C9 CHAPTER 9

MUSIC, EVOLUTION, AND THE EXPERIENCE OF TIME

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C9.P1 'Music' is both the observable product of intentional human action and a basic mode of thought by which any human action may be constituted. The most characteristic and effective embodiment of this mode of thought is what we call 'music' but it may also be manifested in other human activities, and even in the organization of verbal ideas, such as Martin Luther King's famous 'I have a dream' speech or the poetry of Gertrude. (Blacking 1995: 224–225)

C9.P2 Time and measure are to instrumental Music what order and method are to discourse; they break it into proper parts and divisions, by which we are enabled both to remember better what has gone before, and frequently to foresee somewhat of what is to come after: we frequently foresee the return of a period which we know must correspond to another which we remember to have gone before; and according to the saying of an ancient philosopher and musician, the enjoyment of Music arises partly from memory and partly from foresight. (Smith 1980[1777/]: 204)

C9.P3 I think I have an idea of where I'm going and then I think [. . .] for each tone you play, you could say it such that time was a long, long line and you had a lot of points on the line [. . .] so for each point you advance, then [. . .] it gives [. . .] it will give the premise for where the next point would be because the tone itself in a sense defines the next tone and so on because otherwise the phrase becomes unnatural. And therefore you're really in the tone you're really on and then it kind of gives itself how the next tone will become [. . .] You need a smooth [development] and therefore each tone, each and every vibrato, each and every oscillation, bowing, phrasing, everything builds towards how it is going to become and it is impossible to predict how it will play out. It depends on what you laid as ground. (Fredrik Sjölin (cellist), quoted in Schiavio and Høffding 2015: 13)

C9.S1

Introduction

C9.P4 Something we would describe as 'music' is widespread and ubiquitous across history and cultures. It is, overwhelmingly, an active integral part of human experience and reality. It is individually and collectively embodied as well as being socially reflective and generative. Its meaning and significances necessarily emerge and project in symbiosis with culture, the intricacies of interaction, and the individual experience from which they are born (Cross 2003). Consequently, contrasting physical manifestations of music can appear to reveal little, if any, definite and observable common ground. Beyond an appreciation of basic levels of surface structure, neither practical nor analytic musical skills translate across divides of cultural style, immersion, and learning. Music can only ever be appropriately and fully heard, felt and understood with a corresponding practice, knowledge, and experience of its complex histories, values, conventions, institutions and technologies (see Cross 2001). Nevertheless, as something like music appears from our cultural vantage point to be recognizable as such across cultures (Blacking 1995), it is logical to assume that some identifying features or distinct conglomerations of features are commonly present.[1] It is, furthermore, consistently functional in common social settings and contexts. In countless and multifarious practices and performances of music across time and geographical divides, we find music to be functioning in regulating emotional, cognitive, and physiological states; mediating between 'self' and 'other'; representing cultural symbolisms; and/or coordinating individual, dyadic, or group actions (see Clayton 2016; Nettl 2010). Any notion, perhaps inspired by recent cultural and technological quirks, of music as something distinct, pure/autonomous, or as a commercial product is highly problematic, and certainly fails to provide a generalizable account of music and the shared roots of our human capacity for music (Bispham 2012). Our experience with music and its situated efficacies is inextricably interwoven with the full mosaic of our evolutionary past, our fundamental psychology and physiology; cultural and individual histories; most central prosocial drives; and artistic motivations to express and create.

C9.P5 Crucial to the further course of argument in this chapter is the consideration that many, if not most, of music's seemingly integral and most significant features are—perhaps extended or abstracted—but certainly not unique to music. They are seeded in common predispositions and ontogenetic trajectories, manifest in our earliest developmental explorations and are dynamically shaped throughout our lifespans. Fundamentally in *all* physical movement and interaction we are continually creating rhythmic and quasi-melodic shapes, sensing, engendering, and expressing our individual and collective vitalities (see Stern 2004; 2010). In terms, at least, of semantically describable categories of emotion, music seems to share with vocal communication in general a common 'code' or set of cues (Juslin and Laukka 2003). Physical posture and gesture too are inextricable parts in any fully manifest and successful communication (Kendon 2004), with joint actions and moments of synchronicity providing empathic attunements and generating points of agreement and accord (Gill 2015). Mutually negotiated intrinsic motive pulses (Trevarthen 1999) and tonal synchronies (Van Puyvelde et al. 2015) provide coordinative frameworks for interpersonal interaction, intersubjectivity, attachment, participatory sense-making (De Jaegher and Di Paolo 2007), and the regulation of affect in parent–infant dyads and beyond (Stern 1985; 2009). In oratory and/or poetry, dynamically generated expectancies and accents can add credence and persuasiveness (Woodall and Burgoon 1981), while metre and cadence can allow emphasis, subvert expectations, highlight changes in mood of interpretation, and/or aid in mnemonic retention. Additionally, broad analogies of combinatoriality, embedded structure, implicitly acquired 'grammars', and recursion in music and language show further overlap in terms both of macro design, organizational principles and of the cognitive mechanisms of learning and working memory in particular that afford them (see Rebuschat et al. 2011).

C9.P6 The full human capacity for music is clearly an intricate, interwoven, and phylogenetically emergent mosaic (see Foley 2012; 2016) overlapping in scope and relevance with all of the above. It is the result of a complex evolutionary history of continuous and cumulative change. Each initially random mutation will have been assembled gradually upon pre-existing biology and genetic coding, and will have endured for specific reasons and in response to particular environmental and social pressures. Regardless of continuing debates concerning the specifics, it is demonstrably a critical constituent part of our species and essential to a full understanding of hominid evolution. Consequently, music is embedded in afferent and efferent connections with more primary processes—our most foundational and central kinaesthetic, vocal, affective, and socio-intentional drives and capacities. Its many regulatory, affective, and psychodynamic effects and functions are contingent upon the whole and the gregiological process of our species' past.[2] Most notably for the current concerns in this book, a full account of music is necessarily contingent upon an appreciation of the perception of time and the most central sensations of being in time. Even in trying to describe the basic building blocks of a 'simple' musical pulse, for example, we are, from the outset, reliant upon describing mechanisms that serve as reference points in the continuity of action in time (e.g. Thaut 2005; 2015) and form our essential understanding of the flow of life events and phenomenological experience. The following sections of this chapter will, therefore, offer a brief review of some of the more pertinent psychological facets of our experience of time in relation not only to musical pulse but also to musical tone and musical motivation. These will focus, in particular, on describing features that are particular to music, and will propose that specific features of the human capacity for music are most directly concerned with affording a form of sustained attention— a continuous linking between the immediate future, the perceptual present, and future expectation. Although pulse may initially appear to have the most direct relevance to this perspective and to the structuring of time in music,[3] it is key to the argument presented here that the intrinsic nature and specificities of engaging with a musical pulse *and* musical tone and musical motivation are all concerned essentially with crafting an extended experience in action and time—a musical moment.

C9.S2

The Experience of Time

C9.P7 Reflections on time and experience are, of course, long-standing and highly complex. Over 2000 years ago Aristotle deduced the continuity of time—its infinite divisibility—from the continuity of motion. This, in turn, was deduced from the continuity of the space negotiated by any moving object. Time here is, as Gale describes, 'made continuous by the indivisible, present-now moment, which links the past to the future by serving as the termination of the past and the beginning of the future' (1968: 1). This is only the starting point of intense philosophical debates, straddling our central understandings of physics and psychology, which goes considerably beyond the current scope of discourse in this chapter.

C9.P8 From a psychological perspective we can understand Gale's description of the experienced continuity of time, in conjunction with our fundamental nature, allowing us to perceive temporal ranges as being simultaneous, sequential, flowing/happening, present, experienced, and/or anticipated. Wittman and Pöppel (1999), for example, describe three basic temporal experiences––simultaneity, non-simultaneity, and temporal order––and have suggested that the temporal processing of sequential information can be classified into four temporal ranges. Their description of the types of temporal order and the timespans involved has stimulated some discussion and refinement (see Block and Gruber 2014). However, the shortest two have been accepted as being pretty clear and uncontroversial (see Eisler et al. 2008): Between 0 and 2 ms, simultaneous and non-simultaneous events are perceived to be simultaneous (Hosokawa et al. 1981; Moore 1993), whereas events separated by 2/3 ms–20/40 ms create the impression of non-simultaneity even though the temporal order of events cannot be confidently or unerringly distinguished (Hirsh and Sherrick 1961; Lotze et al. 1999). In their review, Block and Gruber (2014) follow with timespans of roughly 30–3,500 ms in which events appear as a changing present—there is an experience of time flowing and experience happening. This has been supported, for example, in paradigms of film-frames/snapshots being presented at increasing interstimulus intervals (e.g. men walking and bread being toasted (Gruber and Block 2013)). Participants generally report that the flow of time starts to get lost at about three seconds and has completely disappeared by seven seconds. In the same study, subjects were also presented with the first four notes of Beethoven's fifth symphony; participants no longer recognized the opening phrase at an interstimulus interval above three seconds, and also reported that it did not sound like music. This all fits well with earlier research arguing that three seconds is a time constant in perceptual tasks representing a central neural mechanism that functions to integrate successive events into a 'gestalt' in order to create a 'subjective present' (Pöppel 1973; 1978). Pertinently for our concerns, it is within this temporal range that repetitive isochronous events have been shown to easily build perceptual expectancies towards future events (Jones 1976; Jones and Boltz 1989) and in which musical pulse is predominantly operational (see London 2012). Repp (2005: 973), for example, summarizes that the comfortable lower and upper inter-onset-intervals limits in tapping tasks (roughly from 100–170 ms to 1,800–3,000 ms (Bolton 1894; Fraisse 1982)) are musically relevant, in that they coincide approximately with 'those within which a sequence of events can be perceived to have rhythmic and metrical structure'.

C9.P9 Overlapping considerably with the three-second timespan is the notion of the 'specious present' (James 1890/1950) or 'living present' (*lebendige Gegenwart*: Husserl 1991). In the simplest sense this is a subjective experience of 'now'—of the 'present moment'. James's original estimate for this phenomenon was that it varied in length from a few seconds to 'probably not more than minute' (p. 642). Block and Gruber's review concludes that subsequent research suggests a time interval of about *three seconds to, arguably, about seven seconds*, 'during which the brain can compare and analyze very recent high-density memories in working memory' (p. 130). James famously describes that 'the practically cognized present is no knife-edge, but a saddle-back, with a certain breadth of its own on which we sit perched, and from which we look into two directions into time' (p. 609). Further on, he states that 'its content is in a constant flux, events dawning into its forward end as fast as they fade out of its rearward one [. . .] meanwhile the specious present, the intuited duration, stands permanent, like the rainbow on the waterfall, with its own quality unchanged by the events that stream through it' (p. 630). This idea that this 'present' enables our awareness of change and sequence but is also itself a constant, invariable structural form of consciousness is also reflected in Husserl's characterization of the standing present (*nunc stans*). Husserl argues, however, that this is 'flowing' rather than static. He concludes: 'what abides, above all, is the formal structure of the flow. That is to say, the flowing is not only flowing throughout, but each phase has one and the same form' (1991: 118). As Dainton (2013: 391) summarizes, Husserl's characterization 'combines sameness—an 'absolutely abiding form'—with continual change and renewal [. . .] it is an invariant *structural* feature of our consciousness'.

C9.P10 Although the question of whether the processing of larger timing intervals is operated by similar or overlapping mechanisms is open (Gibbon et al. 1997), it is widely accepted that durations exceeding three to seven seconds involve an additional memory process that link moments that passed with the present (Fraisse 1984). This further timing mechanism is thought to process the formation of perceptual gestalts by binding successive events in perceptual units of two to three seconds (Pöppel 1978; 1997; also see Pöppel and Wittmann 1999).[4]

C9.P11 It is certainly no coincidence that music and melody constantly provide an ideal example in philosophical discourse on the binding of temporal experience (e.g. Husserl 1977). First and foremost, music is most fundamentally a form of structured action in time and provides an almost perfect archetype of James' famous 'saddle-back' quote. The significance of music's inherent features depends holistically and relationally on the shapes they create with what has come before and the further course that they inspire and suggest. As testified by the three quotations at the head of this chapter, we are not, at the time of musical immersion, primarily concerned with a mental representation of others, the communication of particular emotional states, or the complete acoustic outcome—the final 'portrait'. Instead, we are experiencing a moment—a psychological present that is constantly extended in relation to the timing, tuning, and dynamic form of the immediate past and corresponding future-directed expectations and the on-going generation of action and attentional focus. To my mind this suggests a critical question. Does music represent a paradigmatic example in our broad understanding of the experience of living in continuous time as is implied in the philosophical discourse referenced above? Or is there something distinct about the psychological mechanisms and phenomenological experience of time in music?

C9.P12 At first glance, evidence for shared timing mechanisms across communicative domains, modalities, perception and performance (Ivry and Hazeltine 1995), and even across species (see Meck 2005), may suggest the former. Although the precise nature of the central timing machinery—the 'internal clock'—has been the subject of a huge body of psychological modelling, experimental research, and debate (see Ivry and Schlerf 2008; Grondin 2014), fundamental abilities to perceive and interact with the temporal structures of the physical world and to direct our movements in time are certainly present in all higher-order senescent animals. Leading researchers working on comparative timing between species confidently state, for example, that 'humans share with other animals an ability to measure the passage of physical time and subjectively experience a sense of time passing' (Allman et al. 2014), and that 'an essential component of primate cognitive function is the ability to extract and represent temporal information from the environment. The quantification of the passage of time, in turn, is crucial to coordinate motor behavior' (Zarco et al. 2009). Furthermore, although models of dynamic attending (Jones 1976)[5] resonate strongly with models of musical time (see Jones 2016) and offer a clear explanatory model for the psychology of pulse in music (Large and Jones 1999), it is worth noting that the theory in itself seeks to explain our broad capacities to interact with the temporalities of our movements and environments rather than music specifically. Once again music, with its commonly increased levels of predictability and stability, has typically been presented as an ideal experimental testing ground and empirical paradigm for the theory, rather than as something intrinsically separate.

C9.S3 Musical Pulse

C9.P13 Evidence for a particular psychological manifestation of temporal structure in music does start to emerge in considering the distinction between relative/beat-based and absolute timing.[6] Neuroscientific and neuropsychological studies seem to strongly suggest a difference between beat-based and non-beat-based timing. For example, in response to rhythms that induce a beat compared to those that do not, the basal ganglia and supplementary motor areas are more active (Grahn and Brett 2007; Grahn and Rowe 2009). Conversely, during absolute timing perception and motor tasks the cerebellum is more active (Grube et al. 2010; Teki et al. 2011). Further support for a functional distinction comes from fMRI studies of processing material that can be interpreted either relatively or in absolute terms. McAuley et al. (2006) devised an interestingly ambiguous paradigmatic stimulus in which a periodic (600ms) beat is implied but not explicitly emphasized. This leads to contrasting reports from participants of either slowing down or speeding up at the end of a row of tones, thus indicating a difference in whether the sequence was processed in relation to the implied beat or in terms of more absolute interstimulus intervals. Crucially, both processes were equally effective: researchers found no evidence that duration-based timing was less accurate or precise than beat-based timing. Subsequent neuroscientific analysis (Grahn and McAuley 2009) supports the idea that different strategies are supported by cortical activation differences reflecting the engagement of different neural timing mechanisms.[7]

C9.P14 In active sensorimotor synchronization tasks (an experimental paradigm in which participants tap to match a range of metronomic and/or perturbed stimuli), we find further evidence for some specific capacity in engaging with a 'musical' pulse (Repp 2005; Repp and Su 2013; Stevens 1886). In stark contrast to studies of animal entrainment (Bispham 2006; 2018), this is a straightforward and absolutely universal skill in humans. Even individuals categorized as being 'amusic' (Ayotte et al. 2002; Peretz 2006; Peretz et al. 2002) typically show a normal ability to synchronize movement to the beat of popular dance music as well as potential for improvement when given a modest amount of practice (Philips-Silver et al. 2013). In the one reported case of 'beat-deafness', the individual in fact showed near-normal synchronization with a metronome, suggesting that his deficit was concerned with finding the beat in music (Philips-Silver et al. 2011) rather than sensorimotor synchronization per se. Typically this ability is developed by the age of 4–6, with age-specific entrainment regions evidently narrower in childhood and late adulthood than in midlife (see McAuley et al. 2006). ERP studies would appear to suggest further that the neurological foundations of beat induction and corresponding future expectation are innately manifest (Winkler et al. 2009).

C9.P15 Another crucial distinction in the attempt to describe the particular psychological manifestation of temporal structure in music is between phase and period correction mechanisms. Sustaining regular sensorimotor synchronization with other musicians or even with an artificially isochronous pulse (such as a metronome) requires some forms of corrective mechanisms. Without these, timing errors due to motor and/or internal timekeeper variance (Wing and Kristofferson 1973) would simply accumulate and lead to a loss of synchrony (Hary and Moore 1985). In tapping with another human or in a musical setting, we are constantly exploring and reacting to further voluntary and involuntary fluctuations due to features of individual style (Collier 1996; Collier and Collier 2002) as well as expressive and structurally motivated modulations of tempo and microtimings (e.g. Iyer, 2002). Studies using experimentally controlled perturbations to the target stimuli have provided a wealth of data and have been interpreted with regard to two principal models of error correction mechanisms: dynamic systems theory (e.g. Schöner and Kelso 1988) and information-processing theory (e.g. Vorberg and Wing 1996). Each case represents extensions of more general models of dynamic attending (see above) or linear timekeeping (Wing and Beek 2002). Regardless of theoretical stance, two interacting yet behaviourally and neurologically distinct correction mechanisms are widely accepted to be independently operational: phase correction and period correction (Mates 1994; Praamstra et al. 2003; Repp 2001; Semjen et al. 1998; and also see Repp 2005). Phase correction essentially adjusts for asynchronies between the last response and stimulus events assuming an unchanged period. Period correction instead modifies the next target interval on the basis of discrepancies between the oscillatory or timekeeper interval and the last or last few interstimulus intervals, thus altering the period of the attentional musical pulse.

C9.P16 Crucially, phase correction seems to be a predominantly automatic process. It operates by and large without awareness in participants, and is equally effective within and beyond perceptual thresholds for detecting perturbations and/or asynchronies (Repp 2001; Repp and Penel 2002). Period correction is, however, a more challenging cognitive task (e.g. Stephan et al. 2002). It is largely under cognitive control, requires attentional resources, and relies on the conscious perception of a tempo change in the pacing sequence. This was shown clearly in an important study by Repp and Keller (2004), who found that period correction is dependent upon variables of intention, attentional load, and awareness, whereas phase correction was only affected partially by intention in supraliminal conditions.[8] They therefore argue that phase correction and period correction seem to represent independent processes of largely automatic action control and of intentional cognitive control, respectively (Repp and Keller 2004). They hypothesize that their findings reflect the notion that 'period correction is based on a more complex form of sensory evidence—namely on a difference between intervals ("relative period")—than is phase correction, which is triggered by a difference between time points (or relative phase)' (p. 517). In effect they are highlighting the distinction that period correction can be characterized as an interval comparison—a second-order difference—whereas phase correction results from a simple phase discrepancy—a first-order difference. The latter they posit 'even inanimate dynamic systems can perform' (p. 517). Another way of explaining this idea, in the context of the effects of intention only, is given by Repp (2001), who hypothesized that the differences were due to 'period correction requiring memory for at least one preceding event and as such greater computational complexity calling for greater neural resources, thus making the process more extensive in brain space and in time, and hence more accessible to higher-level cognitive processes' (pp. 310–311). Expanding on this in a later paper, Repp (2004: 76) states: 'it is likely that period correction is a specifically human ability [and] is a manifestation of the more general human ability to set the tempo of a rhythmic activity at will' (see Bispham 2006; 2018).

C9.P17 Research and experimental findings in sensorimotor synchronization are, of course, indicative of only some of the mechanisms involved in temporal coordination in music perception and performance. In musical settings, innumerable additional social and interactional capabilities are operational in achieving temporal and physical coordination. Interpersonal musical entrainment (Bispham 2003; Clayton et al. 2004) in social contexts is, for example, inextricably embedded with our broad capacities for culture, action-mirroring, and intersubjectivity (see Himberg 2014; Keller et al. 2014; Nowicki et al. 2013). A musical pulse is, in practice, infinitely more fascinating, variable, playful, and complex than the scope of the discussion and studies considered above. It is manifest worldwide as an essentially boundless source of convention and creativity. Nevertheless, we can, in my opinion, safely assume that these observations of two correction processes reflect part of the basic temporal framework for musical rhythmic behaviours and interactions across cultures. It even seems entirely plausible that the relative reliance on these foundational mechanisms in music increases––revealed perhaps by a 'stricter' adherence to pulse––with the challenges of larger group size and lack of social sympathy, familiarity, and experience. Broadly speaking, phase correction mechanisms can be supposed to be operational in all activities involving future-directed attending where expectations are constantly updated based upon asynchronies between attentional pulses and stimulus events (Large and Jones 1999). In contrast, period correction is almost by definition functional, specifically, within the framework of a sustained musical pulse. It is this latter process that arguably ties together an awareness of the recent past, the psychological present, and our immediate expectancies into a longer phenomenological experience. It also affords impressive structures of group coordination and a collective sense of shared time in music. I argue therefore that it forms part of a foundation for the specificities of our experience of time in music and some of the particular efficacies of music.

C9.S4 Musical Tone

C9.P18 A similar argument to that set out here on musical pulse can be made for the most fundamental psychological architecture of a musical tone. The use of pitch in music, across composition, culture, and time, is as immeasurably variable and fascinating as rhythm. It is ultimately a corresponding source of individual character, cultural identity, playful exploration, socio-intentional drive, creativity, and emotional expression and regulation. I have suggested, however, that the capacity to engage with a 'simple' musical tone universally grounds the organizational use of pitch in music.[9] Just as capacities to engage with a basic musical pulse ground a wealth of complex rhythmic structure, the specific nature of musical pitch across cultures is built upon a primary ability to produce and engage with a sustained stable fundamental frequency, and the ability to create or process certain relationships between pitches. Musical pitch structure worldwide—whether monotone or florid—can be characterized as being relationally organized with reference to sustained yet variable tonal areas (McAllester 1971).[10] This applies, in principle, from the most unadorned use of a persistent musical drone, through a private rendition of a folk melody, to instances of its fullest potential across cultures in impressive group displays of choral harmony and instrumental symphony. Crucially, however, this perspective does not necessarily imply any particular form of designed tonal system or hierarchy. It merely suggests that—whether structured as sustained chanting, in relation to a persistent underlying drone, as 'chordal' homophony, or as a complex polyphony of individual 'voices'—musical pitch at any given time (or possibly within breath or phrase boundaries) is organized relationally within a framework of a dominant pitch region or regions (Bispham 2009).[11] In recent cross-cultural research, for example, it has been shown that even in musical traditions featuring equitonic equal-spaced scales (e.g. East African music) there is evidence to suggest that tonal centres are still perceived by idiomatic listeners (Ross and Knight 2017).[12]

C9.P19 The root structure of pitch in music is, therefore, in many ways similar to a sustained pulse. A musical tone is inherently a sustained physical and attentional practice that is rooted in particular correction mechanisms (e.g. Natke et al. 2003; see also Larson and Robin 2016) and a degree of volitional control (Keough et al. 2013). Initial experimental results further suggest that it is inextricably imbued with an awareness of a pitch-structural framework (Hafke et al. 2013; 2016). Musical tone and musical pulse both provide a mutually manifest focal point and framework for individual experience and social interaction. In comparative analysis of both pulse and tone relational processing is a key and pronounced (if not absolute) difference between humans and other species (Hage and Nieder 2016; Patel and Demorest 2013).[13] Most notably for the principal concerns of this chapter, it is correction mechanisms that permit *sustained* utterance and attention, a high degree of volitional control, and an awareness of architectural framework that appear distinct to the context of music. Although the connection to time is less overt, it is in some sense the same. Even in humming or listening to a single note, we are constantly integrating the events of the previous moment with our current actions, and incessantly correcting and adapting our future anticipations. Of further critical importance is that, in comparative analysis of tone and pulse, it is precisely those features that distinguish the particular nature of individual experience with music that also afford group synchronous and harmonious interaction. Effectively, configurations of musical pulse and musical tone provide an attentional structure for managing personal experience in an extended perceptual present—a continual phenomenological linking of the immediate past, the current moment ('now'), and future expectation—and a specific architectural framework for interpersonal communication and an enacted sense of shared time.

C9.S5 Musical Motivation

C9.P20 To briefly summarize the course of discussion this far, not only can we posit something particular about the psychological mechanisms and phenomenological experience of time in music, but I contend that investigating the specificities of music's essential architectural roots reveals that music is most fundamentally distinct from other forms of communication in the way we structure attention and action in time. We can go further still and ask: what motivates us to put any given character or social action into musical form? Why structure the 'communicative musicalities' of our dynamic mediations with others and the flow of our individual experience around the specificities of a musical pulse and/or musical tone? Here again, I propose that the answer is directly related to the temporal structure of attention. As discussed briefly in the introduction, music can effectively encapsulate and/or abstract all of our most central vitalities, social drives, and cultural reflections (in varying combinations). It is intrinsically motivated by our most central human motivations of emotional experience (Schiavio et al. 2017), expression (Juslin and Sloboda 2011), and regulation (Gross and Thompson 2007); intersubjectivity (Trevarthen et al. 2011; Beebe et al. 2005); shared intention (Tomasello et al. 2005); social alignment (Gallotti et al. 2017); cultural belonging (Clayton 2003); and communitas (Rappaport 1999). It is a prominent component in our suite of behaviours directed towards achieving hedonic and eudaimonic well-being through meaningful personal reflection and socio-intentional connection; it is culturally generative and reflective, an artistic expression of individual creativity, character, and cultural belonging. These motivations and their dynamic correlates are, however, not *specifically* enacted in music; they all emerge early in ontogeny, and are manifest in many active and social forms in the course of human development. They are instead given and afforded particular space in music—a space that constantly binds from one perceptual present to the next; offers a constant renewal of attentional focus; provides a degree of predictable continuity; and can be interactively manifest in groups. Therefore, the distinct nature of a musical motivation lies in giving our central affective and socio-intentional drives extended phenomenological space, stability, and a degree of abstraction, intensity, and meaning and in providing a framework for ritual action and for interpersonal and group interaction.

C9.S6

Musical Time

C9.P21 The above discussion can be understood in terms of other recent work of mine on the specific features of the human faculty for music—qualities that are at once universally present and operational in music across cultures whilst also being specific to our species and to the domain of music (see Bispham 2018; also termed music's evolutionary 'design features'–– Bispham 2009). In that paper, I conclude that unique features of the human capacity for music—musical pulse, musical tone, and musical motivation—provide a sustained attentional framework for managing personal experience and a coordinative structure for interpersonal interaction. They are respectively embedded in and have developed from our most foundational and central kinaesthetic: vocal, affective, and socio-intentional drives and capacities. However, features that appear unique to the context of musical engagement do not in or of themselves express or affect anything. Rather, they offer a sustainable socio-intentional coordinative strategy. They extend a phenomenological present, thus affording a continuing focus, and intensity of affect, stability, regulation, memory, and meaning. Accordingly, music can be understood primarily as an educational or therapeutic playground, a protracted, liminal, and enhancing field that allows a memorable event a ritualization and intensification of emotion and meaning. In accordance with Blacking's (1995) description of it as a primary modelling system of

AQ: which paper are you referring to here, 2018 or 2019?

human thought, it is an indispensable tool of consciousness and a transformative technology of the mind.[14]

C9.P22 Music, I suggest, should not be understood merely as a paradigmatic example of temporally dependent gestalt formation and our general experience of the continual flow of time. It is inextricably embedded with our general timing mechanisms and fundamental capabilities to manage our environment and negotiate interactions with others. However, it is also distinctly and profoundly a particular form of structuring attention, action, and communicative intent. To be clear, I am not positing any kind of uniform experience. Other chapters in this book, for example, testify to the varied nature of time perception across musical styles and performances, and how it can be an integral and widespread source of compositional technique. Another point to iterate clearly is that positing the specificities of music and the corresponding experience and attentional structure of time in its seemingly most basic firmament of a pulse, tone, and motivation should not be understood as presenting a reductionist account of music, or as a position that discussion on music or music in time should ever be exclusively framed in these terms. Rather, they constitute a potentiating space, a particular experience of action in time that affords and supports the extraordinary flexibility of dynamic form and function across cultures. They afford an extended musical moment in which a virtually infinite variety of individual creativity, emotional reality and regulation, social connection, group coordination, and cultural history and reflection can be given a particular attentional shape. Therefore, music's distinct character lies in its being an *ordered* expression of human experience, behaviour, interaction, and vitality, all shaped, shared, given significance, and/or transformed in time.

Notes

1. An important point to note is that these traits may not be physically or knowingly/descriptively evident but may reflect implicitly learned ontology and/or empathy with the underlying psychological mechanisms and experience.
2. Non-teleological.
3. As testified e.g. by the predominant focus on pulse and rhythm in most chapters in this book.
4. It is worth noting that these time-ranges seem to be operational across modalities, and in both perception and performance. Studies have shown e.g. that the threshold between events whose temporal order is or is not distinguishable is consistent for acoustic, visual, and tactile stimuli (Hirsh and Sherrick 1961). Furthermore, timing processes inherent in kinesthetic abilities is constant across a range of effectors (Franz et al. 1992). Much empirical evidence has, also, been collected to support the theoretical framework of the 'psychological present' in perception across modalities and in both perceptual and motor behaviour (see Wittmann and Pöppel 1999/2000).
5. In this model, which is less focused on judgements of time as on the operational side of how we and other animals interact in time with our environments, internal oscillatory mechanisms create points of attentional focus and expectation (Large and Jones 1999). Central to the theory is the view that attention is not a continuous operation but rather one

in which we constantly build expectancies and subsequently direct efficient energy pulses towards expected events whilst reacting to the unexpected. A key feature of this model, therefore, is that it is attentionally future-directed with internal predictions based upon perceived regularities and/or learned patterns of events entraining with the external world.

6. 'Relative/beat-based timing' refers to the timing of intervals relative to a regular beat, whereas 'absolute timing' (also sometimes termed 'duration-based timing') describes the timing of absolute durations.
7. Relative timing appears also to have been a marked transition in human evolution. It seems that duration-based timing mechanisms are widely shared amongst primate species but that beat-based timing is either unique or particularly advanced by many degrees in humans (e.g. Zarco et al. 2009; Donnet et al. 2014; Honing et al. 2012; Hattori et al. 2013; Large and Gray 2015). Patel and Iverson (2014), Large and colleagues (2015), and Merchant and Honing (2014) offer three contrasting (but possibly also complimentary) hypotheses on the evolution of beat-based timing in humans (see Bispham 2018 for discussion).
8. Correspondingly, different patterns of functional connectivity have also been shown depending on whether corrections are automatic or effortful (Rao et al. 1997; Jäncke et al. 2000; Oullier et al. 2004; Chen et al. 2008; Thaut et al. 2009; Bijsterbosch, Lee, Dyson-Sutton, et al. 2011; Bijsterbosch, Lee, Hunter, et al. 2011).
9. To clarify this should not be understood to imply that all use of pitch in music is necessarily structurally significant. Nor should it be interpreted to suggest that the specific 'musicness' of a performance cannot reside entirely in the rhythmic pulse. Instead I propose that music can be universally identified by engagement with *configurations* of musical pulse and musical tone. One or the other could be entirely absent, but not both.
10. Although I am not aware of any direct experimental evidence it is interesting to consider that, in fast-moving or florid passages, individual notes are likely to be too fast to be the subject for correction of discrepancies between vocal or instrumental production and an internal target or external reference (e.g. Lindblom and Sundberg 2007). Thus, we can perhaps assume that these would be formed into a larger gestalt with the new whole constructed in reference to a more sustained and internally manifest pitch centre. This, in turn, perhaps suggests a more realistic target for adjustment.
11. The human ability to recognize and manifest pitch centre in complex musical structures is discussed in Podlipniak (2016). He argues, with reference to the 'Baldwin effect', that this mental capacity emerged by joining the implicit recognition of the frequency of pitch occurrence, working memory, and the emotional assessment of predicted stimuli.
12. Discrete tones have commonly been presented as one of the few distinguishing characteristics of music across cultures (Cross et al. 2013; Koelsch 2012; cf. Bispham 2009). More precisely and inclusively, however, these can be inferred as resulting from, and being an expected acoustic correlate of, more deeply embedded processes. Essentially, a musical tone is neither primarily defined by nor primarily experienced as absolute values or discrete scalar steps. It can be more or less flexibly instantiated in relation to internal or externally influenced expectancies. More critical to its distinct nature than any absolute acoustic attributes or analysis is that it is understood and psychologically maintained in reference to explicit or implied pitch references or tonal centres. Similarly, rather than attempting to distinguish musical rhythm on the basis of degrees of physical isochrony (Cross et al. 2013; Koelsch 2012; cf. Bispham 2009), a more primal way to consider the specificities of a musical pulse is to consider the involvement of second-order relational processing over time, its inherent continuity, and correction mechanisms (see above). It is these features that

profoundly create the stability of a musical pulse. Relatively high degrees of behavioural isochrony are a particularly likely resultant attribute.

13. Most likely this reflects and follows a wider move towards increased sociality in humans and a motivation to understand others as ourselves—in terms empathetically of our own psychological and physical experience.
14. I am grateful to an anonymous reviewer who notes that the conception of musical structure developed in this chapter could also function as a model or architecture for other human thought. It could, he/she suggests, be a reflection, an artistic mimesis, of the structure of human thought prior to music. This is certainly an interesting idea that could be fruitfully explored further.

C9.S7 ## References

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