R. Timmers (Eds.), *The Routledge companion to music cognition* (pp. 25–35). New York: Routledge.

Schaefer, R. S., Vlek, R. J., & Desain, P. (2011). Music perception and imagery in EEG: Alpha band effects of task and stimulus. *International Journal of Psychophysiology*, *82*(3), 254–259. https://doi.org/10.1016/j.ijpsycho.2011.09.007

Schneider, A., & Godøy, R. I. (2001). Perspectives and challenges of musical imagery. In R. I. Godøy & H. Jørgensen (Eds.), *Musical imagery* (pp. 5–26). New York: Taylor & Francis.

Taruffi, L., & Küssner, M. B. (2019). A review of music-evoked visual mental imagery: Conceptual issues, relation to emotion, and functional outcome. *Psychomusicology: Music, Mind, and Brain*, *29*(2–3), 62–74. https://doi.org/10.1037/pmu0000226

Thomas, N. J. T. (1999). Are theories of imagery theories of imagination? An active perception approach to conscious mental content. *Cognitive Science*, *23*(2), 207–245. https://doi.org/10.1207/s15516709cog2302_3

Waller, D., Schweitzer, J. R., Brunton, J. R., & Knudson, R. M. (2012). A century of imagery research: Reflections on Cheves Perky's contribution to our understanding of mental imagery. *The American Journal of Psychology*, *125*(3), 291–305. https://doi.org/10.5406/amerjpsyc.125.3.0291

Watanabe, H., Tanaka, H., Sakti, S., & Nakamura, S. (2020). Synchronization between overt speech envelope and EEG oscillations during imagined speech. *Neuroscience Research*, *153*, 48–55. https://doi.org/10.1016/j.neures.2019.04.004

Wilain, S., Omigie, D., Küssner, M. B., Taruffi, L., & Floridou, G. A. (2021, July 28–31). *The Multimodal Mental Imagery of Music Scale (MMIMS): A novel instrument for measuring individual differences in multimodal mental imagery during music listening* [Paper presentation]. 16th International Conference on Music Perception and Cognition and the 11th Triennial Conference of the European Society for the Cognitive Sciences of Music, Sheffield, UK.