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# Music and states of consciousness: A narrative review of the broader significance of music to understanding absorption, mind wandering and creative thought

Pedro T. Palhares [a,b,*], Madalina I. Sas [c], Óscar F. Gonçalves [d]

[a] Proaction Laboratory, Faculty of Psychology and Educational Sciences, University of Coimbra, Portugal
[b] CINEICC, Faculty of Psychology and Educational Sciences, University of Coimbra, Portugal
[c] Centre for Complexity Science, Imperial College London, London, United Kingdom
[d] Brainloop Laboratory, CINTESIS@RISE, CINTESIS.UPT, Universidade Portucalense Infante D. Henrique, Portugal

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ABSTRACT

Due to music's extraordinary capacity to temporarily alter mental and physical states, the domain of *musical experience* offers a natural and accessible field of investigation for the study of states of consciousness. However, despite the continued emergence of music-related investigations into conscious experience, their research paradigms remain on the fringes of consciousness research, with the broader significance of their contributions often overlooked. In this narrative review, we aimed to address this gap by offering a twofold contribution. Firstly, we have highlighted and critically assessed key contributions of empirical research in music psychology and music neuroscience to our understanding of non-ordinary states of consciousness, such as absorption, mind wandering and creative thought, emphasizing the broader significance of exploring consciousness through music. Secondly, we have identified the unique aspects of music that offer special insight into consciousness and discussed how these aspects can shape future investigations. Overall, our review underscores the importance of integrating music into consciousness research and highlights avenues for future exploration in this interdisciplinary field.

## 1. Introduction

Listening to and performing music is frequently associated with significant transformations in the quality and intensity of subjective experience, configuring, in many cases, altered states of consciousness (i.e. notable deviations from ordinary mental functioning). Such states may include absorption (Høffding, 2018; Vroegh, 2019), trance (Herbert, 2011), or flow (Tan and Sin, 2021). Additionally, musical activities can facilitate spontaneous cognitive phenomena, such as mind wandering and creative thinking (Christoff et al., 2016; Girn et al., 2020). Due to music's extraordinary capacity to temporarily alter mental and physical states, the domain of musical experience offers a natural and accessible field of investigation for the psychology, philosophy, and sociology of consciousness (Clarke and Clarke, 2011; Herbert et al., 2019). Despite this potential, the broader significance of existing music research for addressing a central contemporary challenge in consciousness science — namely, discerning the (neuro) phenomenological properties of conscious experience (Seth, 2021) — while seemingly far from insubstantial, remains unclear.

This narrative review seeks to clarify and critically assess the significant contributions of empirical research in music psychology and music neuroscience to our understanding of both ordinary and non-ordinary states of consciousness. The review places particular emphasis on the phenomena of absorption and spontaneous thought—two areas often object of conceptual ambiguity but which have been effectively addressed by recent music-related studies. Ultimately, this review seeks to establish that *musicking* — any musical act, from performing to listening (Small, 1998) — not only provides insights into consciousness, akin to other human activities, but also holds a distinct potential to explain several facets of conscious experience.

We commence by framing altered states of consciousness and synthesizing contemporary theoretical and methodological perspectives for their phenomenological identification and quantification. Then, we highlight music-related studies that provided important insights on

* Correspondence to: Proaction Lab, Faculty of Psychology and Educational Sciences, University of Coimbra Colégio de Jesus, R. Inácio Duarte 65, Coimbra 3000-481, Portugal.
*E-mail address:* pedro.torres.palhares@gmail.com (P.T. Palhares).

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various states of consciousness, including absorption, creative thought, flow, and mind wandering. Concurrently, we critically analyse their broader theoretical implications. In doing so, we disentangle and progressively delineate key aspects of musicking that may underlie music's special grip on human subjective experience, thereby paving the way for researchers to effectively leverage the benefits of musical paradigms. We conclude by addressing the potential for a *musical exploration of consciousness* to provide novel and privileged avenues for expediting research in the realm of consciousness.

## 2. Methodology and positionality in reference selection

Reference search was conducted using Web of Science, Scopus and Google scholar with the following keywords, either singularly or in combination: "music", "music absorption", "everyday listening", "musical improvisation", "jazz improvisation", "musical creativity", "musical performance", "musical communication", "mind wandering", "creative thought", "expertise", "flow", "consciousness", "states of consciousness", "phenomenology", "cognition", "neuroscience", "EEG" and "fMRI". References were then selected based on a combination of factors: recency, peer-reviewed publication status, and inclusion of real-time or retrospective assessments of conscious states in a musical context.

Given that this is a narrative review, it is essential to acknowledge that subjective judgments played a role in the selection and interpretation of these studies. As researchers engaged in the study of consciousness through the prism of psychology, cognitive neuroscience and complexity science, we approach musicking as a stepping stone towards a richer understanding of consciousness in general. While domain-specific research on the cognitive and psychological aspects of music is integral to our discussion, we biased reference selection toward studies whose findings contribute to broader reconceptualizations of key conscious states. We have attempted to mitigate bias by incorporating diverse methodological approaches, from semi-structured interviews to neuroimaging. Still, we encourage readers to approach this narrative review with an awareness of the author's positionality.

## 3. A scientific approach to consciousness and altered states

In an attempt to grasp the diversity and dynamics of subjective experience, psycho-phenomenological investigations generally adopt a *multidimensional approach* to the identification, quantification and description of states of consciousness, which are seen as unique, recognizable and temporarily stable combinations of key phenomenal dimensions (e.g., self-awareness, attention, mental imagery) (Gabrielsson and Wik, 2003). However, the internal configuration of a state of consciousness can vary across different contexts while maintaining its overall identity. As will be discussed in Section 4, even within a single activity such as everyday music listening, absorption can assume different experiential profiles (Vroegh, 2019). This variability highlights that these states are not merely aggregates of experiential attributes, but an emergent outcome arising from the multifaceted interplay among these dimensions.

Building upon this framework, an altered state of consciousness, when contrasted with ordinary wakeful states, manifests as an experiential profile diverging from an individual's customary patterns of sensory awareness of the external environment, perception, thinking, and/or self-experience (Vaitl et al., 2005). These alterations can range from subtle shifts in attention to profound and transformative experiences. Examples of altered states of consciousness encompass absorption, dissociation, flow, and trance, predominantly discerned and quantified through self-report assessment techniques (e.g., Pekala, 1991).

It's essential to recognize, however, that while states of consciousness are subjectively perceived as discrete, stable, or uniform, they are inherently dynamic, continuously evolving phenomena. Recent neuroscience-based models of conscious states (Christoff et al., 2016; Girn et al., 2020) have acknowledged this, favouring a taxonomy that prioritizes the dynamics of thought over its content. Nevertheless, the terminology associated with various states of consciousness serves as valuable holistic 'shorthand' representations of the qualitative essence of specific subjective experiences (Herbert, 2011), facilitating cross-comparisons and playing a crucial role in the analysis of consciousness under phenomenologically distinct conditions.

## 4. States of absorption

### 4.1. Everyday music listening as a probe into absorption

Everyday music listening episodes are lived experiences that can be intense, emotional, and completely captivating. However, a concentrated and exclusive focus on the music itself seems relatively rare, even when listening to music is the main activity. Instead, everyday music listening entails various *listening modes* (Weining, 2022) – i.e. distinct ways of engaging with music – that are often marked by distributed and fluctuating attention, along with a heightened awareness of multi-sensory nature, leading to rich and intricate experiences that extend beyond the music alone (Herbert, 2011).

Empirical evidence supporting this notion comes from studies such as those conducted by Herbert (2011;2012), wherein participants maintained 'listening diaries' for two weeks, documenting their subjective experiences. These studies yielded phenomenological profiles consistent with Gabrielsson and Wik (2003), Gabrielsson (2011), and Vaitl et al.'s (2005) seminal descriptions of strong experiences with music and altered states of consciousness, particularly highlighting the prevalence of *absorption* during music listening.

In psychology, absorption has traditionally been characterized as a unique state of intense focal concentration and cognitive engagement, often involving the exclusion of other content from conscious awareness, including aspects of self-awareness and self-reflection (Butler, 2004). However, Herbert's research, while still identifying these prototypical instances of absorption, uncovered profiles of absorption that include elements of mind wandering and even dissociation from the act of music listening. This led Herbert (2019) to differentiate absorption into three distinct forms: *narrowed awareness*, where attention is primarily focused on the music (aligning with classic definitions of absorption); *broadened or fluctuating awareness*, where attention seamlessly shifts between music, self-generated thought, and the external environment (a superimposition of focused attention and mind wandering); and finally, a form of involvement with music where the latter gradually fades from conscious awareness, redirecting attention to self-generated thought or the external environment (i.e., a music-induced mind wandering episode).

Recent studies by Vroegh (2019), (2021) have provided additional empirical insights into absorption. Employing the Phenomenology of Consciousness Inventory (Pekala, 1991) and a network approach to analyse states of consciousness emerging from music listening tasks, these studies identified distinct phenomenological profiles, including *mind wanderers*, *concentrators*, and two types of absorption: *zoning-in* and *tuning-in*. Interestingly, in addition to highlighting the multiplicity of absorption states, these studies challenge traditional views of absorption as a wholly non-volitional, automatic state. Instead, they uncover instances where metacognitive awareness and a sense of volitional control persist, particularly in the experiential profile of tuning-in, which directly contrasts with zoning-in, a prototypical example of self-forgetful absorption. This suggests that absorption does not always involve a complete abandonment of rationality and self-awareness, as was previously believed (Tellegen and Atkinson, 1974).

Altogether, Vroegh and Herbert's investigations seem to position everyday music listening as a privileged test-case for the study of absorption and dissociative phenomena in a normative population, mainly due to its seemingly universal capacity to potentiate altered experience

in a fast and accessible way, independent of the contribution of the *experiencer* to sensemaking. It remains unanswered, however, if musical stimuli possess, in fact, intrinsic properties that would account for such capacity.

Herbert (2012) aimed to empirically elucidate this question by having several experimental subjects log their subjective experience across different activities and contexts, thus allowing comparisons between different agents as to their effectivity in facilitating absorption, music listening being one of them. The latter proved to be, indeed, an inherently absorbing activity. By means of Interpretative Phenomenological Analysis (Smith, 2003), the author showed that this can be explained in terms of music's rich landscape of affordances – i.e. "multiple potential entry points to involvement […] a wide variety of attentional loci" (p. 57). These include the acoustic attributes of music (e.g. rhythm, tempo, timbre, resonance, pitch or dynamics), physical entrainment to music's sounds, imaginative involvement triggered my music via memories and personal/cultural associations, and finally, the fusion of aural, visual, kinaesthetic modalities evoked by all of the above. In addition, by being flexible and adaptable in terms of meaning and subsequent sensemaking at the level of the *experiencer*, music's affordances are accessible in a variety of circumstances.

In conclusion, everyday music listening offers a fertile ground for exploring altered states of consciousness, including absorption and spontaneous thought phenomena like mind wandering. Indeed, Herbert and Vroegh's research challenge traditional conceptualizations of absorption as a singular, non-volitional state of intense focal concentration. Instead, they propose that absorption can encompass a plurality of states, each characterized by varying degrees of volitional control, self-awareness and even mind wandering.

Leveraging a heterophenomenological approach, which integrates self-reports with bodily and neurophysiological indicators, could further deepen our understanding of absorption without sacrificing ecological validity. While live concert environments may offer heightened bodily, affective, and cognitive involvement, everyday music listening remains a valuable context for studying absorption and related phenomena.

### 4.2. Absorption in concert: the performer's perspective

Accounts of musical absorption in performing musicians have presented a recurrent paradox, which revolves around the description of absorption as a state characterized by both heightened and diminished bodily, reflective, and affective self-awareness (Høffding, 2018). Attempting to unravel the nature of this paradox, Høffding and Martiny (2016), developed the "phenomenological interview" method as a sensible and valid probe into the conscious experience of so-called extreme cases, populations whose experiencing and meaning-making deviates significantly from ordinary (Ravn and Høffding, 2017). Utilizing this framework, Høffding (2018) conducted a series of interviews with the Danish String Quartet, culminating in the delineation of a "topography" of musical absorption, where five distinct types of absorptive experiences were identified: *standard absorption*, *mind-wandering not-being-there*, *frustrated playing*, *absorbed not-being-there*, and *ex-static absorption*.

This topography reveals significant differences and similarities among various types of absorption experienced by expert musicians. Notably, although derived from qualitative case studies of expert musicianship, we note that certain elements of Høffding's conceptual landscape of musical absorption overlap with the findings of Vroegh (2019) and Herbert's (2019). The concept of "absorbed not-being-there" aligns with "zoning-in," both fitting within the broader notion of narrowed awareness. Conversely, "ex-static absorption" corresponds to "tuning-in" and exemplifies broadened awareness. This convergence further confirms that distinct types of absorption do not necessarily involve a loss of agency or metacognitive awareness; rather, they may, in some cases, amplify these aspects. Additionally, Høffding's work underscores the value of phenomenological interviews in qualitative studies of consciousness, offering a valuable complement to quantitative research within a mixed-method phenomenological framework (Martiny et al., 2021).

### 4.3. A unifying account of musical absorption

The previous sections highlighted how both everyday music listening and expert musicianship reveal absorption as a multifaceted state, encompassing varying degrees of focused attention and mind wandering. But notably, in instances of ex-static absorption and broadened or fluctuating awareness, these processes appear to coexist harmoniously.

This presents a paradox when viewed through the lens of cognitive neuroscience and psychology, where focused attention and mind wandering are often considered opposing processes associated with distinct neural networks: the attention network and the default mode network, respectively (Fox et al., 2015; Raichle, 2015). Typically, these networks function in opposition, with the default mode network activating during rest and mind wandering, while the dorsal attention network engages when focus is directed toward external tasks. While cooperation between these networks has been observed during complex cognitive activities requiring internal thought or creative problem-solving, such as musical improvisation (Beaty, 2015), it remains unclear whether the simultaneous experience of mind wandering and "total" attention can be fully explained at the neurocognitive level.

In a recent review, Høffding et al. (2024) presented a framework aimed at explaining the underlying mental processes of absorption and their associated subjective experiences. Drawing on their concept of ex-static absorption—a prime example of absorption's paradoxical nature—the authors propose the notion of "mind surfing" to better capture this phenomenon. In this mode of experience, attention "is not necessarily or singularly focused on the music but is attuned to or entrained by it" (p. 4). Similar to ex-static absorption and Herbert's concept of broadened and fluctuating awareness, mind surfing involves a dynamic interplay between focused attention and mind wandering, wherein "the listener or player remains attentive to both the process of musicking and to additional thoughts, feelings, or memories that are unintrusive" (p. 5).

The "unintrusiveness" of self-generated thought in mind surfing is particularly significant. Unlike classic instances of mind wandering, where self-generated thoughts are generally irrelevant and disruptive to the task at hand (Smallwood and Schooler, 2015), this form of "wandering" is perceived as a constructive and enriching cognitive feature in the musicking process (Høffding, 2018). We believe that in the context of expert musicianship, the ability to mind wander while playing likely stems from a training-induced optimization of executive processes (e.g., Pinho et al., 2014), which frees up cognitive resources for mind wandering (Palhares et al., 2022).

The concept of mind surfing highlights the limitations of traditional definitions of absorption—as discussed previously in relation to ex-static absorption—but also mind wandering. Research on mind wandering typically defines it as instances where the content of one's thoughts is unrelated to the primary task, consisting of spontaneous, stimulus-independent, or task-unrelated thoughts, feelings, or memories (Smallwood and Schooler, 2015). While this framework is useful for relatively simple laboratory tasks, where the "primary task" and the "task-relatedness" of thoughts are clearly defined, it fails to apply to more complex activities like musical performance. In such musical contexts, seemingly unrelated thought content (e.g., visual imagery, mental time travel) can exist in "causal loops with the sonic properties and meanings of the actual music, such that a particular imagination might change the quality of the tone, which again may lead to new imagery and so on" (Høffding et al., 2024, p. 6). Additionally, we note that given music's inherently embodied nature (Newen et al., 2018), the "spontaneous, stimulus-independent" aspect of mind wandering is also problematic, as no form of cognitive processing operates entirely disembodied or independent from stimuli arising within the body via interoceptive input and proprioception.

In response to these complexities, Høffding et al. (2024) proposed a model of musical attention based on two fundamental aspects: intensive attention and selective attention (see Fig. 1). This model differentiates mind wandering into two distinct states within the weak attentional allocation spectrum: one where attention is decoupled from musicking and engaged in internal thought unguided by the music (*decoupled*), and another where attention fluctuates between musicking and equally unguided internal thought (*unguided*). Within the strong attentional allocation spectrum, *focused mind* corresponds to classic instances of absorption (e.g., zoning-in, absorbed not-being-there), while *mind surfing (guided)* represents the optimal mode of experience, where focused attention and mind wandering mutually reinforce and enrich each other.

By moving beyond the dimensions of task-relatedness and internal/external allocation of attention (as in Smallwood and Schooler, 2015), this taxonomy better accommodates complex activities where being "on-task" may be difficult to define. Additionally, by prioritizing the dynamics of thought over its content, this model aligns with the Dynamic Framework of Thought (Christoff et al., 2016; Girn et al., 2020) (see Fig. 2), which offers an empirically grounded and more reliable approach to capturing spontaneous thought phenomena by acknowledging the inherently dynamic nature of consciousness, unlike previous models that rely on a static taxonomy of mental states.

## 5. The case of musical improvisation and creative though

Considerable literature addresses musical improvisation's ability to illustrate creative cognition, particularly in a manner suitable for neuroscientific examination (McPherson and Limb, 2013). And indeed, neuroscience of creativity often relies on musical improvisation paradigms to explain functional and mechanistic aspects of creative cognition (Beaty et al., 2016). However, little attention has been given to the subjective experience underlying creative acts, creating a gap between brain processes and subjective experiences. Creative thought, the consciousness accompanying acts of creativity, is relatively understudied compared to other forms of spontaneous thought (Kucyi et al., 2023; Smallwood and Schooler, 2015). This limits the ability of neuroscientific findings to predict and explain conscious experiences. Addressing this requires analysing the structures and configurations of creative thought across variegated empirical observations.

In this section, we will explore the concept of creative thought and argue that musical improvisation is an ideal test case for studying the consciousness of creativity. Finally, we will review recent research that enhances our understanding of creative thought through musical improvisation paradigms.

### 5.1. The notion of creative thought

CT is unique among spontaneous thought phenomena because it dynamically shifts between extremes of cognitive control. On one end, reduced cognitive control allows for highly spontaneous idea generation. On the other end, increased cognitive control enables critical evaluation of these ideas and constrains creative expression towards achieving an intended goal. Additionally, the nature of the creative task often involves strong automatic sensory-affective constraints, as idea evaluation frequently relies on intuition and emotional reactions (see Fig. 2).

The dynamic interplay between generative and evaluative processes during creative thought (CT) implies that the subjective experience of this state is equally dynamic and unstable. This variability expands the taxonomy of CT, which can phenomenologically resemble goal-directed thought, mind-wandering, or even obsessive thought, depending on the context and time frame (Girn et al., 2020). Still, while CT may appear heterogeneous over short periods, it presents a distinguishable neural and phenomenological profile when viewed from a broader perspective (Beaty et al., 2016; Christoff et al., 2016). However, scientific focus on the latter remains limited, possibly due to the perceived lack of rigorous methods to capture the complexity and dynamics of such states of consciousness fully.

Indeed, CT's spontaneous nature renders it elusive and challenging to study empirically in a controlled manner. Furthermore, considering the various stages of the creative process—problem definition, knowledge acquisition, information gathering, incubation, idea generation, combination, selection, and externalization (Sawyer, 2012) — CT does not emerge continuously or equally across all stages. It is one of many

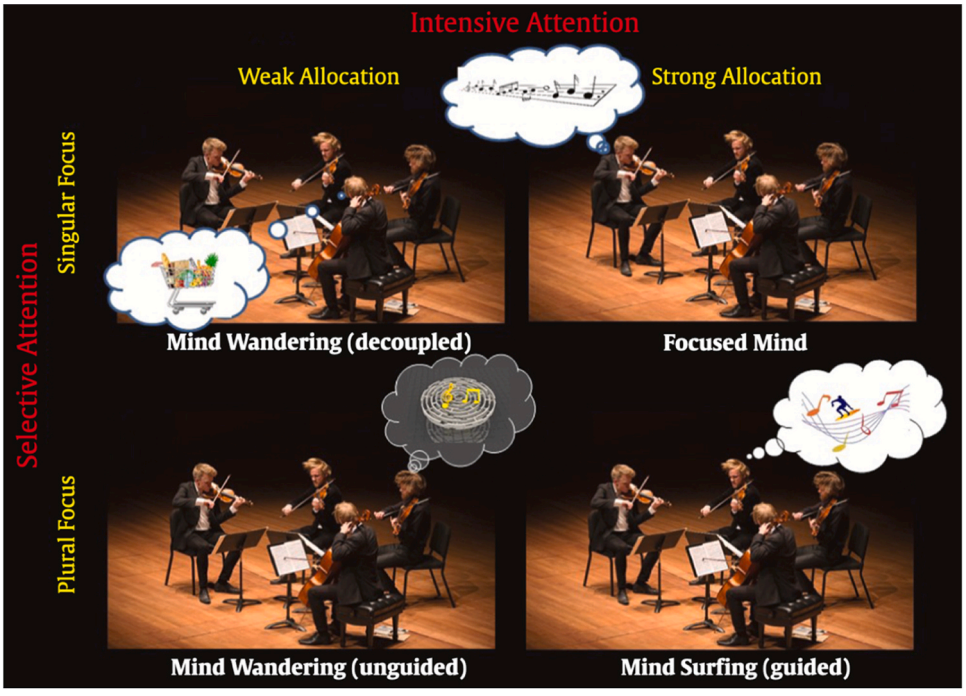


**Fig. 1.** Høffding et al. model of musical attention. *Note.* From "Mind surfing: Attention in musical absorption" by S. Høffding, N. Nielsen and B. Laeng, 2024, *Cognitive Systems Research, 83*, 101180, p. 7. CC-BY 4.0.

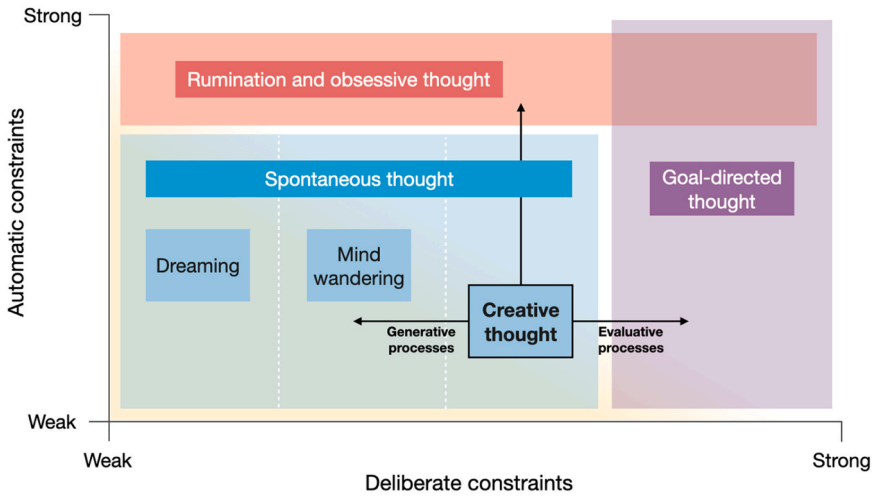


**Fig. 2.** The Dynamic Framework of Thought (revised). *Note.* Deliberate constraints refer to the degree of cognitive control. Automatic constraints refer to mechanisms that operate outside of cognitive control, including sensory and affective salience. Girn et al., (2020), *NeuroImage, 213*, 116726.
(a) Adapted from "Updating the dynamic framework of thought: Creativity and psychedelics", by M. (b) Copyright 2020, with permission from Elsevier.

possible states involved in externalizing a creative product, with goal-directed thought likely dominating earlier stages and moments of planning and revision in later stages.

In summary, CT is fundamentally defined by its dynamic profile and the perceived goal-directedness of its shifts. Unlike simpler states like absorption, which can be identified by specific perceptual and content-based aspects of subjective experience, CT is too broad a construct to be reduced to particular experiences. It is more appropriately regarded as an overarching state that encompasses sub-states such as flow, absorption, and certain forms of mind-wandering, goal-directed thought, and obsessive thought.

We argue that musical improvisation, particularly in jazz, provides an ideal test case for the neuropsychological study of CT for three main reasons:

(i) With acts of improvisation impelling the experimental subject to conceive and realize, essentially at once, their musical composition, the emerging state of mind across the entire performative act will necessarily be one of CT, whereby all stages of the creative process occur simultaneously.
(ii) Musical improvisation offers substantial flexibility in experimental design, allowing researchers to analyse CT across various experimental conditions.
(iii) The intrinsic temporality of sound and musical performance provides continuous sonification of cognitive processes, enabling real-time analysis of the relationship between neural and phenomenological processes across multiple timescales and parameters.

### 5.2. *Improvisational state of mind as a model for creative thought*

In Western societies, improvisation is most commonly associated with jazz, where it is a fundamental and omnipresent element. Although non-Western music traditions, such as Indian, Indonesian, Middle Eastern, and African, are equally rich in improvisatory practices (Nettl, 1974), neurocognitive research on musical improvisation has predominantly focused on jazz (Beaty, 2015). This emphasis likely arises from jazz's large global community of contemporary improvisers and its suitability for experimental research, owing to its foundation in a notated system from which improvisation departs. The present section draws primarily on findings from these studies.

Musical improvisation is an acquired skill of artistic expression and is often considered one of the most complex forms of creative behaviour. Unlike notation-only based performance, such as mainstream Western classical music, improvisation requires greater creative effort, involvement, and risk-taking by the performer (Nettl, 1974). Classical performance, while nonetheless a creative act, typically emphasizes strict and accurate adherence to a written score, minimizing spontaneous and improvisational elements (Creech et al., 2008).

Improvisation involves the spontaneous generation of new musical ideas—notes, motives, harmonies, rhythms, and structures—on a relatively fast timescale within a performance, aiming to produce novel and aesthetically pleasing music (Pressing, 1988). Cognitively, this entails a complex interplay between generative and evaluative processes. Generative processes support the broad, spontaneous, and fluid creation of musical ideas, while evaluative processes guide and focus their implementation in a contextually appropriate and goal-directed manner (Beaty, 2015).

Proficient improvisation, as opposed to beginner-level improvisation, relies less on conscious monitoring and deliberate cognitive constraints (Pinho et al., 2014). Instead, it features a predominance of automated, non-conscious, and associative processes (Limb and Braun, 2008; Rosen et al., 2016, 2020). This efficiency in executive control processing allows proficient improvisers to engage in creative thought (CT) at will, aligning with the conceptualization of creativity as a distinct, trainable mental state (Lopata et al., 2017).

The phenomenology of the improvisational state of mind reflects similar dynamics to the cognitive processes involved—subjective experiences characterized by free yet non-random movement, goal-directedness, and fluency in thought content (Dolan et al., 2013, 2018; Norgaard, 2011; Sawyer, 2006). This improvisational state of mind exemplifies CT, where generative and evaluative processes continuously interact and overlap, operating under decreased cognitive control.

The subjective experience of improvisation, or the improvisational state of mind, is closely related to the concept of flow. Flow is a state of total involvement in a task, characterized by enhanced creativity, intrinsic motivation, well-being, altered awareness (e.g., altered perception of time), effortless control, and attentional focus, along with clear goal definition (Csikszentmihalyi, 1990). In jazz improvisation and musical performance, flow describes the peak experience of performing at one's best, often referred to as "being in the zone" (Noy et al., 2015; Sawyer, 2006). Vervaeke et al. (2018) expand on Csikszentmihalyi's descriptions by explaining the mechanisms that lead to the experience of flow, conceptualizing it as a "self-perpetuating insight cascade—an extended 'aha!'" and a prototypical instance of spontaneous thought

within the CT landscape.

In sum, musical improvisation reliably instantiates CT in proficient improvisers, equating to the improvisational state of mind—the subjective experience in acts of improvisation. Flow, on the other hand, is a state of consciousness subsumed by CT phenomena, representing a more structured mode of experience that emerges during peak improvisatory performance.

### 5.3. Research problems

Having established the conceptual foundations of improvisational experience, we now turn to the major research challenges in this area. It is increasingly evident that improvisation offers considerable heuristic potential for studying altered states of consciousness. Among the various constructs of conscious experience during improvisation—such as absorption, mind wandering, and broader concepts like creative or spontaneous thought—the phenomenon of flow stands out. Flow has been extensively reported in the context of musical performance across multiple genres and cultures (Chirico et al., 2015; Tan and Sin, 2021). Many researchers claim that music is particularly conducive to flow due to its universal ability to sustain intrinsic motivation, a key driver of the flow state (Csikszentmihalyi, 1990).

However, most quantitative studies on flow (93 %, as of 2019; Tan and Sin, 2021) rely on retrospective self-report measures rather than empirical observation of flow states during performance. This limitation also applies to other states or aspects of conscious experience. Such an approach overlooks the significant advantage of musical research paradigms: their compatibility with naturalistic research methods and direct observation of phenomena.

This situation presents several research problems that warrant further investigation through on-site and real-time neuropsychological experiments, including:

- **Structure of Flow Experience**: What is the inner structure of the subjective experience of flow? This includes understanding the connectivity between dimensions of flow and the relative importance of each dimension in maintaining the flow state.
- **Impact of Improvisational State**: How does the improvisational state of mind shape, and how is it shaped by, ongoing musical performance?
- **Shared Musical Experience**: How is musical experience shared between musicians in collaborative group performances, or communicated to listeners? How are these shared experiences influenced by the social relationships between ensemble members?
- **Sociodemographic and Expertise Factors**: How do sociodemographic factors and musical background/expertise relate to a musician's experiential profile during improvisation?

By addressing these research problems through more direct and real-time methods, we can gain a deeper understanding of the complex dynamics of improvisational experience and its implications for the study of consciousness.

### 5.4. Musical improvisation as a privileged test-case for creative thought

Musical improvisation, uniquely underpinned by the temporality of music and sound, offers a valuable window into the phenomenological, neural, and physical aspects of creative thought (CT) and subjective experience. We argue this to be true for the reasons that follow.

#### 5.4.1. Ubiquity of creative thought in musical improvisation

Proficient improvisation, with its sensory-motor complexity and temporal demands, inherently involves real-time risk-taking and spontaneity. This necessitates continuous engagement in CT throughout the improvisational act, typically unfolding over short time frames (seconds to minutes). This temporal immediacy inherent to music-making distinguishes musical improvisation from other forms of creative expression occurring at longer time frames (e.g., prose writing, visual arts), where a relative lack of temporal constraints configures a creative process that can afford moments of deliberate reflection and revision of previous outputs, thus raising the probability of inflow of a wider panoply of states like intentional goal-directed thought, task-related interference and mind wandering.

#### 5.4.2. Continuous sonification of cognitive processes

Musical improvisation unfolds in a continuous temporal stream, providing an observable behavioural output (musical performance itself) that co-occurs with CT. This allows for real-time analysis of the relationship between behaviour, subjective experience, and neural/physical correlates across multiple timescales—ranging from microstructures (phrases and note sequences) to macrostructures (complete compositions). Unlike other forms of creative expression, where the externalization of creativity occurs in discrete moments, musical improvisation continuously sonifies cognitive processes, making them more accessible to empirical investigation.

#### 5.4.3. Flexibility in experimental design

Jazz is both highly flexible and grounded in clear conventions, creating a semi-structured environment for performers that makes it ideal for accessible, ecologically valid research on CT, where various performance aspects can be controlled and manipulated:

- **Musical Parameters:** These include key, mode, tempo, meter, and duration. Musical prompts can be shaped so as to pose different levels of familiarity (e.g., well-known or pre-learned jazz standard vs relatively unfamiliar chord progression) and specific task constraints (e.g., note choice constrained melodic improvisation vs free improvisation; e.g. Da Mota et al., 2020). With familiarity and task constraints highly affecting the performer's level of deliberate cognitive constraints musical prompts can thus be shaped to induce different forms of CT across the spectrum of cognitive control.
- **Social Dynamics:** Improvisation often occurs in group settings where musicians engage in rich collaborative and interactional dynamics. Much like in conversation, roles like *leader* and *follower* spontaneously emerge, and these roles can shift seamlessly among different members of the group (or be artificially manipulated in an experimental setting; e.g., Sänger et al., 2012). This process plays a major role in shaping individual, and even collective musical experiencing (Bishop, 2018; Sawyer, 2006).
- **Explicit Instructions:** Goal activation through instructions to "be creative" can up-regulate cognitive control, as shown in studies where instructions enhanced musical creativity, especially among less experienced musicians (Rosen et al., 2017).
- **Participant Expertise:** Expertise significantly impacts the balance between deliberate and automatic cognition during improvisation. More experienced musicians achieve a near-optimal balance, relying less on deliberate cognitive control.

In summary, musical improvisation, especially in jazz, offers a unique and effective paradigm for studying CT due to its inherent spontaneity, continuous observable output, and flexibility in experimental manipulation. As McPherson and Limb (2013) suggest, while the specific creative output cannot be predicted, the process of being creative can be reliably replicated in experimental settings, allowing for in-depth exploration of spontaneous cognition.

### 5.5. Contributions of jazz improvisation investigations to consciousness research

#### 5.5.1. Flow

In a recently published paper, Rosen et al. (2024) sought to clarify the theoretical basis and role of flow in creative acts, since flow has been

disparately conceptualized as either a state of *optimized task-specific processing* or as a state of *heightened domain-general associative ideation.*

The former notion posits that flow results from the efficient recruitment of domain-specific functional brain networks, often honed through extensive practice. This process involves optimal cognitive control over task performance—specifically, the ability to maintain top-down attention on relevant stimuli and goals while minimizing the impact of task-irrelevant elements. This control is typically reflected by decreased activity in the default mode network (DMN) (Harris et al., 2017b). Phenomenologically, this would manifest as effortless, focused attention that is insulated from distracting stimuli and thoughts. However, it is important to note that while flow is often experienced as effortless, studies have revealed a dissociation between subjective and physiological measures of attentional effort, suggesting that flow involves efficient yet effortful engagement of attention (Harris et al., 2017b, 2017a).

An alternative perspective views flow as a domain-general process characterized by fluent associative ideation, supported by increased task-related DMN activity (cf. Beaty et al., 2016; Limb and Braun, 2008). In this model, the fronto-parietal control network (FPCN) oversees DMN-driven creative ideation, maintaining a loose task focus. Subjectively, this would be experienced as a hyper-associative state with a broader sense of awareness and highly spontaneous thought content.

Rosen et al. (2024) developed a live jazz improvisation paradigm to examine the relationship between the subjective experience of flow, musical performance, and electroencephalographic (EEG) brain activity. Musicians' EEGs were recorded as they improvised to specific chord progressions, after which they reported their subjective experiences of flow.

Results partially supported the conceptualization of flow as a state of optimized, task-specific processing, showing a flow-related deactivation of DMN regions in experienced musicians. This finding challenges the notion of creative flow as a state of DMN-mediated, domain-general divergent thinking, suggesting instead that flow may be more accurately described in terms of optimal top-down attentional control.

Interestingly, while the intensity of flow was associated with higher subjective ratings of creativity (self-rated), it did not correlate with objective measures of creativity (judge-rated), echoing the dissociation between perceived and objective effort observed by Harris et al. (2017a). This suggests that the relationship between flow experience and creative behaviour is complex and warrants further investigation.

#### 5.5.2. Mind wandering and musical creativity

In another study, Palhares et al. (2022) used a similar experimental paradigm to explore how focused attention and mind wandering modulate musical creativity during improvisation. Unlike Rosen, they employed real-time thought probes, which allowed for more valid assessments of subjective experience. Their findings suggested that musicians improvised more creatively during instances of mind wandering compared to focused attention.

Indeed, mind wandering is thought to positively modulate creativity by increasing pre-conscious associative processing (Baird et al., 2012; Leszczynski et al., 2017). However, this only applies when mind wandering occurs during the incubation period of a creative problem-solving task (i.e. a period of reflection or break in task performance). In contrast, if it occurs during task performance itself, mind wandering becomes disruptive, seemingly decreasing creative ideation by interfering with cognitive processes like working memory and sustained attention (Hao et al., 2015). Palhares et al. finding that mind wandering has a real-time positive effect on musical creativity suggests that this relationship may be more complex than previously thought, one where artistic creativity could pose a more nuanced view of creative thought processes, compared to laboratory-based standardized creative tasks.

#### 5.5.3. Improvisational state of mind (ISM)

The improvisational state of mind (ISM) refers to a distinct mental and neural configuration maintained during improvisatory performance. According to the Entropic Brain Hypothesis (Carhart-Harris et al., 2014), ISM is an altered, primary state characterized by higher entropy and pattern complexity in neural activity. This state has been observed in both performers and audience members during improvisation (Dolan et al., 2013, 2018).

Dolan et al. experimental approach (2013, 2018), focusing on classical musicians adopting an improvisatory approach to the performance of classical/composed music (i.e. performative spontaneity that is not centred necessarily on *what* notes are being played, but *how* these notes are being given expression, spanning aspects like timing, dynamics, timbre and accentuation), offers a novel way to study ISM. This approach allows for the same piece of composed music to be performed either through strict notation-only based performance or an improvisatory approach - effectively solving on of the biggest caveats of jazz improvisation research, which is the lack of a natural baseline condition to compare improvisatory performance with - and thus significantly enhancing the validity of their findings.

Also, this paradigm was inserted in a "concert-experiment" setting, whereby the experimental task was seamlessly embedded in a public concert, further adding to the ecological validity of this investigation. Such endeavour has been independently advocated by Høffding (2023), who recently outlined a methodological design for a "phenomenology in concert" (p. 11) approach to conscious experience, based on the previously mentioned Phenomenological Interview (see Section 4.3.2) in combination with physiological measures, namely heart rate synchronization or pupillometry.

### 5.6. Methodological challenges in improvisation research

When conducting research in musical improvisation settings, one major challenge is balancing reproducibility, control, and ecological validity (McPherson and Limb, 2013). Studies that prioritize reproducibility often limit improvisation to solo performances of short melodies or specific tasks (e.g., using a restricted set of notes; Berkowitz and Ansari, 2008). This controlled approach facilitates larger sample sizes and standardizes conditions, enabling meaningful inter-individual comparisons and higher statistical power. As a result, this method is commonly employed to identify the neural correlates of improvisation and creativity (Beaty, 2015). However, the stringent constraints imposed on musical performance can inhibit full engagement of creative thought and spontaneity, which are intrinsic to improvisation. This limitation is particularly pronounced in neuroimaging studies that require musicians to perform in highly unnatural environments (e.g., fMRI), where embodied cognition and motor memory—fundamental aspects of improvisational proficiency (Pressing, 1988)—are compromised.

On the other hand, studies aiming for maximum ecological validity often take the form of multiple case studies (e.g., Norgaard, 2011; Sawyer, 2006). These studies allow musicians, whether solo or in groups, to engage in more natural, extensive, and open-ended improvisation, thus enhancing the ability to empirically capture the improvisational state of mind. However, this approach presents significant challenges in terms of replicability and generalizability. Without task constraints, it becomes increasingly difficult to control for variables such as tempo, duration, difficulty, and other sonic properties and expressive elements that emerge during each improvisation. Despite these challenges, this method can be invaluable for gaining in-depth insights into complex consciousness phenomena and laying the groundwork for more extensive future research.

Recent studies by Rosen et al. (2024, 2020) and Palhares et al. (2022) illustrate a balanced approach by constraining performance in a way that allows for both control and ecological validity. They prompted proficient musicians to improvise freely but within the framework of pre-stipulated and novel chord progressions. Performance was controlled for tempo, duration, difficulty, and training effects by having

musicians improvise on the spot along with a backing track. This approach is particularly advantageous for neurocognitive studies, especially when using methods that do not heavily compromise elements of embodied cognition and motor memory, such as EEG.

## 6. Group performance: emergence, shared experience, and inter-synchronization

Our cognition and consciousness evolved in interpersonal contexts, yet most studies focus on individuals. Group musical performance, especially improvisation, offers a valuable tool for studying group phenomenology, social psychology, and neuroscience, along with physiological and physical markers of group behaviour.

Group musical performance can be understood through joint action (Keller et al., 2014) and interpersonal synchrony (Mogan et al., 2017), involving coordination towards shared goals. Studies in joint action in music, in particular those employing the novel field of *neural hyper--scanning*, have revealed important insights into the neurophysiological and psychological mechanisms for interpersonal coordination in real time (Keller et al., 2014), including inter-brain synchronisation (IBS) (Gugnowska et al., 2022; Lindenberger et al., 2009; Sänger et al., 2012), as well as the relationship between self and other (Novembre et al., 2016).

Improvisation, with its distinct conditions (e.g., listening, performing prepared pieces, improvising), has allowed for systematic comparisons of underlying neural mechanisms. For instance, distinct patterns of higher IBS in the gamma band emerge uniquely in group improvisation (Gugnowska et al., 2022).

Improvisation also facilitates the study of real-time communication, cooperation, and problem-solving. Leader-follower dynamics can be analysed through body movements (Chang et al., 2019) or neural activity (Wan et al., 2014), either controlled experimentally or emerging from interactions. Research extends beyond dyadic relationships, exploring group behaviour in larger ensembles and audience interactions (Brand et al., 2012; Nozawa et al., 2023), highlighting the embodied nature of musical experience (Tschacher et al., 2023).

In sum, the study of musical improvisation supports an interdisciplinary research framework combining phenomenology, neuroscience, psychology, cognitive science, and performance analysis. This approach probes the emergence of complex social behaviours, including cooperation and co-creation, and the development of collective states of mind or shared experiences (Pacherie, 2017).

## 7. Concluding remarks: a musical exploration of consciousness

In conclusion, despite the continued emergence of music-related investigations into consciousness, their research paradigms remain on the fringes of consciousness research, with their broader contributions often overlooked. However, in this narrative review, we have aimed to address this gap by offering a twofold contribution. Firstly, we have highlighted and critically analysed key contributions of music research to deepen our understanding of non-ordinary states of consciousness, emphasizing the broader significance of exploring consciousness through music. Secondly, we have identified the unique aspects of music that offer special insight into consciousness and discussed how these aspects can shape future investigations.

Our exploration began with the deepening of our understanding of absorption and mind wandering states through everyday music listening and expert musicianship research, as well as the exploration of music's universal capacity to captivate individuals. These contexts of musical experiencing offered a distinct perspective on the dynamic and multifaceted nature of consciousness, fostering a departure from traditional, rigid taxonomies of absorption and mind wandering. We then delved into the study of creative thought, particularly through musical improvisation, elucidating the relationship between creative thought and improvisational expertise, and identifying research problems addressable through improvisational paradigms. Moreover, we discussed how improvisation serves as a privileged test-case for studying creative thought and highlighted its potential in providing insights into flow, mind wandering, and the improvisational state of mind. Finally, we examined musical group performance as a means to understand group phenomenology and social psychology, particularly through phenomena like inter-synchronization.

Overall, our review underscores the importance of integrating music into consciousness research and highlights avenues for future exploration in this interdisciplinary field. We encourage researchers to adopt musical paradigms not only for their accessibility but for their ability to reveal the richness and complexity of consciousness in ways that other stimuli cannot.

## Declaration of Competing Interest

I have no known conflict of interest to disclose.

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