The Science-Music Borderlands

Reckoning with the Past and Imagining the Future

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8 The Musical Mind: Perspectives from Developmental Science

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As developmental scientists who study music, our goals are to describe and track musical experiences and behaviors in the broader context of other developing capacities, characterize the nature of musical experiences at different points in the life span, and understand how individuals both respond to and shape their own unique histories of musical development. Yet to participate in a truly interdisciplinary discussion of the musical mind, we may need to scrutinize and reconsider some of our most fundamental concepts. As noted elsewhere in this volume (e.g., Mundy, chapter 4; Savage et al., chapter 18), basic concepts such as *music*, *musicality*, and *culture* are rooted in a network of ideas and categories of difference that may constrain the kinds of questions we ask and the conclusions we draw in ways that are limiting and perhaps even harmful. In this chapter we argue that a developmental science approach may offer a helpful perspective, given its emphasis on complex interactions of interlocking systems operating at multiple levels (Bronfenbrenner, 1999); its assumption of overlap between perceptual, cognitive, motor, and social processes; and its focus on the unique history of the individual.

First, when attempting to understand the concept of *music*, developmental science considers how an individual's conceptualization of music shifts with accrued experience and changing cognitive, social, and affective mechanisms. Research on infant auditory perception reminds us that we cannot assume that infants parse musical sounds like adults. For example, the perceptual integration of a sound wave and its harmonics (or overtones) as a single auditory event does not occur until four months of age (Folland et al., 2015). And while the definition of music is heavily influenced by culture, even for an individual adult, the point at which patterns of sound are interpreted as music is sometimes extremely unclear. This is illustrated by the popular "sometimes behave so strangely" illusion (Deutsch et al., 2008), in which the repetition of a spoken phrase suddenly sounds "musical" to the listener. When do infants and children form conceptual categories for music and nonmusic? Much of the time, when we say that infants *respond to music* in a certain way, what we really mean is that they respond to *something most Western adults consider to be music*.

Second, what does it mean to be musical? How do these definitions change as development unfolds? As noted elsewhere in this volume (e.g., Ilari & Habibi, chapter 17; Cowan, chapter 16), *musicality* is often conflated with specialized musical skills that typically require music training or formal experience with music. This is problematic for a number of reasons. First, musically trained individuals in Western societies often differ a priori from their peers on a number of factors, including music perception abilities (e.g., Swaminathan et al., 2017; Kragness, Swaminathan, et al., 2021). Moreover, notions of music as performative and reserved for the expert are largely a product of the Western art music culture (Turino, 2008). Everyday musical interactions, however, appear to be universal (in function, if not form), frequent, and salient in early life (Ilari, 2005). Evolutionary psychologists have reframed the notion of *musicality* to refer to capacities that enable musical engagement without training (e.g., Patel, chapter 1 in this volume; Duengen et al., chapter 3 in this volume). Indeed, well before infants and young children can engage in formal music training, they are highly musical creatures who can sing, dance, and respond in socially and emotionally meaningful ways to musical stimuli.

Third, how can we define *culture* without relying on categories that "other" and overgeneralize groups of diverse individuals? As acknowledged here and elsewhere (e.g., Savage et al., chapter 18; Henrich, 2020), the study of music cognition—much like the study of human nature in general—has relied on an oversampling of Western, educated, industrialized, rich, and democratic (WEIRD) populations, which has created an incomplete, nonrepresentative, and fundamentally noninclusive picture of human musicality. At the same time, criticizing the weirdness of WEIRD runs the risk of overessentializing and exoticizing the non-WEIRD and thus reinforcing the very problems the concept is meant to critique (Savage et al., chapter 18; Clancy & Davis, 2019). Instead of labeling a person's musical culture or grouping individuals based on their culture, a developmental perspective might emphasize what that individual "grew up with"—the individual's unique life history of musical experiences and how those past experiences shape that listener's current and future musical experiences. Given that context and age contribute to each and every musical experience we have, conceptualizing culture in terms of an individual's experience with particular musical activities or traditions (e.g., dancing, specific song genres) may enhance precision as well as better capture the wide range of musical cultural experiences that can exist within a particular society or geographic region.

In this chapter, we apply perspectives from developmental science to explore how the so-called musical mind emerges and changes from infancy into adulthood. Given the preceding conceptualizations of music, musicality, and culture, we expand on three ideas from developmental science that may be helpful when thinking about the musical mind. First, we assert that the musical mind does not develop in isolation from other domains. The way individuals perceive and engage with music must be considered in the context of their developing sensory and perceptual systems, cognitive abilities, motor milestones, and social-emotional capacities across the life span. Second, we highlight the need for a more nuanced appreciation of developmental processes for understanding the dynamic nature of musical experience and capacities at different ages. We use musical entrainment as an example of a musical behavior that is often assumed to be "available" from birth but appears to have a strikingly protracted developmental trajectory, depending on the tasks and methods of investigation. Finally, we note that infants and children are not simply passive recipients of musical input; their early and active responses to music influence how parents integrate music into their lives. Beginning early in life, musical experience is driven by a dynamic interaction between the environment and the individual.

Musical Development and Development in Other Domains

Development in any one domain is deeply intertwined with development in others. Consider the case of visual and motor development. Learning to locomote involves the complex coordination of numerous muscle groups and postural control. Once self-propulsion is achieved, infants' interactions and affordances in the world are fundamentally different. Visual information can be harnessed in a new, more sophisticated way and can be used to plan and self-correct infants' own movements in the world. Higgins, Campos, and Kermoian (1996) measured the impact of this motor milestone using a clever "moving walls" contraption that simulates visual input associated with locomoting forward or backward. While prelocomotor infants sit happily and enjoy the visual "show," crawling and walking infants of the same age shift their center of gravity forward or backward to account for the apparent feeling of motion. This is a powerful illustration of the idea that visual perception is affected by motor abilities and that the two systems do not develop independently. Likewise, the musical mind does not have an independent, isolated trajectory but develops in tandem with other perceptual, cognitive, and socioemotional abilities.

Cognitive abilities: Put simply, cognitive abilities are the mental processes that enable us to hold information in memory, as well as recall and manipulate it. Some cognitive abilities are already observable in fetuses—for instance, newborns recognize musical excerpts they heard prenatally (Panneton, 1985; Partanen et al., 2013; Polverini-Rey, 1992; Satt, 1984), implying that a fetus can encode and retain auditory input. With maturation comes increasingly sophisticated mental operations and processing abilities. The speed of mental operations, the amount of information that can be maintained in memory at one time, and the ability to focus attention all increase substantially over childhood as neural function matures and experience is accumulated.

Cognitive abilities are clearly implicated in many tasks that measure musical abilities—for instance, "same or different?" tasks rely heavily on the ability to retain auditory information in short-term memory for comparison. The capacity to perform such tasks is necessarily tied to advances in cognitive development (see the next section for a discussion of this in the context of rhythm perception). Perhaps more importantly, numerous day-to-day responses to musical phenomena presumably rely on cognitive mechanisms. For example, melodic enculturation may depend on a statistical learning mechanism by which cumulative exposure to musical structures shapes musical expectations (e.g., Pearce, 2018). Musical reward is hypothesized to be associated with cognitive evaluation of expectation violation and nonviolation (e.g., Cheung et al., 2019; Gold et al., 2019). Similarly, it has been suggested that the sensation of "groovy" syncopation emerges as a consequence of active inference instantiated at intermediate levels of rhythmic ambiguity (Witek et al., 2014; Matthews et al., 2020; Koelsch et al., 2018). Changes in cognitive ability are therefore potential targets for understanding developmental change in responses to music.

To the extent that changing cognitive abilities account for changes in music cognition, they could have implications for other aspects of musical engagement. The ability to recognize familiar sequences of syllables, rhythms, and pitches enables the emergence of social preferences based on songs (e.g., Cirelli & Trehub, 2018; Mehr et al., 2016; Soley & Spelke, 2016). Similarly, sharing musical expectations with others enables increasingly sophisticated musical engagement—the ability to clap, sing, or dance along and to share emotional responses to music with the people around us.

Language and communication abilities: Comparisons between language (particularly speech) and music are frequently made in the literature, which is not surprising, given that they (usually) share the auditory modality and are communicative in nature. This connection is especially prominent in early life, given that song appears to be an effective form of preverbal communication between parents and infants: caregivers frequently sing to soothe tired infants to sleep or engage them in playful interactions.

The musical qualities of speech, too, seem to be highly salient components of infants' early language development. Rhythm appears to be one of the earliest properties of language (Nazzi et al., 1998). Language and music share parallel rhythmic structures—for instance, the relative frequency of dotted rhythms in English versus French folk songs parallels the contrast in the two languages' spoken rhythms (Huron & Ollen, 2003;

Patel & Daniele, 2003), and this pattern is enhanced in children's songs (Hannon et al., 2016). Aside from communicating affect, early song may provide temporal frameworks on which language abilities are scaffolded. Indeed, rhythm perception has consistently been linked to language ability in children (Gordon et al., 2015; Ladányi et al., 2020).

Exposure to different speech accent patterns also shapes infants' perceptual grouping tendencies. For instance, infants who are surrounded by the Japanese language tend to perceptually group accented tones differently than infants surrounded by English, which is presumably attributable to differences in accents and grouping in those languages (Yoshida et al., 2010). Language experience continues to shape music perception into childhood and adulthood. Tone language speakers have superior performance on melody discrimination tasks (but not other music perception tasks) as early as preschool (Creel et al., 2018), and this advantage persists through adulthood (Swaminathan & Schellenberg, 2020; Swaminathan et al., 2021; Zhang et al., 2020).

Yet an open question is the extent to which music and language are experienced as separate domains, especially in the context of infancy. Though laboratory studies consistently show enhanced responses to song versus speech (e.g., Cirelli & Trehub, 2019; Corbeil et al., 2016), these results do not necessarily imply that infants are able to make a categorical distinction between the two. Instead, they may be responding to a difference in *degree* (of musicality, emotionality, or rhythmicity, for example) conferred by song versus speech. At the same time, nonspeech sounds, such as sine tones or birdsong, fail to facilitate infant learning as readily as speech does (Ferguson & Waxman, 2017; Woodruff-Carr et al., 2021). The contexts in which these domains are distinct have yet to be elucidated.

Motor abilities: When listening to a song, we sometimes find ourselves tapping our toes without even realizing we are doing so. The ability to control and coordinate beat-aligned movements intentionally, let alone without conscious awareness, is not straightforward. In its earliest stages, infants face constant motor challenges as they continuously recalibrate sensory (and multisensory) information as their bodies grow and change. It is no surprise, then, that moving to music also has an extended developmental trajectory. Improvement in beat alignment across childhood is slow, with improvements apparent into adolescence (McAuley et al., 2006).

Importantly, however, movement is not simply a consequence of hearing music. The act of *moving* to music can also shape perception. Tapping along to a beat improves beat perception (Manning & Schutz, 2013), and different effectors are involved, depending on their natural oscillatory frequency, which changes with growth. Research on infants being moved *by an experimenter* shows that different movement influences the perception of a metrically ambiguous rhythmic sequence (Phillips-Silver & Trainor, 2005).

Given the influence of movement on perception, it follows that changes in motor development may lead to changes in music perception. For instance, differences in effector size might differentially affect the easiest metrical level to move to, which could influence tempo judgments. The extent to which syncopation engages the motor system could be affected by motor affordances. And widening the perspective to other implications, being able to move oneself with music enables self-generated social bonding experiences in the context of music (e.g., Cirelli, 2018).

Musical Functions and Capacities Change Throughout Development

Perhaps in support of the idea that musicality is a universal, core feature of human nature, a common approach to characterizing the development of musicality has been to identify or inventory the capacities that appear earliest in development and assume that this evidence supports the existence of evolved, biologically based adaptations for music. Although it is clearly important to examine potential starting points of human musicality, this approach is problematic and may arise from preformationist assumptions that ignore the critical role of developmental processes in shaping the musical mind.

First, this approach reflects a common but unsupported assumption that if something is an adaptation, it should be observed at birth or shortly thereafter, and anything that emerges later must be acquired through learning. This assumption is undermined by examples such as breasts and bipedalism, which are clearly products of natural selection that are not present at birth but emerge later, when they are needed (Al-Shawaf et al., 2018). Likewise, as noted by Patel (chapter 1), developmental plasticity can play a crucial role in the emergence of traits designed by natural selection, such as when a particular capacity or specialization (e.g., motion perception or tonotopic cortical maps) depends on optimally timed exposure to environmental structure (experience-expectant plasticity).

A disproportionate focus on early emerging musical capacities may also promote a more static view of musical development that assumes younger listeners simply have less mature versions of the experiences and musical concepts of (Western) adults. But in fact, the musical experiences of younger individuals may be different from those of older individuals in important ways. Just as others have promoted a less anthropocentric approach to music cognition in nonhuman animals (see Duengen et al., chapter 3), we urge readers to consider embracing a more "ecological" approach to infants and children that doesn't take adults' musical concepts and definitions as the only reference point.

A second and perhaps bigger problem is that any inference about the developing musical mind is inherently limited by the paradigms, tasks, and stimuli used to examine it, and we cannot assume these paradigms always give rise to the same musical experiences, regardless of age. Even if children and adults respond in similar ways to a particular stimulus or task, this does not necessarily mean they rely on the same underlying processes, especially when the task examines only one aspect of a much more complex and multimodal musical behavior or experience. Musical entrainment provides a good example of a fundamental but complex musical capacity that appears to emerge very early or very late, depending on the tasks and methods used to measure it.

Without any specialized training, most adults are capable of dancing, clapping, marching, and other forms of entrainment, and these are arguably some of the most ubiquitous and directly observable human musical behaviors (Begel et al., 2017; Sowiński & Dalla Bella, 2013). Even though these behaviors are widespread, they are highly multimodal and complex, dependent on a host of underlying perceptual, cognitive, and motor processes that are still not fully understood. To be able to dance to music, a listener must segment multimodal musical input into discrete units or events, interpret the rhythmic patterning of those events, infer the beats within the metrical framework, establish and maintain endogenous rhythms that correspond to the beat and meter, and precisely coordinate body movements with that structure.

An extensive body of empirical work has examined adult entrainment behaviors, either by asking listeners to tap in synchrony with metronomes, rhythms, or music (Repp & Su, 2013; Snyder & Krumhansl, 2001) or, more recently, by using motion capture technology to observe dancing directly (Burger et al., 2014; Naveda & Leman, 2010; Toiviainen et al., 2010). When similar technologies are applied to infants and children, however, it is clear that entrainment behaviors develop rather gradually. For instance, although infants exhibit some rhythmic movements in response to music (Zentner & Eerola, 2010; Fujii et al., 2014; Rocha & Mareschal, 2017), and some preschoolers can drum or move periodically (rather than randomly) to music (Eerola, Luck, & Toiviainen, 2006; Kirschner & Ilari, 2014; Kirschner & Tomasello, 2009; Woodruff-Carr et al., 2014), even adolescents as old as sixteen or seventeen are not as precise in their musical entrainment as young adults (Braun Janzen et al., 2014; Drake et al., 2000; McAuley et al., 2006; Thompson et al., 2015). For this reason, much developmental research has focused on more indirect measures of the perceptual and cognitive underpinnings of entrainment behavior.

Studies of children typically use rhythm discrimination or change detection to indirectly measure beat perception during development. These paradigms have provided evidence that newborns and young infants can discriminate simple rhythmic patterns (Chang & Trehub, 1977; Demany et al., 1977; Hannon & Johnson, 2005) and that they are better at doing this for strongly metrical than weakly metrical rhythmic patterns (Trehub & Hannon, 2009; Hannon et al., 2011). Studies have also shown that the newborn brain exhibits larger mismatch negativity responses to deviants occurring on strong rather than weak beat positions (Winkler et al., 2009) and that beat frequencies can be observed in the steady-state evoked brain potentials of infants listening to rhythms (Cirelli et al., 2016). This indirect perceptual and neural evidence is often cited to support the claim that the basic capacity for entrainment to a musical beat is present at or shortly after birth and is continuously available throughout development.

These findings are at odds, however, with a growing body of evidence that rhythm and beat perception undergo significant and gradual changes over the course of childhood, becoming increasingly specific to the child's cultural musical listening experiences (Gerry et al., 2010; Einarson & Trainor, 2016; Hannon & Trehub, 2005a, 2005b; Soley & Hannon, 2010; Hannon, Vanden Bosch der Nederlanden, & Tichko, 2012) and eventually giving rise to robust cross-cultural differences in rhythm and beat perception and production in adulthood (Hannon, Soley, & Ullal, 2012; Kalendar et al., 2013; Jacoby & McDermott, 2017; Ullal et al., 2014). Recent evidence suggests that even for North American children listening to Western music, the capacity to match music to the correct metronome at both the beat and measure levels does not become adult-like until adolescence (Nave-Blodgett, Hannon, & Snyder, 2021; Nave-Blodgett, Snyder, & Hannon, 2021). Likewise, the capacity to sustain an endogenous beat while listening to an ambiguous rhythm appears to have a protracted course of development (Nave et al., in preparation).

It is possible to reconcile these seemingly conflicting findings by proposing that the capacity for beat perception is essentially present at birth but becomes refined in a culture-specific manner over the course of development in parallel with or as a result of improved motor coordination. However, it is also possible that the observed developmental changes represent fundamental differences in the perceptual, cognitive, and motor processes available to listeners of different ages. The fact that these abilities take so long to become adult-like is consistent with evidence of protracted development in other areas such as language, working memory, disgust, and crystallized intelligence (Hartshorne & Germine, 2015; Hartshorne et al., 2018; Rottman, 2014). Assuming that evolved traits should be available at an age when they are most beneficial for survival and reproduction, such developmental evidence can actually be used to evaluate claims or theories about their evolved functions (Rottman, 2014). In this case, although the capacity to entrain to music could be part of an evolved adaptation for music making, the fact that it continues to change throughout childhood and is not fully available until adolescence or early adulthood may have implications for understanding its functional role (perhaps to forge bonds with adolescent peers rather than between infants and caregivers). Thus, rather than assuming that indirectly observed, early-emerging capacities are essentially equivalent to the more complex and directly observed musical behaviors of adulthood, we emphasize the importance of understanding developmental processes and timing and the ways musical functions might change throughout life.

We Play an Active Role in Our Musical Development

The idea that humans start as blank slates ready to be written on by their environment dates back to Aristotle. This perspective on development not only downplays the important role of genetics and biology but also depicts the developing child as a passive recipient of input. Instead, research in the past century reveals that children actively construct knowledge about the world around them, select which inputs to attend to, and influence the behavior of those around them. For example, when infants lock eyes with a parent, their responsive smiles and coos encourage continued parental attention.

We continue to play an active role in our own development across the life span. In this section, we use examples from early childhood to highlight how active engagement and feedback loops affect the musical mind and shape future musical experiences.

Caregiver song provides a compelling example of such a feedback loop. It is one of the most common forms of musical exposure in early life (Ilari, 2005; Mendoza & Fausey, 2021) and is common all over the world (Trehub & Gudmundsdottir, 2015). When parents (as well as nonparents and older children) sing to infants, they adopt an infant-directed singing style. Compared with adult- or self-directed song, infant-directed song is more emotional and often higher in pitch, with slower and more regular rhythms (Nakata & Trehub, 2011; Trainor, 1996). This increased emotionality and modification of acoustic properties are similar to what occurs when we speak to infants (Fernald, 1989).

From birth through infancy, infant attention is captured and emotions are regulated by infant-directed song (Masataka, 1999; Trainor, 1996), often more so than infant-directed speech. For example, infants happily listen to recordings of infant-directed song for twice as long as infant-directed speech before becoming distressed (Corbeil et al., 2016). If infants are already distressed, caregiver song is better than caregiver speech at mitigating distress, reducing physiological arousal, and capturing infant attention (Cirelli & Trehub, 2020). In short, infant-directed song captures infants' attention, regulates their emotional responses, and influences their behavior.

These infant responses reinforce and shape caregivers' emotional responses and continued musical behaviors (Cirelli, Jurewicz, & Trehub, 2020). For example, if an infant responds with interest and joy to a caregiver's song, this may encourage the caregiver to continue singing or to use song in a similar context in the future. If it effectively calms infants before nap time or cheers them up when they are distressed, caregivers may be more likely to build these strategies into daily routines. Guided by infant feedback, even the musically inexperienced caregiver may rapidly develop a repertoire of songs or vocal behaviors. In general, developmental research has demonstrated that infant feedback has a dynamic impact on caregiver behavior. For example, when infants respond with joy and interest to higher-pitched infant-directed speech, caregivers continue to modulate their pitch upward (Smith & Trainor, 2008). This feedback loop may explain why it is so natural for humans to adopt infant-directed vocalization styles when interacting with infants, encouraged by their interest and responsiveness.

Infant musical preferences may also shape musical exposure in the home. For example, familiar songs are more likely to capture infant attention and generate rhythmic movements than rarely heard songs. This preference for familiar songs is robust, whether they are sung by a parent or a stranger, and it remains robust even when the stranger's and parent's renditions differ substantially in terms of tempo and pitch (Kragness, Johnson, & Cirelli, 2021). And although song is generally more effective than speech at cheering up distressed infants, an infant's favorite song is the most effective and is more likely to generate infant smiles (Cirelli & Trehub, 2020). Infants and children also show social preferences for singers of familiar songs (Cirelli & Trehub, 2018; Mehr et al., 2016; Soley & Spelke, 2016). If an infant responds more positively to one particular song than others, this likely encourages the parent to keep that song in the rotation. But how do these preferences emerge? Certainly, caregivers play a significant role in introducing particular songs to infants. However, it is likely that the songs that generate the largest responses from the infant will become part of the daily routine. Adult research highlights that musical preferences can be influenced by personality characteristics (Vella & Mills, 2017). Whether early temperament also influences early musical preferences is yet to be explored.

The preceding examples from infancy highlight that early responses to music actively shape how we experience music in our everyday lives, but these active processes continue throughout life. For example, most of us become active music makers by engaging informally with music, such as by humming while washing the dishes or tapping our feet while listening to a favorite song. Precursors to music making, including rhythmic movements in response to music and early song-like vocalizations, emerge before the first birthday (Reigado & Rodrigues, 2017; Zentner & Eerola, 2010) and become more frequent in toddlerhood (Sole, 2017; Cirelli & Trehub, 2019).

These early music-making behaviors are generally spontaneous and embedded in social-emotional contexts. For example, toddlers' song-like vocalizations are more likely to emerge in response to an experimenter's song (Reigado & Rodrigues, 2017). Music also becomes integrated into early everyday play. A naturalistic study of spontaneous sibling interactions in the home reported common musical play (singing, dancing, or playing real or imaginary instruments) between two- and four-year-old siblings. Musical play became substantially more frequent between these same sibling pairs two years later, and musical play was positively correlated to measures of sibling prosociality (Cirelli, Peiris, Tavassoli, et al., 2020). These observations in a naturalistic context support laboratory work linking musical movements to expressions of joy in infancy (Kragness, Johnson, & Cirelli, 2021; Zentner & Eerola, 2010) and work exploring how musical movement with others encourages prosociality in infants and children (Cirelli, 2018).

The musical mind is not the product of passive exposure to musical input. Individual differences in perception, attention, and personality, combined with genetic and sociocultural factors, lead some infants to respond more favorably to music than others. Responsive caregivers find this favorable reaction reinforcing and continue to integrate music into their infants' lives. Infants also become active participants in their own musical development when they begin to produce musical behaviors (sing, dance) and spontaneously integrate music into play. Early musical experiences are often associated with feelings of joy. In short, infants actively shape and contribute to their musical worlds. Infancy provides powerful examples of how we play an active role in our own musical development, but these feedback loops continue to refine our musical identities across the life span.

The Future of Developmental Science in Understanding Musicality

In this chapter, we conceptualized the musical mind from a developmental perspective and applied three major ideas from modern developmental science: that development occurs across multiple domains, that development is not simply the unfolding of continuous and static capacities, and that individuals shape their own musical experiences.

These ideas point to the importance of combining reductionist and ecological approaches. Reducing musical phenomena to highly controlled experimental settings necessarily omits elements of the musical experience. But without using a reductionist approach to understand basic questions about auditory pattern perception, acuity, and cognitive abilities, we run the risk of imposing unwarranted assumptions and generalizations about any given musical experience. At the same time, laboratory work cannot tell us about an individual's music listening history, the social and emotional contexts in which that person hears music, or the societal contexts in which these experiences are embedded. In the past decade, researchers have used unobtrusive home recording devices to collect daylong samples of infants' auditory home environments (e.g., Benetti & Costa-Giomi, 2019; Mendoza & Fausey, 2021). Combining such approaches with traditional laboratory work offers a promising avenue to better understand how environmental input (versus presumed "group" differences) shapes music perception (see Wojcik et al., 2022, for a related discussion on music-language links).

A focus on *experience-based perception* also implies a role for studying *experience-based change*. Rather than concentrating on the age at which certain musical abilities emerge, we argue that a more productive approach would be to focus on the accumulation of experiences, as well as the neural and behavioral preparedness that might drive the development of these abilities. Although longitudinal studies present logistical challenges, they are crucial for understanding the shape and rate of developmental change. Likewise, studies that emphasize the time periods in which rapid change is most likely to occur ("microgenetic" studies) can be particularly informative in terms of explaining how different elements of music perception emerge and their association with developmental change in other domains.

In conclusion, we return to our emphasis on questioning and redefining our most basic concepts: What is music? What does it mean to be musical? What is culture? These questions are addressed elsewhere from various perspectives. Iyer (2012) describes music as "the sound of bodies in motion." Patel (chapter 1) discusses how music is a socially constructed category and focuses instead on musicality. Ilari and Habibi (chapter 17) point out that the definition of musicianship varies across disciplines and cultures and often ignores musical skills acquired informally during childhood. Building on these ideas, we propose that any claims about music and musicality should be considered in light of development in other domains and an individual's lifetime of musical experiences. We cannot ignore individual differences in how musical abilities mature, interact with other facets of development, and become driven by feedback loops if we want to understand the complex and idiosyncratic musical mind. Just as we should not assume that infants experience music the same way as adults, we should not assume that every adult's experience of music is similar. This entails better measures of prior musical experiences and the sociocultural contexts in which these experiences took place. It also requires careful consideration of the tasks and stimuli we use so that the diversity of individual experiences can be more purposefully integrated in the research process.

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