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Bimusicalism: The Implicit Dual Enculturation of Cognitive and Affective Systems

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Abstract

One prominent example of globalization and mass cultural exchange is bilingualism, whereby world citizens learn to understand and speak multiple languages. Music, similar to language, is a human universal, and subject to the effects of globalization. In two experiments, we asked whether bimusicalism exists as a phenomenon, and whether it can occur even without explicit formal training and extensive music-making. Everyday music listeners who had significant exposure to music of both Indian (South Asian) and Westerners traditions (IW listeners) and listeners who had experience with only Indian or Western culture (I or W listeners) participated in recognition memory and tension judgment experiments where they listened to Western and Indian music. We found that while I and W listeners showed an in-culture bias, IW listeners showed equal responses to music from both cultures, suggesting that dual mental and affective sensitivities can be extended to a nonlinguistic domain.

Keywords

musical culture; recognition memory; tension; perceptual learning; biculturalism

Interests in music and the brain have sparked prominent recent exchanges on neural constraints (Trainor, 2008; Wong, Skoe, Russo, Dees, & Kraus, 2007; Zatorre, 2003; Zatorre, Belin, & Penhune, 2002), evolution (Justus & Hutsler, 2005; McDermott, 2008; McDermott & Hauser, 2005), and music and language parallels (Patel, 2008; Patel & Daniele, 2003). As music is a centerpiece of many world cultures, questions arise as to how cultural exposure, even in the absence of explicit formal training, shapes our responses to music. As the force of globalization begins to penetrate all cultures, a particularly interesting and timely question is whether and how exposure to multiple cultures may influence our sensitivity to music. While previous research has examined the effects of monocultural experience on various cultural-dependent and independent tasks (Balkwill & Thompson, 1999; Gregory & Varney, 1996; Grosjean & Miller, 1994), documenting differential responses to rhythmic (Drake & Ben El Heni, 2003) and melodic (Demorest, Morrison, Beken, & Jungbluth, 2008) features after years of exposure to one culture, the effects of bicultural experience remain little understood outside the domain of language.

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Balkwill, Thompson, and Matsunaga (2004) found that listeners were able to use acoustic cues such as tempo and loudness to recognize expressions of joy, anger, and sadness in music from their own culture as well as music from two unfamiliar cultures, suggesting that some aspects of affective responses to music do not depend on prior exposure. Contrastingly, Gregory and Varney (1996) found that listeners with different cultural backgrounds used different adjectives to describe the same musical excerpts, suggesting a large role for culture. It remains unclear whether experiences of musical tension, another aspect of affective response, transcend culture in this way.

Cross-cultural studies of cognitive responses to music have found more dependence on exposure. Demorest et al. (2008) showed that recognition memory was better for music from a listener's home culture than for music from an unfamiliar culture. Morrison, Demorest, and Stambaugh (2008) demonstrated that this improvement in memory performance for novel excerpts from a listener's home culture characterized children (fifth-grade students) as well as adults. Using fMRI, Morrison, Demorest, Aylward, Cramer, and Maravilla (2003) showed that although recall performance for musical excerpts depended on cultural familiarity (with improved performance for excerpts from the home culture), excerpts from both cultures seemed to activate similar neural resources.

Other cognitive responses beyond memory have been examined cross-culturally as well. Lynch, Eilers, Oller, and Urbano (1990) found that adults perceived mistunings better in melodies in native than non-native scales, but 6-month-old infants perceived mistunings equally well whether the melodies were in native or non-native scales, suggesting that (as in the case of language), infants are born with equipotentiality for scale perception, but that musical exposure gradually enculturates them into the specific musical practices of their home culture. Lynch and Eilers (1991) showed that this enculturation results in better performance on mistuning detection for melodies in native scales by age 10–13, but that formal music training can accelerate this enculturation.

A few studies have explored cross-cultural music perception from a neurological perspective. Neuhaus (2003) found distinctive ERP responses to scale tones in listeners who were culturally familiar with the scale. Also using EEG, Nan, Knösche, and Friederici (2006) found that in the context of phrase perception, cultural familiarity influenced processing at a very early time window, but later responses looked similar, regardless of cultural familiarity. Nan, Knösche, Zysset, and Friederici (2008) used fMRI to examine the neural basis of perceiving phrase boundaries in culturally familiar and unfamiliar music.

Bilingualism is a familiar concept to many; it is estimated that most people of the world speak more than one language (Central Intelligence Agency, 2008) and the number of bilingual speakers is growing (Tucker, 1999). As a result of different degrees of exposure and active use, individuals can learn to speak two or more languages with varying levels of proficiency in different social contexts (Grosjean & Miller, 1994), resulting in evidence of dual cognitive representations (Spivey & Marian, 1999), neural processes (Kim, Relkin, Lee, & Hirsch, 1997), and to a certain extent, affective responses (Pavlenko, 2005). As another human universal, music is ubiquitous and shows cultural characteristics. However, a marked difference between language and music for everyday people is that music requires relatively little active use (specifically for listeners without extensive formal training). Language experience, on the other hand, usually includes not only extensive listening, but also extensive production: speaking.

By examining participants who received extensive exposure to either one (Western or Indian) or two cultures, we ask whether "bimusicalism" can occur as a phenomenon of biculturalism outside the domain of language, and whether relatively implicit auditory exposure without significant production experience can result in dual mental and affective sensitivities. Under our *bimusical hypothesis*, we expect that exposure to music from one culture will result in increased sensitivity (as manifested in recognition memory and tension responses) to music of that culture, whereas exposure to music from two cultures will result in sensitivity to both cultures. Alternatives include the possibility that only sensitivity to one culture is dominant, based on either musical exposure early in life (*early-exposure hypothesis*), or the more recently exposed and most frequently occurring music in the current environment (*current-exposure hypothesis*). In two experiments, we examined recognition memory (Experiment 1), a form of cognitive functions, and tension judgment (Experiment 2), a form of affective responses, in an attempt to address cultural effects on two prominent aspects of music. Since people in all known cultures connect music with emotional experiences, and commit these music-emotional connections to memory, we believe that it is important to explore both affective and cognitive responses, using proxies such as recognition memory and tension judgment in order to tap into representations and sensitivities to music that are culturally driven.

Method

Participants

Three groups of everyday adult listeners (nonmusicians) were tested in two experiments. All participants had less than three years of formal music training of any kind. Monocultural Westerners (henceforth, W group) were born and raised in the United States and reported no previous exposure to Indian music; all were native speakers of English. Monocultural Indians (henceforth, I group) of Asian Subcontinent ancestry were born and raised in seven rural villages in the state of Bihar where little Western music exists in the ambient environment; these participants reported no exposure to Western music. These participants were native speakers of a language spoken in the Asian Subcontinent (e.g., Hindi) and none spoke functional English. Bicultural Indian-Westerners (henceforth, IW group) were U.S residents who were born to Indian families in the U.S. or India and were primarily exposed to Indian music before age 4 years and currently receive about equal exposure to Indian and Western music. All bicultural participants were bilingual (English and at least one Asian Subcontinent languages).

Participant characteristics are summarized in Table 1. No age difference was found across groups; Experiment 1: $F(2, 44) = 1.28$, $p = .29$; Experiment 2: $F(2, 47) = 0.35$, $p = .70$. Participants also self-reported the amount of their weekly musical exposure. For W and I groups, there was a significant difference in the amount of weekly music exposure across the two cultures; Experiment 1, W: $t(11) = 4.17$, $p = .002$; I: $t(21) = 9.95$; $p < .001$; Experiment 2, W: $t(13) = 6.10$, $p < .001$; I: $t(21) = 9.95$; $p < .001$. For the IW group, no such difference was found: Experiment 1, $t(12) = 1.32$; $p = .21$; Experiment 2, $t(13) = 1.58$; $p = .14$, despite the fact that Western music occurs more frequently in these IW participants' ambient environment. All participants in the Indian (I) group ($n = 22$) participated in both experiments. Twelve Western (W) and 13 Indian-Western (IW) participants participated in Experiment 1. Fourteen W and 14 IW participants participated in Experiment 2. Ten participants from each group for Experiment 2 were taken from Experiment 1 (when analyzed separately, these 10 participants showed the same patterns of results as when all participants were included in the analyses).

Stimuli and Procedures

All participants were tested in a quiet room in Bihar, India (for the I group) or in the U.S. (for the W and IW groups). All stimuli were RMS amplitude normalized to a constant value and were presented by headphones binaurally via Direct RT (Jarvis, 2008) from a PC laptop computer. The same pair of headphones and the same laptop computer was used for testing in India and the U.S. For Experiment 2, a Continuous Response Digital Interface (Gerringer, 2003) dial was used to record tension response; the dial was labeled ‘0’ on the far left side (least tension) and ‘255’ on the far right side (most tension) to indicate amount of tension in a continuous but arbitrary unit.

Experiment 1 replicates and extends Demorest et al. (2008), by using a recognition memory task to assess untrained listeners from two cultures, but adding in a third, bicultural group. Participants first participated in an exposure phase where they listened to 30 s excerpts of symphonies composed by J. Stammitz and G. B. Sammartini (Western music) and by N. Banerjee and U. R. Khan (Indian music), pieces which they reported to be unfamiliar. Previously composed and distributed music was chosen in order to increase ecological validity to the greatest extent possible in an experimental framework. These excerpts were blocked by culture (two 5-excerpt blocks per culture) and counterbalanced across participants. After the exposure phase of each block, participants completed the testing phase in which they listened to 60 4 to 6 s stimulus clips taken either from the music that they had been exposed to or from novel clips (excerpts taken from the same symphonies but not presented during the exposure phase). Participants were asked to indicate whether they had heard the stimulus clips during the exposure phase.

In Experiment 2, participants’ tension response to music was assessed. Participants listened to short (10–18 s) Indian and Western melodies and were asked to judge the tension evoked by these stimuli by using a Continuous Response Digital Interface dial (Gerringer, 2003). The use of this dial for recording tension responses follows previous tension studies (e.g., Margulis, 2007). However, because this task was administered to listeners across different cultures, upon pilot testing, we modified the original task and only asked participants to provide a tension response at the end rather than throughout the melody to ensure the simplicity of the task (however, note that the scale of the tension rating remains continuous, ranging from 0 to 255). These melodies were composed and played by professional piano and sitar players. Eight base melodies without syntactic violations for each culture were composed on different cultural-specific scales with tempo, meter, and key matched across cultures (see Table 2). For each base melody, four variants with syntactic violations (two in-key and two out-of-key) were composed. For the in-key violations, the last note of the melody did not correctly resolve, but the note was within the key of the melody. For out-of-key violations, the last note did not correctly resolve, and the note was out of the key of the base melody. Syntactic violations were created in order to induce overall greater tension responses following previous studies (Lerdahl & Krumhansl, 2007). For each culture, half of the melodies were played on piano and half were played on sitar. Participants heard melodies with and without violations. Although we attempted to increase ecological validity to the greatest extent possible, it proved impossible to find previously composed and distributed music from the two cultures that were matched in all relevant parameters. Instead, it was necessary to compose musical excerpts specifically for this project. To increase the level of experimental control, these excerpts were composed with a monophonic, single-line texture.

Results

Experiment 1 (Recognition Memory)

D-prime and accuracy in recognizing the stimulus clips as old or new were entered into separate 3 (Group) × 2 (Culture) repeated ANOVAs. The key findings for this experiment were significant Group × Culture interactions on both measures, revealing that the memorability of music from a particular culture depended on the everyday listeners’ cultural background. This significant interaction was found without any main effects, D-prime: *F*(2,

44) = 5.92, $p < .005$, $\eta^2 = 0.21$; Accuracy: $F(2, 44) = 12.06$, $p < .001$, $\eta^2 = 0.35$. Figure 1 shows the accuracy results; posthoc *t*-tests showed an in-culture advantage for both W, $t(11) = 3.06$, $p = .005$, and I, $t(21) = 4.85$, $p < .001$, groups but no statistically reliable difference between the two cultures for the IW group, $t(12) = 1.04$, $p = .16$. (Bonferroni correction applied for determining significance level at $\alpha = .05$ for all posthoc *t*-tests in both Experiments 1 and 2). The lack of main effects of group and culture indicate that music from both cultures was equally memorable and that all groups had similar general recognition memory. The monocultural groups (W and I) showed increased recognition memory for music of their culture, but the bicultural group (IW) showed no such distinction. These results present the first evidence for bimusicalism in everyday music listeners.

Experiment 2 (Tension Judgment)

Similar to Recognition Memory (Experiment 1), we found a significant group × culture interaction, $F(2,47) = 13.61$, $p < .001$, $\eta^2 = 0.37$ (Figure 2), indicating that everyday listeners' judgment of musical tension depended on their own cultural background and the cultural background of the music to which they were listening. Posthoc *t*-tests revealed that everyday listeners judged music of another culture to be tenser; i.e., the W group judged Indian music to be tenser, $t(13) = 2.81$, $p = .007$, and I group judged Western music to be tenser, $t(21) = 4.17$, $p < .001$, while no tension rating difference was found in the IW group, $t(13) = 0.93$, $p = .19$. These results indicate that bimusicalism encompasses not only cognition as found in Experiment 1, but also a form of affective response. Also similar to Experiment 1, we found no main effect of culture, meaning that no one particular type of music was judged to be tenser overall. But interestingly, we found a main effect of group, $F(2,47) = 3.80$, $p = .03$, $\eta^2 = 0.14$; posthoc Tukey's tests revealed a significant difference only between the Western and Indian group. Several previous studies have shown that Americans assign higher intensity ratings to affective stimuli than their Asian counterparts (Ekman et al., 1987;Matsumoto & Ekman, 1989;Matsumoto, Kudoh, Scherer, & Wallbott 1988), and the difference between Westerners and Indians on the tension task could stem from these cultural variations in the nature of affective reports.

Discussion

The present study demonstrates that relatively passive exposure to stimuli from two cultures can result in dual mental and affective sensitivities for music, providing evidence for the *bimusical hypothesis*. These sensitivities are not dominated merely by the music that the participants were exposed to early in life (Indian music) per the *early-exposure hypothesis*, nor by the most recently exposed and frequently occurring music in the current ambient environment (Western music in the U.S.) per the *current-exposure hypothesis*. Such bimusicalism, though similar to bilingualism, exists in this case without active and explicit music-making, highlighting the saliency of perceptual learning (Goldstone, 1998). Furthermore, dual sensitivities arose in the absence of formal training. Although previous studies have shown musical cultural sensitivity at behavioral and neurophysiologic levels (Demorest et al., 2008; Nan et al., 2008), they have not examined both mono and bicultural cognitive and affective effects. The addition of a monomusical Indian group who had little exposure to Western music, and the inclusion of an affective response task allowed us to examine bimusicalism more comprehensively. Although ethnomusicologists have hinted at trained musicians' ability to play two instruments (Fung, 1994), they do not point to everyday people's sensitivity to music of different cultures played in their ambient environment as found here.

It's important to note that neither group was familiar with the particular pieces used as stimuli; moreover, neither group was composed of musicians avidly involved with these classical forms of music. Rather, the demonstrated sensitivities emerged out of largely passive and infrequent exposure. Although there are many different styles within the music of a particular culture (for example, in the case of Western culture, classical, and jazz), these different styles are not fundamentally distinct at the level of tonal organization and harmonic vocabulary in the way that music from Western and Indian cultures are (accounts of the structure of Indian music can be found in Qureshi et al., 2008, and Jairazbhoy, 1995). The results from this study demonstrate dual sensitivities to music that are fundamentally different in organization.

A clear limitation of the current study is that it can only go so far as to provide initial evidence for bimusicalism, i.e., show that dual cognitive and affective sensitivities in the domain of music can exist as a result of being exposed to two cultures. Many questions pertaining to biculturalism remain unanswered, especially those mirroring the well-studied phenomenon of bilingualism. For example, our experiments cannot answer whether there are one or two memory systems for music or whether the memory systems are interdependent or independent (see Heredia & Brown, 2004, and Pavlenko, 2000, for reviews). They cannot answer whether the presence of one type of music activates another type and whether competitions of the two types exist (e.g., Marian & Spivey, 2003). Furthermore, they cannot answer whether one type of music exists as a "parasite" of another type (e.g., Hernandez, Li, & MacWhinney, 2005). To put it more specifically, if two systems of musical syntactic representations exist in a bimusical participant's mind, we do not know if knowledge of one (e.g., Western) would interfere with the processing/perception of another (e.g., Indian) as in the case of second language processing (e.g., Marian & Spivey, 2003). Future studies are needed to answer these important questions. Another limitation of our current study is that participants across cultures might have come from different socioeconomic and educational backgrounds that contributed to the patterns of results we found. More careful documentation of these variables should be included in future studies.

While we view culture as the main driving force of mono and bimusical sensitivities seen in our experiments, it is important to note that universal responses to music are not completely ruled out, as evidence exists suggesting that certain musical properties elicit similar responses from listeners of different cultures (Trehub, 2003). Although it is not the goal of the current study to delineate cultural-dependent and cultural-independent musical effects, we believe it would be of paramount importance for future studies to investigate both of these effects, and to examine how and why certain universal properties might be reinforced by cultural experiences. Furthermore, future studies should examine the precise mechanisms, including neural mechanisms, that drive the dual enculturation effects in the cognitive and affective systems (e.g., to document whether the memory differences we found occurred at the encoding, retrieval, or storage levels).

Huron (2008) observes that the "homogenizing effects of globalization" precipitate the need for the scientific community to examine the "range of musical minds" across cultures and across experiences; teasing out the universal from the cultural will be more difficult as musical monocultures disappear. The current study represents an attempt to investigate Huron's "range of musical minds" at this critical junction of globalization where few monocultural experiences of music remain and numerous multicultural experiences are emerging. Bigand and Poulin-Charronnat (2006) have argued that musicians and nonmusicians (whom we call "everyday music listeners" here) do not show fundamental differences in musical responses. Here, we extend their claim by arguing that the musicianship of people without formal training is subject to dual enculturation. Such dual sensitivities are likely shaped by statistical and implicit learning (Saffran, Aslin, & Newport, 1996) and allow bicultural listeners to meaningfully experience the essential functions of music that occur in different cultural contexts. Bimusicalism of this sort will no doubt increase in prevalence as globalization continues to flourish.

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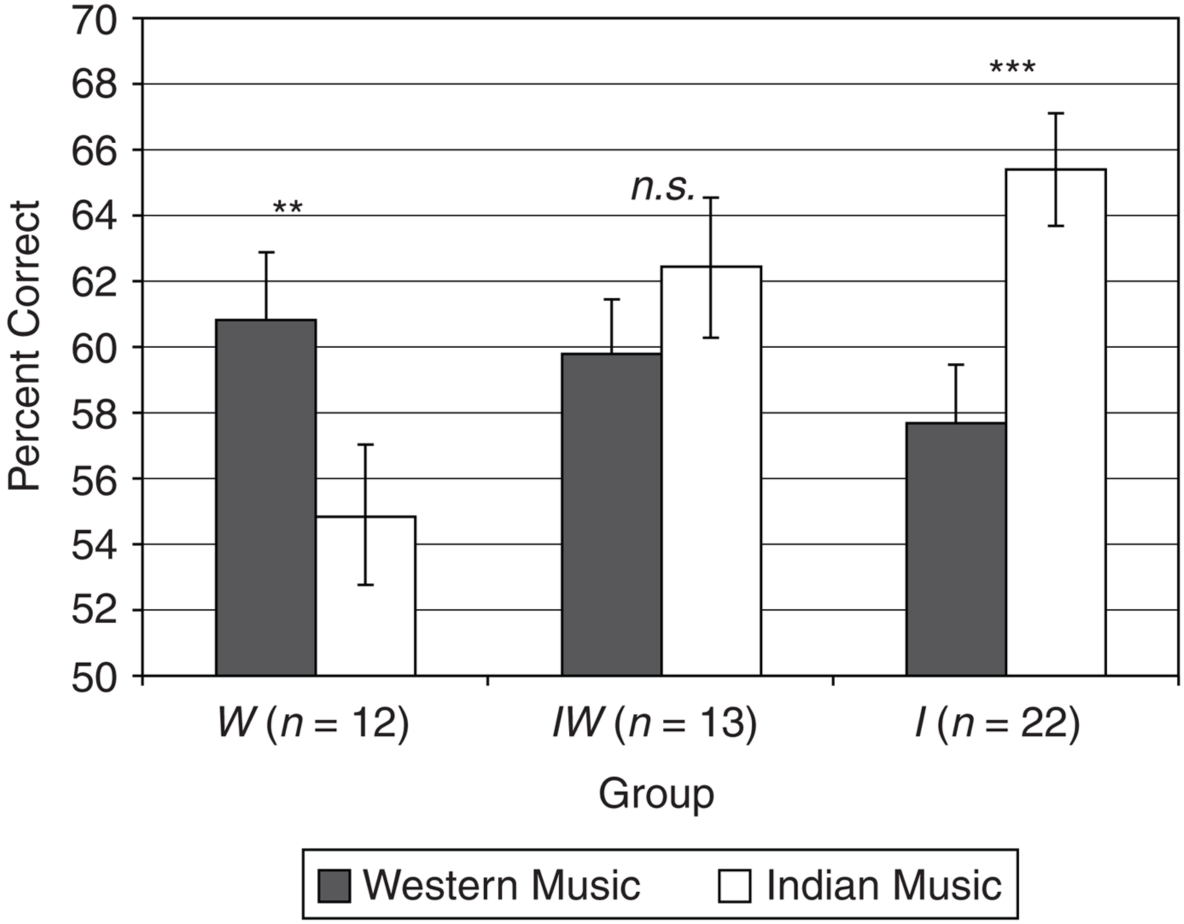

FIGURE 1.
Accuracy (% correct) for Experiment 1 (Recognition Memory). Error bars reflect standard error of the mean for all graphs (**p =0.005; ***p <0.001).

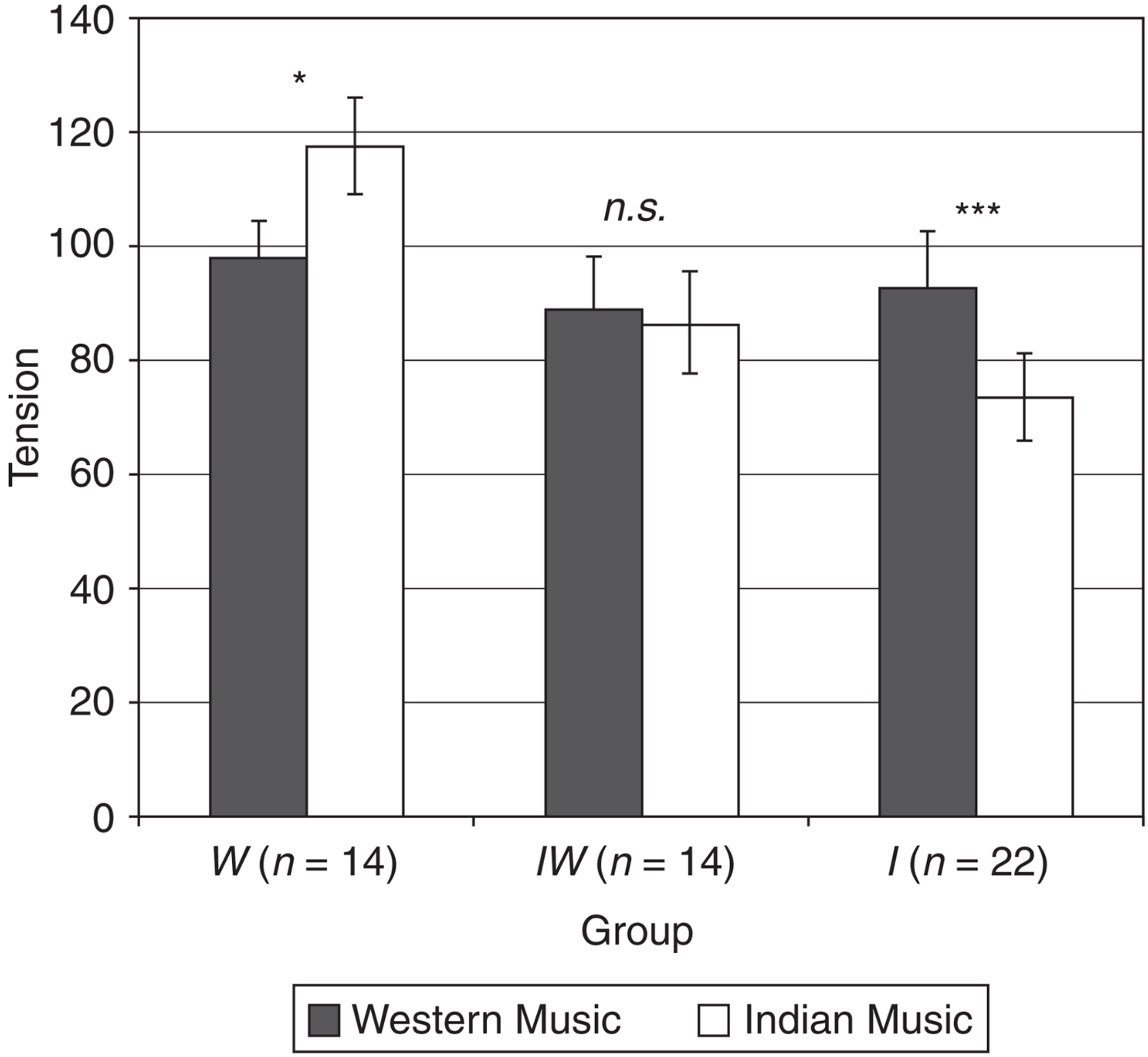

FIGURE 2.

Tension judgment for Experiment 2 (responses to all melodies were averaged). The y-axis shows a continuous but arbitrary unit of tension corresponding to the labeling of the Continuous Response Digital Interface dial that the participants used to evaluate tension (**p* =0.007; ****p* <0.001).

TABLE 1

Participant Characteristics for Each Experiment.

		Mean Weekly Music Exposure in Hours (Range)	
Mean Age (Range)		Western	Indian
Experiment 1 (Recognition Memory)			
W (*n* =22)	20.9 (19–24)	10.4 (0–35)	0
IW (*n* =12)	21.5 (18–25)	5.5 (0.5–20)	4.0 (0.5–10)
I (*n* =13)	22.6 (18–33)	0	9.5 (2.5–21)
Experiment 2 (Tension Judgment)			
W (*n* =22)	22.1 (19–31)	10.3 (0–28)	0
IW (*n* =14)	21.6 (18–25)	7.7 (0.5–20)	6.0 (0.5–18)
I (*n* =14)	22.6 (18–33)	0	9.5 (2.5–21)

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TABLE 2

Base melodies for Experiment 2.

	Shared Characteristics for both Western & Indian Melodies		Western Melodies		Indian Melodies	
Melody #	Key	Tempo	Scale	Meter	Scale	Meter
1	C	medium	Major	4/4	Bhairav	tintal
2	C	fast	Major	2/4	Bhairav	ektal
3	D	medium	Major	4/4	Bhairav	tintal
4	D	slow	Major	3/4	Bhairav	rupaktal
5	C	medium	Minor	4/4	Todi	tintal
6	C	slow	Minor	2/4	Todi	ektal
7	D	medium	Minor	4/4	Todi	tintal
8	D	fast	Minor	3/4	Todi	rupaktal

Note: Eight Indian and eight Western base melodies were composed on a range of matched musical parameters with scale being the primary differing factor. Base melodies have no syntactic violations. In order to induce greater tension responses, four additional variants with syntactic violations (two in-key and two out-of-key) were generated from each base melody.