Affordances and the musically extended mind

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INTRODUCTION

One of the main reasons we listen to music is to regulate our emotions (Krumhansl, 2002). Musical activity – temporally patterned activity by which individuals or groups produce or perceive intentionally structured sound (Chinn, 2001; Croom, 2012, p. 2) – is often undertaken in the service of emotion regulation. We listen to music to elicit powerful feelings. And by eliciting powerful feelings, music can function as a tool for motivating both individual and collective actions. Considerations such as those led Small (1998) to coin the term “musicking” to stress the active character of our musical engagements. Following Small, I will use “musicking” to encompass the different ways that we actively engage with – and indeed use – music to animate behavior, cultivate and refine affective experiences, and orient ourselves to others and the world more generally. Specifically, I consider how musicking-in-listening enables us to develop novel emotions and, in so doing, expand our emotional repertoire. I argue that music does, indeed, often grant access to novel emotions – and it does so by scaffolding and enhancing the functional complexity of certain endogenous resources, thus granting phenomenal access to experiences that we would otherwise be unable to develop. First, I discuss the idea of “musical affordances” and specify both what musical affordances are and how they invite different forms of musical engagement. Next, I argue that musical affordances enhance the functional complexity of various endogenous, emotion-granting regulative processes, drawing novel experiences out of us with an expanded complexity and phenomenal character. I suggest that, since music is an essential resource needed to access these experiences, it is therefore warranted to speak of the musically extended mind.

MUSICKING AND MUSICAL AFFORDANCES

In everyday life, we do many different things with music. A common use of music is as an atmosphere-enriching sonic additive. Dynamic beat-heavy music can elevate spirits at a party, creating a joyous atmosphere, and compelling listeners to mingle and dance; slower reverent music – at a funeral, for instance – can have the opposite effect, bringing about an atmosphere of quiet grief and remembrance. Music can also coordinate actions both solitary and social. In elevating our mood and sharpening our attentional focus (Sridharan et al., 2007), music can get us into different states of action-readiness necessary for various activities, including combat (Giuliano, 2004; Protevi, 2010), athletics (DeNora, 1986), erotic encounters (DeNora, 1997), and dining out (Caldwell and Hibbert, 1999), or studying (Rauscher et al., 1993).

The point of these observations is that within everyday life, music is generally not perceived merely as an esthetic object for passive contemplation. Rather, we perceive it as a resource we can actively engage with to regulate our affective experiences. In so doing, music becomes an essential resource needed to access our emotional experiences. I defend a model of the musically extended mind. I consider how acts of “musicking” grant access to novel emotional experiences otherwise inaccessible. First, I discuss the idea of “musical affordances” and specify both what musical affordances are and how they invite different forms of entrainment. Next, I argue that musical affordances – via soliciting different forms of entrainment – enhance the functionality of various endogenous, emotion-granting regulative processes, drawing novel experiences out of us with an expanded complexity and phenomenal character.
When I speak of affordances in what follows, I mean simply action possibilities in a perceiver’s environment that are specified relationally, that is, by both cultural features of the environment and things in it, as well as the perceiver’s history and embodiment. As Gibson (1979, p. 8) puts it, there is a mutuality between perceiver and environment. In what follows, I am mainly concerned with the perceiver’s experience of affordances – the phenomenology of their sensorimotor responsiveness to affordances. I am particularly interested in the way that musical affordances exhibit a kind of felt allure (cf. Rietveld, 2008). This idea refers to the way that we often experience music as affectively irresistible; we are drawn to it, emotionally – often in a very powerful way – in part because we immediately recognize it as meaningful, that is, as something with a distinctive activity signature that we can use or do things with (cf. Krueger, 2011a; Reybrouck, 2012). Part of music’s impact comes via the way that it presents itself as an environmental resource inviting interaction (both potential and actualized), from simple affective and behavioral reactivity to more complex, synchronized forms of engagement. The first personal character of this affective allure thus consists in the manner that musical affordances are, from a very early age, experienced as potentializing a delimited range of context-sensitive responses (Rietveld, 2008, p. 977). More on this idea as we proceed.

Considering auditory affordances is not a novel endeavor. Gibson (and those who follow him) speak mainly of the visual detection of affordances. But since affordances are specified via the perceptual pick-up of structured information in the environment, they are potentially available via any modality – including audition. And despite the optical emphasis of most discussions of affordances, some working within this tradition have investigated how the perception of auditory events specify different affordances (e.g., Warren and Verbrugge, 1984; Warren et al., 1987; Heine and Guski, 1991; Gaver, 1993a,b; Cummins, 2009). For example, Warren et al. (1987) found evidence for the intermodal character of auditory event perception: in half-bouncing tasks, the information observers used to determine bounce height was identical in both visual and auditory conditions (see also Kohler et al., 2002). We will return to the intermodal character of auditory perception below.

Nevertheless, despite this existent work on ecological acoustics, the notion of “affordances” has not received much application in music cognition literature generally – although there are a few exceptions here, too (e.g., Gaver, 1993a,b; Reybrouck, 2001, 2005, 2012; Windsor, 2004; Clarke, 2005; Krueger, 2011a; Windsor and de B閟anc, 2012). As we will see, however, the notion is valuable within a musical context. It can help elucidate the extent to which audition (including music listening) and action are fundamentally intertwined (Warren et al., 1997). It also helps to clarify the informational richness of music (Furneaux, 2009) and the manner by which musical information exerts its characteristically strong pull on us (i.e., its affective allure) as we do things with it in everyday life (DeNora, 2000).

So what does music afford the listener? And what are the structural features of music, as perceived by the listener, that specify these affordances? An obvious but nevertheless important initial answer to the first question is that music affords movement. Unlike non-musical noise in our environment – the sound of a passing car outside our window, say, or a slamming door, the laughter
of children playing in the yard, or the steady murmur of water flowing through a nearby brook – music generally presents a sonic profile that invites a synchronous motor response (Clayton et al., 2005; Bispham, 2006). This response can be as subtle as tapping our fingers or nodding our head; or it can be an elaborately choreographed dance routine. While a slamming door may solicit its own sort of motor response (e.g., a sudden grimace or flinch), that sound event does not invite synchronous and sustained motor engagement; it lacks the requisite sonic profile, the relevant affordances. But music often does offer such a profile (in a way to be clarified momentarily).

Music in this way affords what Windsor and de Bézenac (2012, p. 112) helpfully term “advancing behavior” – a mode of sustained and responsive engagement in which the acoustic structure of a musical event – features like cyclical patterns of rhythmic or melodic accentuation, goal-directed tonal movements, modulation of volume or intensity, etc. – draws the listener into a patterned response reflecting the dynamics of this acoustic structure. A simple example is the way that the buoyant melody of a children’s song seems to draw a similar range of bounce, swaying movements of the head and trunk from those who listen to it. To a certain extent, the morphology of our advancing behavior mirrors the dynamics of the experienced music – although there are, of course, individual differences in the reactive behavior we display.

Music thus often affords responsive movements in a way most other environmental sounds do not. But we can specify more precisely the character of this musically solicited responsive movement. As the example of the children’s melody demonstrates, musical dynamics exert an organizational control over our motor responses. In other words, the acoustic structure of a music event affords a fine-grained synchronization or bodily alignment with the music. Again, a simple example is the way that we instinctively start tapping our fingers or nodding our heads along with the periodic modulations of melody or rhythm of a piece of music that catches our attention (cf. Repp, 2005). Even in these rudimentary cases of everyday listening, music exhibits a strong affective allure; it is difficult to ignore it or repress our bodily responses (Brown and Parsons, 2008), even very early in life (Haidbeck, 2004; Zentner and Eerola, 2010). From the start, we experience music as something that naturally invites this kind of synchronized interaction.

Music therefore affords not just movement but, crucially, entrainment. Entrainment is a concept from complex systems theory. It occurs when two or more independent oscillatory processes are synchronized with each other, gradually adjusting toward – and eventually locking into – a common phase and/or periodicity (Clayton et al., 2005; Will and Turow, 2011). A classic example of entrainment – first identified by the Dutch physicist Christiaan Huygens in 1656 – involves the movement of two pendulums gradually coming into phase-synchrony via minute vibrations in the walls and floor (Windtree, 2001; Bennett et al., 2002). The notion has since been applied to multiple domains including work in mathematics, as well as physical, biological, and social sciences. Entrainment has been described in multiple systems and at multiple time-scales: from Asian fireflies flashing in synchrony (Buck and Buck, 1968), human interactants synchronizing gestures, and speech patterns (Chartrand and Bargh, 1999), to a group gradually transitioning from random to synchronized clapping (Néda et al., 2000). Generally, entrainment emerges via mutually modulatory interaction between different oscillators (e.g., two swinging pendulums influencing one another’s movements). But the interaction can also be one-way, such as with human entrainment to diurnal cycles – or music.7

Music studies have thus far made little use of the notion of entrainment. This is surprising, as the idea seems to accord naturally with how we engage with music. It seems particularly well-suited to capture the impact that music and musical rhythms have on the reactive behavior of embodied listeners (Will and Turow, 2011, p. 12). Since music is a structured “sound-time phenomenon” (Reybroeck, 2012), rhythm becomes a key component for bodily marking the temporal development of a musical event. Musical entrainment occurs via the behavioral coordination resulting from an individual’s responsiveness to rhythmic signals, such as a simple (e.g., 1:1 in-phase or anti-phase) or more complex (e.g., 2:3 or 3:4) phase relations (Phillips-Silver et al., 2010; cf. Bispham, 2006; Merker et al., 2009; Nazaradjan et al., 2012). This way of coordinating our reactive behavior to the music is a way of bodily gearing onto musical structures. This process emerges and takes shape as the music unfolds around us in acoustic space, where we (often unthinkingly) coordinate our movements with the dynamics of this unfolding – much the way that a dance between two partners emerges dynamically, in real-time, from the ongoing interplay and synchronization of each partner’s movements and their individual responses to what the other is doing. Temporality is thus a key feature of musical entrainment.8

But musical entrainment also has another key feature relevant to this discussion: affective synchrony (Phillips-Silver and Keller, 2012, p. 1; cf. Trevarthen and Malloch, 2002; Janata et al., 2012). This notion refers to the sharing of feeling states that often emerge when individuals entrain their movements with one another – for example, when jointly listening to or performing music (Keller and Appel, 2010), or when engaging in non-musical activities such as simply walking in sync with a partner, or having a conversation and (unconsciously) mimicking their postures, facial expressions, and gestures (Hartfeld et al., 1995; Chartrand and Bargh, 1999; Lakin and Chartland, 2003; Krueger and Michael, 2012). Within the context of musical entrainment, affective synchrony refers to the pleasure we take simply in moving our bodies in time with the music, letting musical rhythms (and the movements they solicit) draw certain felt responses out of us – and, when others are present, the pleasure we take in sharing this process (i.e., of getting into the “groove” together; Pressing, 2002; Madison, 2006; Janata et al., 2012; cf. Schutz, 1951). Affective synchrony in this way seems to be a central part of the affective allure of music-making. We engage with music because, unlike most other non-musical sounds, it affords synchronously organizing our reactive behavior and felt responses; and we take pleasure in letting music assume 8Although, strictly speaking, our engagement with music is not really one-way since, as we will see, the experiential character of the music-as-perceived – as well as the sort of reactive behavior we experience the music as affording – is shaped by the form of our “advancing behaviour.”

The allure of music as a resource for entraining is not necessarily confined to human perceivers (see Poal et al., 2009).
some of these organizational and regulative functions that, in other contexts, normally fall within the scope of our own endogenous capacities. In other words, we “offload” some of these regulative processes onto the music and let it do some of the work organizing our emotional responses for us.9

Via soliciting entrainment responses, music thus exerts an organizational control over the form and dynamics of our embodied musical engagements. This is reflected in the way that different styles of music invite different patterns of entrainment with their own unique temporal signature and affective synchrony. Entrainment responses that fit Tango or Salsa, for example, may differ significantly – as will those more organically aligned with the acoustic structure of different musical genres like Pop, Country, Electronic, or Post-Rock.9 The spatiotemporal movements of our entrainment responses to music are thus organized in a way that reflects the hierarchically organized rhythmic and melodic structure of the music (Windsor and de Bèzenac, 2012, pp. 112-113; cf. Leman, 2008; Burger et al., 2013). The pitch intervals and contour of melody, for instance, establish trajectories through mental representations of pitch space that – at least potentially – map cross-modally onto movement possibilities within physical space (Phillips-Silver and Keller, 2012, p. 2; cf. Etain and Granot, 2006; Rusconi et al., 2006; Lidi et al., 2007; Etain and Timmers, 2010). Phenomenologically, we feel certain movements to be more contextually appropriate than others, relative to metrical and melodic patterning within musical structures. For example, by the triple meter of the waltz is not experienced as affording marching – trying to march to a waltz feels somehow odd, as though the music is working against us and our bodily gestures are not “fitting into” the appropriate musical cues – a dupe meter at the correct tempo would establish a different entrainment context, one in which marching responses do feel more appropriate (Windsor and de Bèzenac, 2012, p. 113). The acoustic structure of the music-as-heard thus determines the form of our musical advancing behavior; it shapes how we interact with and “inhabit” the music, experientially, and what we do with it (cf. Leman and Naveda, 2010; Naveda and Leman, 2010).9

So what is it about music that affords entrainment? I have considered this idea in some detail elsewhere (Krueger, 2011a). For our purposes, we can answer this question briefly. The salient structural features are musical features that contribute to its dynamic quality: its character as temporally extended, spatially and acoustically complex sound event exhibiting its own internal organizational coherence, its own compositional logic. The particular structural features that comprise musical dynamics are many, and quite varied: cyclical patterns of rhythmic or melodic accentuation, goal-directed tonal movements, modulation of volume, intensity, cadence, or tempo, etc. This is but a partial list; there are other features of music that potentially contribute to its dynamism. The point is that these qualities – and many more like them – are what imbue music with its “aliveness,” its vitality – and its ability to summon impressions of movement, expression, and spatiality (Molnar-Szakacs and Overy, 2006; cf. Krueger, 2011a,b). In other words, they are structural features of music that determine it to be an event that unfolds dynamically and coherently in acoustic space and time, and which – when paired with an appropriately sensitive listener – thus affords specific forms of interaction and motor entrainment. Again, we cannot entrain with non-musical sounds – or rather, at least not with the same degree of reactive complexity – precisely because they lack the dynamics and organizational coherence of music. There is a specific profile that does not specify well-articulated and, crucially, varied entrainment possibilities – that is, possibilities for musicking.12

AFFORDANCES, MUSICKING, AND THE EXTENDED MIND

I now want to consider the way that music and musical affordances grant access to kinds of experiences otherwise inaccessible. The specific idea I want to defend is this: at times, music serves as an external (i.e., outside-the-head) resource that can profoundly augment, and ultimately extend, certain endogenous capacities. When we engage in bouts of musicking, we potentially use music to become part of an integrated brain–body–music system – and within this extended system, musical affordances provide resources and feedback that loop back onto us and, in so doing, enhance the functional complexity of various motor, attentional, and regulative capacities responsible for generating and sustaining emotional experience: it is thus sensible to speak of the musically extended (emotional) mind.

To head off an immediate worry, music does not necessarily express or represent neatly articulated emotions; perhaps it does not represent emotions at all.13 Whether or not music can be said to properly represent emotions is a heated debate; it

9 In the embodied cognition literature, “offloading” refers to the manner by which we overcome cognitive limitations (e.g., limits on attention and working memory) by exploiting our environment in a strategic way to reduce our cognitive workload. For example, we post sticky notes on the side of our computer monitor or place a box full of cans bound for the recycling bin by the front door as a memory prompt.

10 See the experiential character of entraining with music as a way of experiencing and potentiating a range of reactive responses that are itself a sonic profile that does not specify well-articulated and, crucially, varied entrainment possibilities – that is, possibilities for musicking.

11 I invite the reader sceptical of this musical vs. non-musical contrast to compare the experience of entraining with the steady pulsing of a car alarm, say, or ticking of a clock with that of any random pop music hit. We can, of course, entrain with non-musical sounds. But I am confident that, for most of us – congenital amusiacs, for example – feeling more appropriate (Windsor and de Bèzenac, 2012, p. 113). The acoustic structure of the music-as-heard thus determines the form of our musical advancing behavior; it shapes how we interact with and “inhabit” the music, experientially, and what we do with it (cf. Leman and Naveda, 2010; Naveda and Leman, 2010).9

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need not concern us here (see, e.g., Kivy, 1989; Robinson, 2005; Zangwill, 2007). Rather, following Sloboda, I instead affirm the idea that “the so-called power of music may very well be in its emotional cue-impoverishment. It is a kind of emotional Rorschach blot” (Sloboda, 2000, p. 26). On the affordance-based conception of music I am here advocating, music is conceived of as an information-rich perceptual object. But representations of emotions need not be part of its informational structure. Rather, what matters is that music affords a sonic profile enabling the listener to use it to cultivate and refine specific emotional experiences. Music, when being used by the engaged listener, therefore becomes part of the extended vehicle by which these experiences are realized.

Framed thusly, I am intentionally situating this affordance-based approach to music listening within discussions of the extended mind thesis (Clark and Chalmers, 1998; Clark, 2008; cf. Chemero, 2009; Menary, 2010), or the hypothesis of extended cognition (HEC), as it is sometimes called. According to HEC, the vehicles of cognition need not be confined to the head. Within certain circumstances, artifacts, tools, technologies, cultural institutions – and perhaps even other people – can become part of a spatially extended cognitive system in virtue of the active role they play in driving various cognitive processes such as reasoning, remembering, planning, calculating, perceiving, and navigating our environment, etc.

One way to think about HEC is therefore to understand it as a theory of access. Without the ongoing, active contribution of external resources, we cannot access the different cognitive functions they support. For example, certain mathematical calculations are only accessible with the aid of external props such as a pen and paper, calculator, or computer; similarly, storage devices (books, maps, cloud computing services, stories and cultural narratives, sticky notes on computer monitors) give us access to short- and long-term recall that far exceeds our native biological capacities (Clark, 2003). When we integrate our biological capacities with these external resources, we thus extend – in a very literal sense – our endogenous function and become part of an increasingly complex, functionally and spatially expanded cognitive system (cf. Sutton, 2006; Wilson and Clark, 2009). We access new and more powerful forms of cognition.

Discussions of HEC have only recently begun to move beyond a consideration of the lone agent fiddling with different bits of his material environment to consider the possibility of both interpersonal and emotionally extended cognition (see, e.g., Gallagher, 2013; Krueger, submitted; Slaby, forthcoming; Stephon et al., 2014). This expanded perspective on HEC is a welcome development. Cognition rarely (if ever) proceeds independently of emotions and affect; and it is, moreover, always situated in essentially nodding along to a musical rhythm, for instance, is a kind of motorically motivated attending to particular sound elements – and both are ultimately modulated by music’s external regulatory force. So, while I occasionally focus on individual dimensions of musicking in isolation, I will in what follows also try to highlight their interrelation.

We can begin by reemphasizing the extent to which musical experiences are enactive, multimodal processes involving the integration of perception and action (Molnar-Szakacs and Overy, 2006; Krueger, 2009, 2011b). This is not just the case for musical performance. Clearly when performing music, the different sensorimotor strategies we use to engage with the instrument are enhanced by the affordances unique to that instrument; there are certain movements and acts of sound creation unique to a guitar, trumpet, or xylophone. Within the context of musical performance, agent and instrument form a coupled system in which morphologies of movement and musical structure are mutually constraining (cf. Baby, 1992; Davidson, 2012; Thompson and Luck, 2012).

But a similar principle also applies to music listening. We have already observed how readily music draws movement out of us: from simply tapping our fingers to participating in an elaborately choreographed dance or music-fueled religious ritual, musical experience is multimodal (Iyer, 2002; Janata et al., 2012). And by soliciting different forms of movement, music functions as a real-time emotion regulator. It solicits – and crucially, modulates the general shape of – attention and expressive behavior responsive for generating specific affective experiences (cf. Damasio, 1994; Hohbein et al., 1996; Niedenthal, 2007).

Consider first how we use music to facilitate activities like exercise or manual labor (Karaageorghis and Terry, 1997; Robinson, 2005, pp. 395–409). Music is known to sharpen and sustain our attentional focus (Seidharian et al., 2007), which can be helpful when working through strenuous activity. More strikingly, however, music can also reduce how difficult strenuous activity feels. It does so not simply by masking unpleasant proprioceptive feedback one gets during strenuous exertions – that is, by directing our attention away from unpleasant sensations – or by providing a calming effect that reduces muscle tension and increases oxygenation (although these consequences are likely part of its efficacy). Additionally, and more pertinent to this discussion, music can function as a kind of surrogate agency: a “musical agency” (Fritz et al., 2015). It directly modulates reactive behavior and affect (“emotional motor control”) on the listener’s behalf by providing ongoing feedback in the form of “virtual goals”: dynamic representations of movement possibilities “with anticipatable but adaptable endpoints” that enable listeners to “regulate and monitor the extent and the timing of their movements more effectively”
(Fritz et al., 2013). In short, music assumes an external regulative function. Rhythmic structures, in particular, keep time for the listener and contour the shape of musically induced bodily expressions and movement patterns (i.e., via rhythmic accentuations, increased or decreased tempo, etc.) that propel them through their strenuous activity. In these cases, the listener offloads certain regulative functions onto the music, instead of attending to this time-keeping, action-monitoring information herself, she allows the music to tell her both when and how to act. Along with whatever additional positive physiological effects music may have, then, this offloading reduces the listener’s cognitive burden and, predictably, lowers her feeling of perceived exertion since she now has one less thing to worry about and can thus direct her attention elsewhere.

As a point of contrast, consider how dramatically one’s mood and behavior is altered – and how difficult the strenuous activity suddenly becomes – when this offloading possibility is suddenly unavailable: for example, when one’s MP3 player abruptly shuts off in the middle of a workout due to a dead battery (cf. Lim et al., 2009).

Looking at concrete instances such as this of how we use music in everyday life reinforces how deeply movement and music listening are intertwined. But to further understand the motoric dimension of musicking, we must note that music does not merely cause us to move and feel in particular ways. The causal chain does not simply proceed in a tidy linear fashion from music (as heard) to action (as caused by heard music). It also runs the other way. The experience of agency is intrinsic to how we hear and respond to music. In other words, as the case discussed above suggests, there is an irreducibly interactive dimension to music perception – even when “passively” listening.

This idea is confirmed by other empirical studies. In one of them, Chen et al. (2008) found that subjects who listened to musical rhythms with the knowledge that they would soon be asked to tap along with these rhythms showed activity in the supplementary motor area, mid-premotor cortex, and cerebellum. However, “naïve” subjects – subjects unaware that they, too, would soon be asked to tap along – displayed the same activity, passive listening (i.e., listening without anticipation) recruited the same motor regions. It seems that, even for listeners not overtly engaged in behaviorally responding to music, musical affordances were nevertheless perceived as soliciting engagement. Other studies likewise support the idea that the motor system is involved in processing musical rhythms (see, e.g., Sakai et al., 1999; Grahn and Brett, 2007; cf. Kohler et al., 2002). They also suggest that the experience of agency and bodily movement plays a role in shaping the perceptual character of music as heard – even, once again, during supposedly passive listening episodes (Phillips-Silver and Trainor, 2005).

These studies, and others like them, suggest that we quite literally hear music through movement. Perceived motor potentialities are a central feature of our musical “advancing behavior” (Windasar and de Bézenac, 2012); they frame how music is brought to phenomenal presence as music. It is telling to observe how the phenomenology of musicking is altered when motor potentialities are no longer a part of the listening experience. In cases of congenital amusia (Ayotte et al., 2002) – the inability to recognize musical melody, time-changes, or discriminate pitch despite otherwise normal hearing – music is experienced as presenting a very different sort of sonic profile. Total amusiacs report that they experience music as having a highly disagreeable character: it may sound like a car screeching or the banging of pots and pans (Sacks, 2007, pp. 98–119). Accordingly, the phenomenal character of their musicking experience is very different from that of the non-amusiac in that they fail to detect musical affordances; they are not attuned to music’s affective allure and thus do not experience it as potentiating a range of entrainment responses. This lack of responsiveness is born out in studies showing that amusiacs have great difficulty synchronizing bodily movements with music, despite an otherwise normal ability to synchronize with sequences of non-musical sounds (Dalla Bella and Peretz, 2003; cf. Krueger, 2009, pp. 118–121).

We thus hear music qua music through the motor potentialities it affords. But again, to return to an earlier point, music clearly also solicits movement, different forms of entrainment (both voluntary and involuntary) that shape what we hear, how we hear it, and how we respond emotionally. For example, listeners in one study exhibited spontaneous facial mimicry when presented with auditory-visual presentations of emotional singing (Chan et al., 2013). Happy singing elicited happy facial expressions, sad singing elicited sad expressions. But this effect does not rely upon the observation of another person. More strikingly, spontaneous facial expressions were also observed in individuals listening to expressive non-vocal music (Witvliet and Vrana, 1996; Lundqvist et al., 2009). These motor solicitations appear to occur from our earliest exposure to music. Infants discriminate musical from non-musical sounds: they coordinate their reactive behavior to the former but not the latter (Trainor and Heinmiller, 1998; Zentner and Kagan, 1998; Nawrot, 2003). Even neonates and preterm infants bodily entrain with sung lullabies and consonant music, syncing respiratory patterns, sucking (both rhythm and intensity), tongue and mouth protrusions, eye opening and closing, and vocalizations along with the rising and falling of melodic contour (Hasluck, 2004; cf. Krueger, 2013a). This entrainment has cognitive and emotional significance. It leads to greater equilibrium and brainwave stabilization of affect (DeNora, 2000, p. 79). For our purposes, there are two important points here. First, our engagement with music is always reciprocal and interactive. Even when “passively” listening, we are, in fact, not really passive listeners. Rather, we are active perceivers: we latch onto musical affordances and respond, motorically, to the solicitations of these affordances – even if this response is at times involuntary. And crucially, the way we latch onto musical affordances determines the phenomenal shape of how the music comes back to us, so to speak, how the music is constituted, perceptually (cf. Phillips-Silver and Trainor, 2005). Again, recall how dramatically the phenomenal shape of music changes when motor potentialities are absent (e.g., as with amusia). The amusiac and non-amusiac may be said to listen to the same piece of music considered purely as a sonic object. But what they hear in the music and what they get out of it will differ greatly. For amusiacs, music is perceptually encountered as a sonically impenetrable object; for non-amusiacs, it is perceptually
encountered as a structured acoustic landscape affording various forms of reactive behavior. Motor potentialities thus partially constitute the perceptual character of the music-as-heard. And via motor entrainment, we can be said to integrate with musical affordances in a dynamic, two-way relation of continuous reciprocal causation (Clark, 1997, p. 163): what we hear determines how we respond, which shapes what we hear, which informs our further responses, etc. Motor entrainment is one of the mechanisms that secures this ongoing, mutually modulatory integration.14

Second, these studies also support the idea that acting with musical affordances potentially enhances the functional- ity of various micro-practices responsible for emotional experience and self-regulation. Via the iterative cycles of motor entrainment that emerge within the music-listener system, ongoing feedback/feedforward loops are generated that have regul- atory significance at both the neural and behavioral level. Without this ongoing input from these musical affordances, however, these regulatory processes would not emerge — much the same way we cannot access certain cognitive func- tions (e.g., working out long multiplication problems) in the absence of ongoing feedback from the relevant external props (e.g., pen and paper; cf. McGelland and Rumelhart, 1986).

Musical dynamics thus provide external scaffolding support- ing the synchronic emergence of novel music-specific experi- ences.

At the neural level, the perception of musical gestures — rhythm- mic structures and melodic contour, which replicate the dynamics of human movement and emotional expression — may create a simulation of an emotional state in the listener (Gridley and Hoff, 2006). Two brain regions, the posterior inferior frontal gyrus and the anterior insula, are commonly activated during musically evoked emotional states (Koelsch and Siebel, 2005; Menon and Levitin, 2005; Korolch, 2010). Molnar-Szakacs and Overy (2006) propose that these structures are part of the simulation mechanism by which music communicates emotion to the lis- tener. We hear the music as articulating dynamics akin to human emotional expressions and we (involuntarily) create a motor representation of that emotion within ourselves. The dynamics of musical gestures in these cases integrate with the listener’s rele- vant neural mechanisms, giving rise to autonomic and somatic responses that generate associated emotional responses, both physiological and phenomenological (Overy and Molnar-Szakacs, 2009).

At the behavioral level, music, as we have seen, solicits differ- ent forms of gestural and postural entrainment — overt physical expressions (e.g., facial expressions when listening to happy music) that induce the felt experience of emotions (e.g., Ekman et al., 1983; Niedenthal, 2007). There is a great deal of empirical evidence indi- cating a reciprocal relation between an emotional experience and its behavioral expression. Simply adopting emotion-specific facial expressions or postures, for example, is often sufficient to bring about the associated experience (see Laird, 2007 for an overview).

What is relevant for our purposes is that musical affordances scaffold our access to these emotions by quite literally pulling these emotion-inducing responses out of us (cf. Berger et al., 2013). But music’s impact does not stop there. By continuing to provide ongoing feedback, music serves as a real-time regulator: the tem- poral structure and periodic modulations of the music (melody, rhythm, volume, intensity, etc.) in its unfolding regulates the form that our physical expressions take (cf. Windsor and de Bézenac, 2011).15

In short, the music shapes our reactive behavior in a fine-grained way. Musical input (in the form of dynamic musical gestures) gives expressive shape to our reactive behavior, much the way that ongoing input from a dance partner extends, transforms — and in an important sense, completes – the shape of our own partner-dependent responses. The overt physiological and postu- ral changes these musical gestures induce — and which arise via the auditory-motor integration characteristic of our perceptual engagement with these affordances — thus provide affulent feed- back enhancing and transforming our affective state. When the music lifts, so do our expressive responses and the emotional states they induce; when it falls, so do we (cf. Wittliv and Viana, 1996; Lundqvist et al., 2009). In manipulating our behavioral responses via patterns of entrainment, music thus manipulates our emo- tional experience by assuming a critical regulative function. We let music do some of the emotional work for us. And to return to an earlier point, this offloading is, I propose, a central part of the pleasurable “letting go” experience we tend associate with episodes of deep listening: heightened experiences of music listening in which we feel as though we are experientially consumed by, and somehow taken up into, the music as it unfolds around us and leads us on a sonic and affective journey (Kruuger, 2009, 2011b; cf. Bicknell, 2009; Gabrielson and Bradbury, 2011). Within these experiences, we become acutely aware of the way that “musical agency” (Fritz et al., 2013) profoundly augments, extends, and organizes our own affective resources.

In sum, I suggest that, as with the performer–instrument rela- tion, listener and music similarly form an integrated system (cf. Reybrouck, 2012). Within this system, the listener uses music (via

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14 Clark himself appeals to musical examples to support this idea. He tells us that “continuous reciprocal causation (in not a rare or exceptional case in human prob-

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15 Recall the earlier discussion of music and strenuous activity, as well as the discus-

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Musical affordances potentially expand our affective repertoire and open up new forms of experience. In adults, musical affordances enhance the functionality of endogenous process by providing additional regulative properties—properties which the listener exploits to access a more nuanced means of emotional refinement, attention, and expression than, say, the relatively coarse-grained possibilities offered by facial expressions, gestures, or postural adjustments (e.g., Niedenthal, 2007). This nuance is reflected in how we tend to speak about music and its ongoing impact on the listener: its affective power, vitality, and seemingly infinite ability to convey a range of subtle feelings and expressions. Musical expressions of emotions can have, for instance, increased complexity, temporal range, subtlety, and force in contrast to their non-musical counterparts (Cochrane, 2008, p. 338). These properties help to explain why, when listening attentively to a piece of music, we often feel as though we have temporarily accessed a realm of feeling and expression that somehow goes beyond that of our everyday non-musical life; it also helps explain why musical expressions of emotion can seem simultaneously familiar and alien.23 When we integrate with music via musical affordances, we thus gain access to this expanded expressive palette, much the way that dancing with a highly skilled partner provides ongoing feedback that, for a time, at least, elevates one’s own dancing. As a result, we are able to temporarily access musically scaffolded forms of experience and expression that we cannot access outside of this music-listener system.

This is vividly demonstrated by looking at the narratives of those living with Moebius syndrome, a congenital form of bilateral facial paralysis (Cole, 1998; Bregel, 2006; Cole and Spalding, 2009). Since people with Moebius syndrome have no facial animation, they are unable to facially articulate emotions. They often report a diminishment or loss of emotion and affect that they feel results from their lack of facial expressivity (Cole, 2009). For example, one individual with Moebius writes that, “I think there’s a lot of dissociation [from emotional experience]. But I think I have to say this thought is a happy thought and therefore I am happy”; another tells us that, “I did not express emotion. I am not sure I felt emotion, as a defined concept...I don’t think I was happy, or even had the concept of happiness as a child” (Cole, 2009, pp. 353-354). These narratives appear to lend support to the previously discussed link between emotional experience and its behavioral expression (Laud, 2007; Niedenthal, 2007). But they are also interesting in virtue of what they tell us about the various compensatory strategies people with Moebius syndrome adopt (Bogart et al., 2012; Bogart et al., in press; Krueger and Michael, 2012). Since people with Moebius syndrome cannot use their face to express emotion, they often utilize other resources and strategies: modulating their tone of voice, intentionally speaking in a loud and clear voice, speaking candidly about their feelings, using humor, exaggerated gestures, touching, or employing various props or articles of clothing (e.g., a smiley face pin on a jacket lapel; Bogart et al., 2012). These strategies involve recruiting compensatory strategies for expressing emotions to others. But people with Moebius syndrome also utilize compensatory strategies to experience emotion—and a common feature of their narratives is their reliance upon art and music in this regard (2009). The experience of both performing and listening to music seems in particular to be a means of accessing certain emotional and affective experiences—or at least emotional and affective experiences of a certain phenomenal quality or intensity—that, in virtue of their facial paralysis, they cannot otherwise access.24 One way to understand music’s efficacy in helping people with Moebius syndrome recalibrate their emotional phenomenology is, once again, to appeal to emotional offloading. People with Moebius syndrome offload certain regulatory and expressive functions onto the music—regulatory and expressive functions which they lack—and in so doing allow the music to scaffold experiences of a kind and degree that would otherwise remain inaccessible. Musical agency provides surrogate regulatory functionality. For all listeners, music can also scaffold our access to novel emotional and affective experiences by shaping our perception and experience of time. We tend to experience time as passing more slowly during sustained engagement with emotionally compelling music (Kellaris and Kent, 1992; Schafer et al., 2013). This expanded sense of temporal presence offers additional regulative functionality. It allows us to attend more carefully, and in unaccustomed ways, to the development and modulation of our music-enhanced emotions. As an esthetic technology, music augments emotional expression and exploration. Again, when we engage with music, we potentially access an expanded horizon of regulative possibilities that bring with them a richer palate of emotional expression and experience than we could access purely by appealing to our own internal (i.e., non-musically enhanced) resources.

The regulatory functionality that musical affordances provide can also have a profound impact on the cognitive development and performance of children and young infants. In the case of young infants, music potentially offers an enhanced means of exploring and regulating emotions by providing access to a means of emotional expression that we cannot otherwise access.17 One way to understand music’s efficacy in helping people with Moebius syndrome recalibrate their emotional phenomenology is, once again, to appeal to emotional offloading. People with Moebius syndrome offload certain regulatory and expressive functions onto the music—regulatory and expressive functions which they lack—and in so doing allow the music to scaffold experiences of a kind and degree that would otherwise remain inaccessible. Musical agency provides surrogate regulatory functionality. For all listeners, music can also scaffold our access to novel emotional and affective experiences by shaping our perception and experience of time. We tend to experience time as passing more slowly during sustained engagement with emotionally compelling music (Kellaris and Kent, 1992; Schafer et al., 2013). This expanded sense of temporal presence offers additional regulative functionality. It allows us to attend more carefully, and in unaccustomed ways, to the development and modulation of our music-enhanced emotions. As an esthetic technology, music augments emotional expression and exploration. Again, when we engage with music, we potentially access an expanded horizon of regulative possibilities that bring with them a richer palate of emotional expression and experience than we could access purely by appealing to our own internal (i.e., non-musically enhanced) resources.

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23This is not to suggest that people with Moebius syndrome live utterly impoverished emotional lives. Far from it. The point, rather, is that certain emotional experiences seem to be diminished in virtue of their loss of facial expressivity. But even here, these experiences can be compensated for by adopting various alternative strategies available both to the person with Moebius as well as to those they interact with (Bogart et al., 2012).
listeners, musical engagement can augment cognitive processes and emotional experiences that far exceed their current level of endogenous development. For example, background music has been shown to assist students with various developmental and learning disabilities by helping them to regulate their emotions, enhance motor coordination, and organize the attention needed to sustain task focus (e.g., Citape, 1986; Hallam and Price, 1998; Savan, 1999).

More striking, however, is the impact that music has on very young perceivers (neonates and preterm infants) in terms of giving them access to elevated cognitive and affective competence. Neonates lack the neurobiological resources needed to self-regulate endogenous control of attention, emotion, and behavior (for details, see Rothbart, 1989; Gopnik, 2009, pp. 106–123). Accordingly, because their attention is largely engenous (i.e., world-determined) at this stage of their development, they are extremely vulnerable to environmental perturbations. The impact of caregivers thus becomes extremely important in managing their attention and stabilizing their affect. Caregivers assist infants here by employing a range of different physical strategies (exaggerated movements, gestures, and facial expressions; manipulating gaze, body orientation; “infant-directed” speech consisting of raised pitch, slowed tempo, elongated vowels, and slow pitch contours with large frequency ranges) designed to actively modulate the attentional and affective character of early interactions in a way that is vital for the infant’s social-cognitive development (Stern, 1985; Tronick, 2005; cf. Krueger, 2012b). However, musical affordances can, as we saw previously, integrate with the infant’s native interest in and responsiveness to music and provide surrogate endogenous function, organizing attention, behavior, and affect in a way that exceeds their current level of development.

For example, not only do infants display an evaluative preference for consonant over dissonant music, in that the former guides their attention toward it while the latter repels it (Trainor and Heimiller, 1998, p. 83). Additionally, they latch onto affordances specific to the former in order to regulate their internal states and bring about a more inquisitive and emotionally balanced state in relation to their environment (Zentner and Kagan, 1998). In Zentner and Kagan’s study, the infants actively engaging with consonant music fretted less, exhibited slower and more controlled motor activity (i.e., they were less fidgety while absorbed in the music) and vocalized more (i.e., expressed interest in the music) than when listening to dissonant music or non-musical sounds. In short, they exhibited significantly enhanced behavioral, attentional, and emotional organization within a specifically musical context. Hadsbeck (2004) similarly found that pre-term infants entrained bodily movements (sucking, tongue and mouth protrusions, eye opening and closing), respiratory patterns, and alerting responses with consonant music (in this case, lullabies) and, in so doing, exhibited a heightened regulatory competence specific to the music therapeutic context. In these cases, the music does more than provide sensory input to be processed by the infant’s internal resources. Rather, it assumes an regulative function that determines the infant’s behavior and affective responses. The distributed listeners-music dynamics of this ongoing, mutually regulative exchange are where the infant (for a time, at least) is able to realize novel musically enhanced cognitive and emotional feats.

CONCLUSION
I have argued for a picture of the musically extended mind. I sketched a picture of “musical affordances” and argued that, in some circumstances, musical dynamics provided ongoing resources and feedback that enhance the functional complexity of various motor, attentional, and regulative capacities responsible for generating and sustaining emotional experience. A cascade of neural and behavioral entrainment responses are what secure the sort of sustained integration with musical affordances needed to bring about music-specific regulatory processes. In these cases, I claimed, specifying the nature of the relevant processes—and the emotions they give rise to—requires that we look beyond the boundary of the individual.

I do not claim to have conclusively defended the existence of a musically extended emotional mind. More work would need to be done—for example, to specify why an extended way of thinking about musically induced emotions is explanatorily superior to adopting a more conservative situated approach (cf. Rupert, 2004; Sprevak, 2010). I would also need to explicitly address the much-discussed coupling-constitution objection (Adams and Aizawa, 2001, 2008): the objection that, just because a given cognitive process is causally dependent upon an environmental process, it does not follow that the environmental processes thereby becomes a constitutive part of the causal process. I have responded to this objection elsewhere (Krueger, 2012). For what it is worth, I do not find this objection as formidable as is often assumed, in part because it strikes me as dangerously close to begging the question (see, e.g., Hurley, 1998; Ross and Ladyman, 2010; Kagan and Lassiter, 2013). But that is a discussion for another time. My point is simply that, if we take seriously the possibility that certain environmental resources can scaffold the emergence of extended emotions—as an increasing number of philosophers and cognitive scientists are inclined to do—we ought to take seriously the possibility that music is a particularly powerful example an emotion-extending resource.

Few would dispute that music plays a powerful role in our everyday lives. Its ubiquity and enduring popularity testifies to its ongoing impact; without music, our lives would, indeed, be greatly impoverished. But if something like the above story is true, the loss of music would not only diminish its esthetic quality but, additionally, our capacities as emotional agents. Thankfully, we still have music—and as such, a musically extended mind.

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