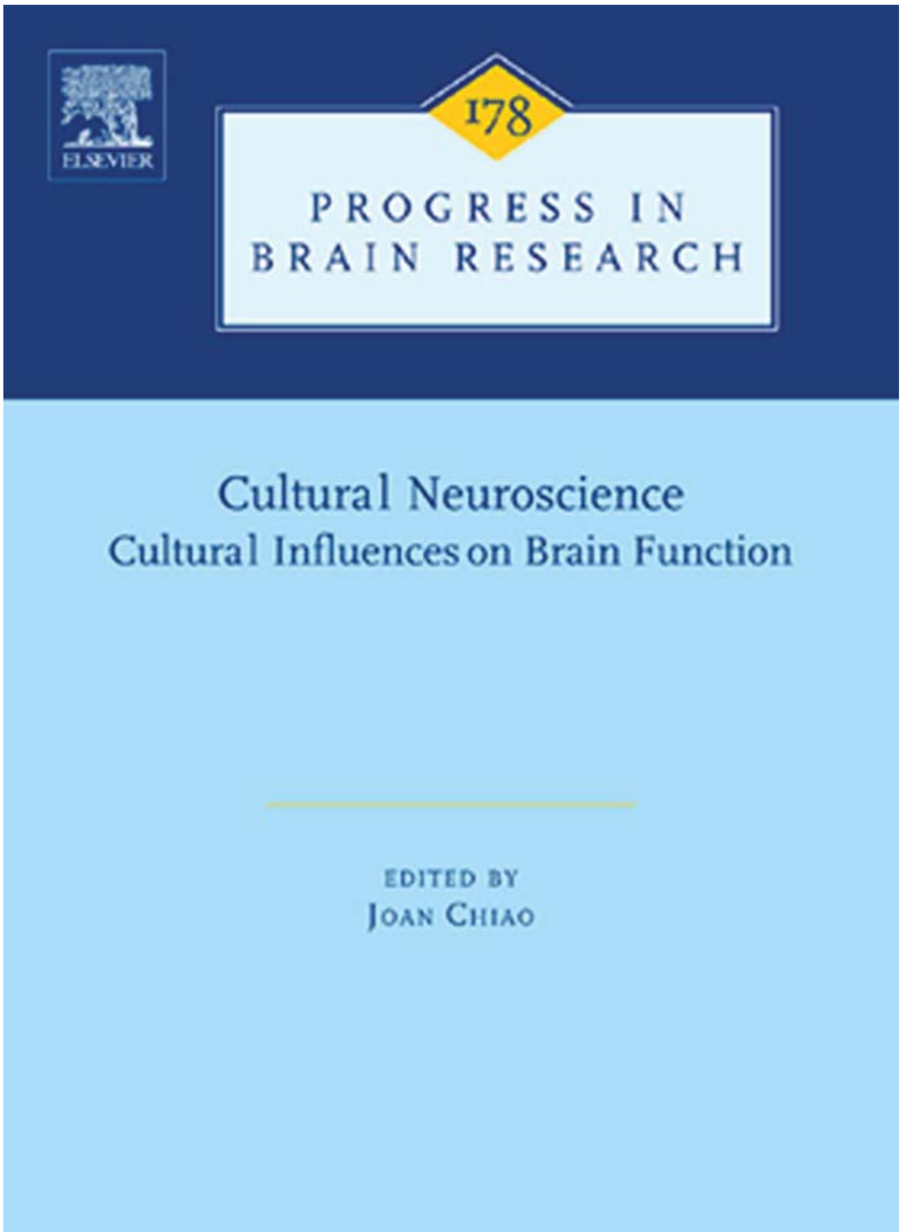

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CHAPTER 5

Cultural constraints on music perception and cognition

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Abstract: Research suggests that music, like language, is both a biological predisposition and a cultural universal. While humans naturally attend to and process many of the psychophysical cues present in musical information, there is a great — and often culture-specific — diversity of musical practices differentiated in part by form, timbre, pitch, rhythm, and other structural elements. Musical interactions situated within a given cultural context begin to influence human responses to music as early as one year of age. Despite the world's diversity of musical cultures, the majority of research in cognitive psychology and the cognitive neuroscience of music has been conducted on subjects and stimuli from Western music cultures. From the standpoint of cognitive neuroscience, identification of fundamental cognitive and neurological processes associated with music requires ascertaining that such processes are demonstrated by listeners from a broad range of cultural backgrounds and in relation to various musics across cultural traditions. This chapter will review current research regarding the role of enculturation in music perception and cognition and the degree to which cultural influences are reflected in brain function. Exploring music cognition from the standpoint of culture will lead to a better understanding of the core processes underlying perception and how those processes give rise to the world's diversity of music forms and expressions.

Keywords: cross-cultural music; enculturation; music learning; memory

> Music is the universal language of mankind
> (Longfellow, 1865, p. 202)

> Music takes as many forms as culture
> (Cross, 2008, p. 2)

Constructs such as language, rituals, and belief systems often serve as delineators of cultural groups, functioning to identify who is an insider and who is an outsider, culturally speaking. Music, on the other hand, is often thought of — and even promoted — as a both an accessible path into a culture and a source of commonality across cultures. While this notion of music as a "universal language" has been largely discredited (Campbell, 1997; Nettl, 2001; Wachsmann, 1971), it is easy to ascertain how it gained popular acceptance.

First, music as a phenomenon can reasonably be argued to be universal. It is present in some form in virtually every society and evidence of its existence appears to stretch back well before recorded history. Second, the non-universality of any specific music is not readily apparent.

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The more propositional nature of language leads to reasonably clear determinations of that which is understood (or understandable) and that which is not. The more indeterminate ‘‘meaning’’ of musical sounds — apart from specific associations or other cultural references — can lead to misunderstanding, misinterpretation, and mistranslation, though these inaccuracies are rarely as evident or consequential as those involving language. Indeed, Cross (2007) proposes that music’s ‘‘floating intentionality’’ may be at the very heart of its evolution within the human species, ‘‘affording conceptual and social spaces within which individual and collective imaginings can take place’’ (p. 157). In other words, music’s ability to accommodate multiple interpretations may have facilitated negotiation among early human societies. Third, a small number of music styles and genres have gained popularity (or at least visibility) throughout many of the world’s societies. The ubiquity of Western classical and popular music across the world may lead one to presume a global commonality of musical taste and experience.

Coupled with these observations is the arguably limited generalizability of current cognitive models of music processing. Much of the research literature investigating processes of musical development and music cognition reports data collected from a culturally limited range of participants, typically individuals encultured in Western or, to a lesser extent, Asian societies. Likewise much of the material used in music research to date predominately includes either music from a limited collection of traditions (largely Western art music) or musical stimuli pared down to isolate some specific parameter (e.g., duration, frequency) to the extent that any particular cultural association is removed. While the conclusions of these studies may be valid across a variety of musical interactions, it is only through comparative study of a broad array of music traditions and listeners that we can begin to develop more generalizable conclusions about human musical thinking.

In this chapter we will consider several ways in which culture has been approached as a variable in the study of music perception and cognition, with particular attention paid to recent neurological investigations of musical interactions. We will examine the process of music enculturation beginning from fundamental categorization of music stimuli through increasingly complex music processing challenges, including an overview of our own research on the influence of culture in musical memory. We conclude by proposing some promising areas for future study.

Foundations of music enculturation

While constructs such as pitch and duration serve as fundamental components of music, it would be unlikely that any given isolated instance of pitch or duration could be characterized as culturally grounded. Culture-specific practice begins to emerge in the relationships among these basic units and the degree to which such relationships are considered typical, acceptable, or desirable. It is this very typicality that underlies current theories of development which posit that individuals use a process of ‘‘statistical learning’’ to generate rule structures including those that govern interactions with music (McMullen and Saffran, 2004; Saffran et al., 1999). Fundamental features that distinguish one music culture from another include the pitch collections from which melodic material is derived (scales) and the strong/weak pulse patterns over which duration is organized (meter). General sensitivity to pitch and metric features is evident early in infancy. Infants can discriminate relevant musical features without regard to cultural boundaries up to about 10 months of age. After that point, Western children begin to respond differentially to musical structures from their home culture compared to culturally unfamiliar scales or meters (Hannon and Trehub, 2005a; Hannon and Trainor, 2007).

Responses to pitch structures

A series of studies by Lynch and colleagues (Lynch et al., 1990, 1991; Lynch and Eilers, 1991, 1992) explored the influence of cultural background on the perception of mistuned notes in major, minor, augmented, and Javanese *pelog* scales. They found a clear benefit (lower discrimination thresholds) for culturally familiar stimuli (major and minor scales) among children and adults though perceptual acuity differed by both age and training. In two studies employing infants (Lynch et al., 1990; Lynch and Eilers, 1992) they found that enculturation effects emerged most clearly after one year of age.

Hannon and Trainor (2007) speculated that enculturation is a bottom-up process in which culture-specific music knowledge is built upon more general sensitivities to pattern and categorization. Further, they observed that sensitivity to more culturally specific characteristics (harmonic structure) appears to follow sensitivity to more broadly applicable characteristics (key membership). As an illustration, Neuhaus (2003) reported use of both general listening strategies (categorical perception, pattern detection) and culture-specific responses among Turkish, German, and Indian musicians when listening to a variety of familiar and unfamiliar scale patterns. The participants demonstrated common differential ERP responses — P300 as well as a late-occurring (430 ms+) general negative shift — that reflected expectancy violations relative to their own music systems but not in response to violations within culturally unfamiliar systems.

Differences in musical responses observed between cultural groups may reflect differences in the ways in which individuals interact with music in a given society. When compared to English-speaking Canadian children, Japanese 5 and 6 year olds demonstrated greater proficiency recognizing original versus pitch-shifted versions of familiar melodies (Trehub et al., 2008). Trehub and colleagues argued that an emphasis on pitch labeling characteristic of music teaching in Japanese schools could have facilitated more robust processing of tonal stimuli thus resulting in a greater sensitivity to deviations from known melodic material.

It is interesting to note that children with more advanced second language production skills are more successful at discriminating non-native phonemes as well as fine mistunings of a major triad (Milovanov et al., 2008). As individuals with more sophisticated language skills are required to re-categorize phonemic units according to new rule systems, one might speculate that a similar degree of sensitivity is required to interpret culturally unfamiliar music on its own terms. Future work may examine whether advanced second language skills could facilitate more authentic (more like that of a cultural insider) processing of music built using unfamiliar pitch constructions.

Response to rhythmic structures

Organization of rhythmic material may also reflect the influence of enculturation. In a study of cross-cultural rhythm perception, Hannon and Trehub (2005a) found that, unlike adults, 6-month-old infants were equally adept at recognizing rhythmic violations in culturally familiar (Western) and unfamiliar (Balkan) metric contexts. A subsequent study (Hannon and Trehub, 2005b) found that North American infants as young as 12 months of age began to demonstrate less sensitivity to disruptions of unfamiliar non-isochronous metric patterns (varied durations between pulses) typical of Balkan folk music while maintaining sensitivity to familiar isochronous metric patterns (equal durations between pulses) typical of North American folk music. These changes in sensitivity based on cultural norms are similar to age-related changes in responses to pitch structures and linguistic information. However, after a brief period of repeated informal exposure to unfamiliar metric patterns, researchers were able to reverse the effects of enculturation and older infants' responses to non-isochronous examples were virtually identical to their responses to isochronous examples. In contrast, adults showed some improvement in their responses after exposure but to a much more limited extent.

When tapping along with a selection of French and Tunisian popular songs, French and Tunisian adults tapped to hierarchically more complex levels of rhythmic organization among selections that were more culturally familiar (Drake and Ben El Heni, 2003). This finding is consistent with earlier single-culture studies demonstrating that access to rhythmic complexity in tapping is indicative of greater musical expertise (Drake et al., 2000a, b). The degree to which rhythm is a prominent organizational feature of one's most familiar music style may also influence the way in which he or she interprets not only rhythmic material, but melodic complexity as well (Eerola et al., 2006). Even such seemingly basic points of interpretation as location of a downbeat appear dependent on encultured knowledge (Stobart and Cross, 2000).

Suggesting that rhythmic grouping might correspond to language accent patterns, Iversen et al. (2008) reported that English speakers tended to organize metric patterns into short-long groupings, while Japanese speakers exhibited greater variability in their responses though most often preferring long-short groupings. Similar relationships between linguistic and musical rhythm patterns have been observed even in comparisons of the instrumental music of French and English composers (Patel and Daniele, 2003). It is not yet possible to speculate whether characteristics of one mode of expression influences the other or whether each reflects deeper domain-general but culture-specific organizational principles. However, future research could explore the nature and generalizability of these findings that suggest an intriguing approach to the influence of culture across domains.

Interacting with complex musical structures

While the ability to discriminate, categorize, and consolidate discrete aspects of musical information is arguably a prerequisite for musical understanding, most interactions with music involve the processing of constructions that are complex, large-scale (at least compared to isolated tone sequences or patterns), and laden with associations. Moreover, interactions with complex musical structures lead not only to the "figuring out" of a song's organizational principles, but also to such comprehensive outcomes as affective response and retention in memory. For our purposes here we will specifically address individuals' responses to musical sounds themselves rather than to cultural associations or culture-specific social practices in which music features prominently. Admittedly it is likely impossible to parse an individual's encounter with music so neatly.

Scalar and metric structures, among others, provide frameworks upon which musical information can be superimposed and organized. It is the virtually infinite variety of that musical information that gives rise to the vast repertoires within any given music tradition. For example, a task as simple as recognizing the boundaries of a musical phrase requires individuals to draw on a combination of encultured principles of pitch hierarchy, contour, metric patterning, and rhythmic organization of sound and silence. Though both German and Chinese listeners demonstrated similar ERP responses associated with phrase closure for Western and Chinese melodies, both music style and listener culture significantly affected averaged responses early in the time course (100–450 ms) (Nan et al., 2006). In a subsequent study using functional imaging, musically trained German listeners completing a style categorization task demonstrated a right-lateralized network of activation associated only with listening to culturally unfamiliar Chinese melodies (Nan et al., 2008). Activated areas included right middle frontal and inferior parietal regions along with the right posterior insula. Results were interpreted as reflecting increased cognitive and attentional demands associated with the unfamiliar style.

Right-lateralized activity has also been reported among Western listeners in conjunction with melodic rule violations. Out-of-key melodic material evoked early right-lateralized negativities while memory-only violation evoked left-lateralized N400 responses (Miranda and Ullman, 2007). This is consistent with models that implicate right anterior-frontal areas in musical prediction among both adults as well as 10-year-old children (Koelsch et al., 2005; Koelsch, 2009).

When responding to structured versus unstructured melodies, both trained and untrained listeners demonstrated stronger bilateral activation of the inferior frontal gyrus, anterior STG, and premotor cortex along with right-lateralized activation of posterior STG (Minati et al., 2008).

ERP data showed a frontward shift of N2 response for structured melodies indicating activity in areas associated with classification and categorization, possibly reflecting the clearer organizational structure of these melodies.

Levitin and Menon suggest that such bilateral frontal activation may reflect the organization of information across time. They reported significant activation of left (and to a lesser extent right) inferior frontal areas among musically untrained Western adults when listening to intact (temporally organized) as opposed to scrambled (temporally unorganized) selections of Western classical repertoire (Levitin and Menon, 2003, 2005). Interestingly, both Levitin and Minati employed comparisons of organized and disorganized musical material. In contrast, comparing responses to music from different cultures reflects a comparison between organized and ''differently organized'' music. The latter distinction may result in much more subtle differences in both behavioral and neurological responses to music.

Perhaps the broadest aspect of complex music processing is affective response. Japanese listeners with varying levels of formal musical training successfully distinguished Japanese, Western, and Hindustani instrumental performances intended to convey joyful, sad, or angry emotions (Balkwill et al., 2004). Using a similar forced choice design, Fritz et al. (2009) reported that Western and African (Mafa) adult listeners recognized Western music examples characterized as happy, sad or scared/fearful. European and Indian listeners demonstrated less agreement selecting adjectives to describe a series of Western, Indian, and New Age examples (Gregory and Varney, 1996). However, when asked to identify the correct descriptive titles for New Age examples, both groups of listeners responded similarly. Sensitivity to affective content does not appear to be independent of sensitivity to technical aspects of the performance ranging from such broad constructs as loudness or tempo (Balkwill and Thompson, 1999) and mode (Fritz et al., 2009) to more subtle nuances like use of portamento or tenuto (Adachi et al., 2004). Wong and colleagues (in press) reported that adult listeners born in the United States gave higher ratings of tension to examples of Indian music; likewise, listeners born and raised in Bihar, India rated examples of Western art music as more tense. It is notable that the greatest degree of agreement between different listener groups was reported in cases in which the task was one of identifying the affective intent of a performance and the number of possible responses was small. Less inter-group agreement was apparent in cases where listeners were asked to report their own affective responses.

Given the difficulty of ascribing specific, declarative meaning to music, how can one identify conditions under which musical utterances are ''misunderstood'' from a cultural standpoint? Morrison, Demorest, and colleagues rationalized that listeners encountering music constructed according to familiar rules and conventions would be likely to process it more robustly, retaining not only the surface information presented (e.g., instruments, tempo) but the deeper forms and structures of the performance (Demorest and Morrison, 2003). In other words, listeners may more successfully get the ''gist'' of culturally familiar music than that which is unfamiliar (Agres and Krumhansl, 2008), thereby leading to better encoding and recall of what was heard.

Culture and musical memory

In a recent series of studies we have used memory for novel music examples to examine interactions with culturally familiar and unfamiliar music (Demorest et al., 2008, in press; Morrison et al., 2003, 2008). In an fMRI study involving US-born adult musical novices and highly trained professional performers, participants listened to a series of 30 s Western classical and Chinese classical music examples while undergoing a functional scan. Following the scan, participants identified a series of short (4–8 s) music excerpts as either taken from or not taken from the longer examples. Both groups demonstrated more success recognizing previously heard Western examples even though none of the specific selections used were familiar to the participants.

We had hypothesized that listening to culturally familiar music would produce greater levels of brain activation analogous to those demonstrated when listening to a familiar language (Schlosser et al., 1998). However, while behavioral responses (the recall test) showed a clear distinction between the two music types, scanning data did not reveal any activation unique to culturally familiar music listening.

To substantiate the behavioral findings, we conducted a more extensive music memory test employing musical examples from three cultures and 150 adult subjects born in the United States and Turkey both with and without formal music training (Demorest et al., 2008). Again participants demonstrated significantly better memory performance for novel examples taken from their own culture (Western or Turkish classical) than from an unfamiliar culture (Chinese classical). Participants' level of formal music training had no effect on their success at this task. Interestingly, Turkish listeners — who presumably encountered Western music styles on a regular basis and, in the case of the Turkish music conservatory students, formally studied Western classical music as part of their curriculum — demonstrated responses to the Western music examples that, while more accurate than for Chinese music, were significantly less accurate than responses to Turkish music (Fig. 1).

In a follow-up study (Morrison et al., 2008), a similar test was administered to US-born adults and fifth-grade elementary school students (approximately 10–11 years of age) using Western and Turkish music examples of varied complexity. Regardless of age or music complexity, participants were again more successful remembering culturally familiar music, suggesting that certain cognitive boundaries are set in place early in life. This generalized the earlier findings to a much younger age group, but also to a qualitatively different set of stimuli. While the earlier studies had used ensemble music of some complexity, the simple condition of this study involved performance of a single instrument and featured examples with a relatively high degree of motivic redundancy. For these simpler examples to be sensitive to cultural associations suggests that cultural knowledge may influence music processing at a fairly fundamental level.

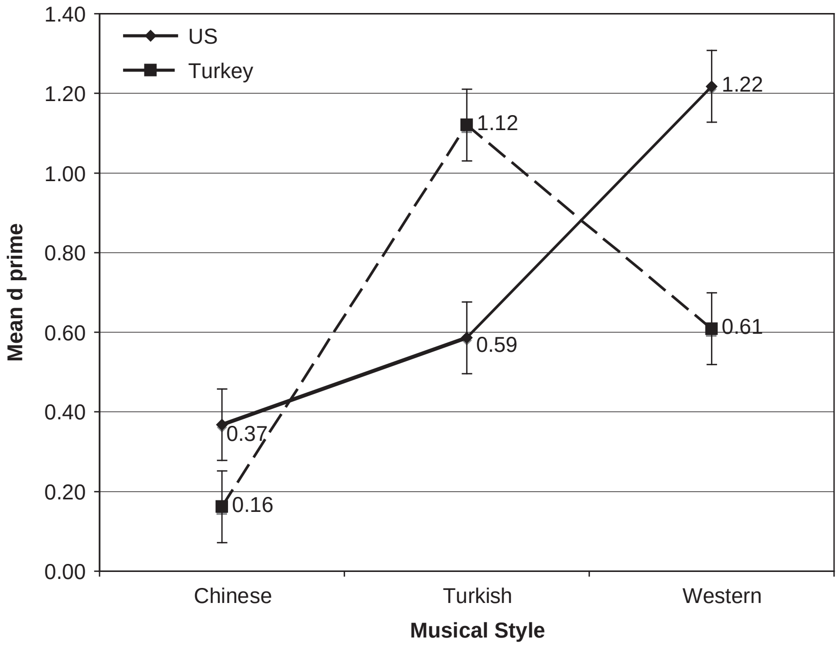

Fig. 1. Mean d-prime scores for adult listeners from the United States and Turkey demonstrate most accurate recall for culturally familiar music (Western and Turkish classical, respectively).

This finding, which we have dubbed an ‘‘enculturation effect’’, has been further replicated in a recent study of Western and Indian adults (Wong et al., in press) allowing generalization to a still broader range of both listeners and styles. Turkish subjects in the earlier study demonstrated better performance for music to which they had limited exposure (Western) versus no exposure (Chinese). To test the effects of concentrated exposure, we conducted a study to determine if the effects of enculturation on memory could be mediated among elementary aged children through focused instruction. We found that even after an extensive and immersive 8-week curricular unit focusing on Turkish music traditions, fifth-grade students failed to demonstrate significant improvement in their memory for Turkish music as compared to Western (Morrison et al., 2009).

Having amassed strong evidence for culture-based differences in music memory, it remained to be examined how this behavioral difference might be reflected in neurological activity. Having observed no pattern of activation unique to culturally familiar music (Morrison et al., 2003), we speculated that this lack of difference might be due to listeners’ employment of identical cognitive strategies — strategies learned through informal learning — regardless of the music they encountered. In other words, perhaps individuals drew on encultured processing approaches in an effort to ‘‘accommodate’’ unfamiliar music material (Demorest and Morrison, 2003). If so, then one might expect to observe evidence of the greater cognitive load presumably necessitated by the awkward and unfamiliar (from the listener’s perspective) music constructions. Increased frontal activity would be consistent with results reported for German musicians categorizing a series of culturally unfamiliar Chinese melodies (Nan et al., 2008) and may reflect increased processing difficulty (Baker et al., 2001). In a related finding that appears to support this supposition, Tillmann et al. (2003) reported that related and unrelated harmonic targets resulted in bilateral inferior frontal activation among adult listeners, with the unrelated targets giving rise to stronger activation.

To test this hypothesis we sampled 16 US and Turkish born subjects with limited formal musical training (Demorest et al., in press). Using fMRI procedures we scanned subjects during two tasks: (1) listening to novel musical examples from their own culture (Western or Turkish classical music) and an unfamiliar culture (Chinese traditional music); (2) identifying which among a series of brief excerpts were taken from the longer examples. Again, behavioral results demonstrated better memory for the culturally familiar music styles. Difference maps showing areas of greater activation during listening to unfamiliar music than familiar music displayed significant activation of the left cerebellar region, right angular gyrus, posterior precuneus, and right middle frontal area extending into the inferior frontal cortex for all subjects (Fig. 2a). For the memory task,

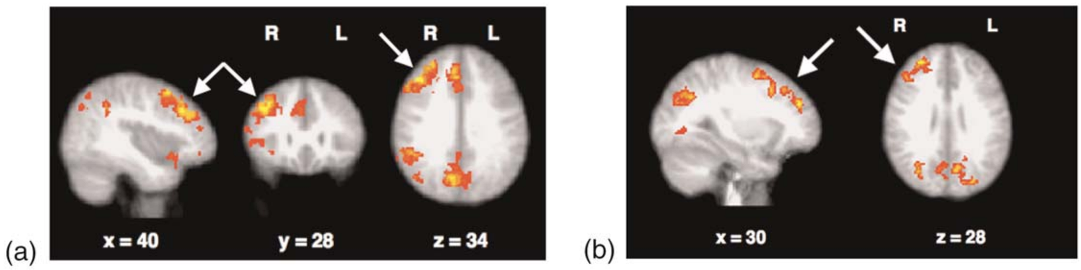

Fig. 2. Difference map showing (a) areas of greater activation during listening to culturally unfamiliar music in R angular gyrus (AG), paracingulate gyrus (PG), posterior precuneus (PC), and middle frontal areas extending into the inferior frontal cortex (FC) for all subjects; (b) for Western subjects listening to Turkish music greater activation of the PC and R middle frontal gyrus (FG); activation in the R AG and PG is shown though it did not reach cluster significance; for purposes of comparison, coordinates displayed correspond to those shown in (a).

comparing unfamiliar to familiar music revealed significant activation in the cingulate gyrus and right lingual gyrus. To test the findings further we compared Western listeners' responses to Turkish music, a second unfamiliar culture. As with the Chinese examples, Western listeners demonstrated significant activation of the precuneus and right middle frontal gyrus when listening to Turkish music contrasted to listening to Western music (Fig. 2b). In all cases, direct comparison of Western and Turkish subjects' difference maps revealed no significant activation unique to either group.

By selecting music memory as a measure of music comprehension we may have chosen a process that is particularly slow to respond to unfamiliar music systems. Other more specific tasks such as familiarization with alternate scale structures (Castellano et al., 1984) might be mastered more quickly as a result of practice or guided learning. Neurological evidence of learning might be observed earlier still. Within the first 14 h of second-language (L2) instruction learners demonstrated characteristic N400 responses to L2 words and pseudowords; they did not demonstrate overt discrimination ability until after over 60 h of instruction (McLaughlin et al., 2004). The application of similar research designs to musical interactions may reveal much about the way in which individuals gain knowledge of unfamiliar musical systems.

Future directions

Research has considered cultural boundaries of music processing at various levels of complexity. However, the interrelationship among these levels remains to be determined. It is possible that the difficulty individuals demonstrate remembering culturally unfamiliar music may be due to an inability to accurately and efficiently parse phrase boundaries that may, in turn, reflect a lack of facility with culturally specific systems and hierarchies of pitch or meter. It will be useful for future research to examine how specific aspects of music may contribute to the broader ability to apply familiar organizational and "sense-making" processes to it.

Recent evidence suggests that, over an extended period of early and largely informal listening experiences, individuals can develop familiarity with multiple cultural traditions (e.g., Western and Indian art music) such that both memory and affective responses are no different than those of native listeners, a phenomenon referred to as "bimusicality" or "bimusicalism" (Wong et al., in press). In contrast, other research reports better memory for culturally familiar music even among those with extensive performance study in a second music tradition (Demorest et al., 2008). The degree to which listening versus active participation, or informal versus formal training, contributes to music enculturation is a promising question for future study.

Though the application of neuroscientific research methodologies to the question of music and culture is still in its early stages, evidence suggests that neurological responses to culturally familiar and unfamiliar music appear to differ more by degree than substance, a conclusion similar to that reported for language processing (Paulesu et al., 2000). It is unlikely that individuals from different cultural backgrounds employ different systems in the processing of musical information. It is more likely that different musical systems make different cognitive demands (e.g., Eerola et al., 2006). For example, Western art music's reliance on harmony, the prominent role of melodic mode structures in North Indian *rags*, and the interaction of rhythmic timelines in the music of the Ewe each requires different balances of cognitive engagement. Among encultured listeners and performers such balances may be reflected in varied patterns and relative strengths of neurological activity analogous to differences observed among speakers of tonal and non-tonal languages (Kaan et al., 2008; Klein et al., 2001).

It is possible that, while enculturation facilitates the establishment of particular schemas through which humans process music, individuals are able to distinguish between not only what is musically familiar and unfamiliar, but what is musically likely and unlikely. Responses to culturally unfamiliar melodic (Nan et al., 2008) or metric (Hannon and Trehub, 2005a) constructions — or even complex intact performances (Demorest et al., in press) — appear to be distinct from responses to material that is merely unconventional or jumbled (Levitin and Menon, 2003; Trehub and Hannon, 2009). Perhaps humans are simply responsive to logical systems of construction even though the specific logic of a specific system may be elusive to a cultural outsider. Hannon and Trehub suggest that pattern detection and categorization are foundations from which culture-specific knowledge springs. One may speculate that listeners are able to deploy systems of pattern detection even in the absence of culture-specific knowledge that would ultimately facilitate such tasks as information parsing (Nan et al., 2008) or prediction (Huron, 2006).

On a broader scale, the question may be raised whether there are more and less delimiting dimensions to musical enculturation. Though culture is often viewed through an ethnic, societal, or geographical prism, can one also speak of an age culture? An historical culture? A philosophical culture? Would similar variability of responses be found along each of these lines of distinction? Considering the long-term nature and arguably permanent enculturation addressed by much of the research presented here, it would seem difficult to equate identity accrued over time as a member of a societal entity — for example, identity as a white Western European city-dweller — with identity adopted on a temporary basis — for example, as an independent-minded adolescent. While both identities may be equally powerful in driving one's actions and decisions regarding musical engagement, it is not known how each may contribute to cognitive processing strategies.

The salience of musical culture may also be task dependent. For example, Turkish listeners demonstrated stronger frontal responses to a familiar instrumental timbre (*ney*) than a less familiar timbre (cello) when music was presented as background to an unrelated oddball task (Arikan et al., 1999). Conversely, other findings show stronger frontal activity among Turkish listeners when encoding Chinese instrumental music (a culturally unfamiliar style) compared to Turkish instrumental music (Demorest et al., in press). Rather than isolating culture alone as a variable of interest, it will be useful to include it in studies of a variety of music-related tasks.

To return to the initial notion of music's universality, study of music and culture may shed light on how constructs of cultural generality and cultural specificity co-exist. Nettl (2001) asks, "can it be true that every musical utterance has in it intervals approximating the major second or something of that general sort?" (p. 467). Perhaps not. Rather, might it be the listener who carries with her the organizational construct of the major second, a construct with which she organizes and makes sense of the musical tradition in which she has been encultured? She might then apply this construct to increasingly distant musical encounters until its application utterly fails. In this way, we might see the notion of musical universality residing within the individual rather than in the construction of the music itself.

Cross (2008) notes that "musicality appears to be integrally bound to the human capacity for culture, not as symptom but as partial cause" (p. 14). Music itself is a practice that is shared across human societies and that gives rise to cultural distinction. It follows that music — far from being simply a cultural artifact — may be seen as a both a broad human disposition and a manifestation of culturally rooted cognitive processes.

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