Cross-cultural Differences in Meter Perception

by

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Abstract

The goal of the present study was to determine whether exposure to complex meters in one musical culture facilitates the detection of metrical changes in a foreign musical culture. Adults with exclusive exposure to Western music, and adults with exposure to non-Western as well as Western music were tested on their perception of metrical changes in foreign (Turkish) music with simple and complex meters. Those whose exposure was limited to the simple meters of Western music were only able to detect the metrical changes in Turkish music with simple meter. By contrast, adults with exposure to non-Western music with complex meters detected the metrical changes in Turkish music with complex as well as simple meter. The superiority of the bi-musical listeners on complex meters and the equivalence of bi-musical and mono-musical listeners on simple meters suggest that exposure to complex meters rather than bi-musicality was responsible for the performance differences.

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Chapter 1

1. Introduction

Adults in all cultures can clap their hands, tap their feet, or dance in time to the music they hear (Brown, 2003). Synchronizing their actions to music necessitates implicit knowledge of its metrical structure, specifically, the underlying pulse or beat of the music and its organization into repeated groups of strong and weak beats (e.g., the **one**-two-three-four pattern of marching music and the **one**-two-three pattern of a waltz). In contrast to rhythm, which reflects the relative durations of notes, meter is not explicitly available in the musical surface but is inferred from periodic regularities in the music (Clarke, 1999). Despite the abstract nature of metrical structure, 6-month-old infants not only infer the metrical structure of auditory sequences (Hannon & Johnson, 2005) but they also discriminate subtle metrical changes in the context of Western and foreign music (Hannon & Trehub, 2005a). Western music consists largely of simple meters, which involve equidistant, or isochronous, beats and simple duration ratios (1:1 and 2:1). By contrast, music in many parts of the world (e.g., Eastern Europe, Asia, Africa) features complex meters with non-equidistant beats and more complex duration ratios (e.g., 3:2) than those in music with simple meter.

Adults' perception of metrical patterns is influenced by long-term exposure to the music of their culture. For example, musically untrained adults tap more accurately and at higher hierarchical levels to culturally familiar music (e.g., on every n th beat) than to culturally unfamiliar music (e.g., on every beat), presumably because of their implicit knowledge of the metrical hierarchy of familiar music (Drake & El Heni, 2003). For naïve adult listeners listening to culturally unfamiliar music, tapping tends to correspond closely to the unfolding musical events (Drake & El Heni, 2003).

Culture-specific metrical knowledge can interfere with the perception of metrical categories that are foreign or atypical relative to the native musical culture (Stobart & Cross, 2000). For example, Western adults have difficulty detecting metrical changes in Balkan music with complex meters, which are atypical in Western music, but they have no such difficulty in the context of Balkan music with simple meters, which are typical of Western music (Hannon &

Trehub, 2005a). Not surprisingly, Balkan listeners detect both types of changes. For Western 6-month-olds, metrical changes are equally detectable in music with simple or complex meters (Hannon & Trehub, 2005a), which reflects their culture-general pattern of responding. By 12 months of age, however, Western infants exhibit difficulty with complex meter, but their difficulty can be reversed by limited exposure to metrically complex music (Hannon & Trehub, 2005b). Comparable exposure is insufficient to reverse Western adults' difficulty with complex meter, perhaps because entrenched knowledge limits their perceptual flexibility.

The primary goal of the present study was to determine whether exposure to complex meters in one musical culture would facilitate the detection of metrical changes in the music of another culture. Although Hannon and Trehub (2005b) claimed that exposure to complex metrical structures was responsible for the enhanced performance of Balkan listeners, their performance advantages could have stemmed from a culturally familiar style of music rather than from its metrical structure alone. Children and adults show better memory for novel musical pieces from their own culture than for those from another culture (Demorest, Morrison, Beken, & Jungbluth, 2007; Morrison, Demorest, & Stambough, 2008). In the present study, Turkish folk music, which features complex as well as simple meters, was used with non-Turkish listeners from different cultural and musical backgrounds, only some of whom had exposure to complex meters. If listeners with exposure to complex meters perform better than those with no such exposure, that would provide evidence for transfer effects from such metrical exposure across cultural contexts.

A related concern was whether exposure to two musical cultures, or bi-musicality, contributes to enhanced performance on some kinds of musical tasks. Bilingualism, or the frequent use of two languages, is associated with enhanced executive function, which can lead to performance advantages on tasks requiring the inhibition of salient but irrelevant information (Bialystok, 2008; Bialystok, Klein, Craik, & Viswanathan, 2004; Bialystok & Viswanathan, 2009). Exposure to two musical cultures may result in functional bi-musicality, as reflected in similar memory and affective responses to musical excerpts from both cultures rather than differential responsiveness, as exhibited by mono-musical listeners (Wong, Perrachione, & Margulis, 2009). If bi-musical individuals are associated with advantages in executive function comparable to those of bilingual individuals, they might perform better on tasks that require them to ignore acoustically salient but task-irrelevant changes.

The Balkan and Western listeners in Hannon and Trehub (2005a) could be considered bi-musical and mono-musical, respectively, but their tasks did not involve a competing acoustic dimension. In the present study, however, listeners were required to rate the degree of rhythmic similarity or difference between a standard musical pattern and an altered pattern that featured a melodic change that was clearly noticeable. The altered pattern either preserved the original metrical structure or violated that structure. In general, melodic patterning is more salient than rhythmic or metrical patterning (Hébert & Peretz, 1997). Moreover, melodic as well as temporal cues influence the perception of meter (Hannon, Synder, Eerola, & Krumhansl, 2004) and melodic complexity (Eerola, Himberg, Toivainen, & Louhivuori, 2006). Thus, the need to judge the temporal organization of a musical pattern in the context of a pitch change would put a premium on selective attention skills that are thought to be enhanced by bilingualism and, perhaps, by bi-musicality. If bi-musicality enhances this aspect of executive function, then bi-musical individuals could exhibit advantages in the context of simple as well as complex metrical structures.

Participants in the present study were drawn from a multicultural postsecondary educational environment, which included adults of North American (i.e., Canadian and American), Indo-Canadian, and Sino-Canadian origin as well as a few others from diverse backgrounds. Those of Indo-Canadian origin could be considered bi-musical in the sense that they had exposure to Western music as well as to traditional Indian music, which differs from Western music in its pitch and metrical patterning (Castellano, Krumhansl, & Bharucha, 1984; Clayton, 2000; Jairazbhoy, 1995; Stevens, 2004; Vidya Bhavan, 1993). Traditional Indian music, which is largely monophonic, includes considerable rhythmic and melodic improvisation, but an accompanying performer commonly maintains the basic metrical structure in the background (Jairazbhoy, 1995). Performers and audience members tend to highlight the temporal structure of the music by clapping and tapping (Clayton, 2000; Jairazbhoy, 1995; Sinha, 1970).

Turkish folk music typically consists of a single melody line with accompaniment that maintains the basic metrical structure. Although there is no harmony in Turkish folk music, various melodic and rhythm instruments are often used to play the melody and rhythm simultaneously. In the present study, the Turkish folk melodies with complex meter featured a 5-beat rhythm (2+3) that is common in South Indian classical music. Although the metrical

organization may have been familiar to some listeners of Indian origin, many aspects of the music would be unfamiliar to these listeners.

The present study compared the perception of meter in Turkish folk music by mono-musical adults, who were exposed to Western music only, with that of bi-musical adults whose exposure included simple and complex meters. All but one bi-musical participant in the present sample had exposure to traditional Indian music as well as Western music. The other bi-musical participant was familiar with Western music and with Macedonian folk music, which features simple and complex meters.

Chapter 2

2.Method

2.1 Participants

The participants were 57 adults (38 women, 19 men; 17-50 years, $M = 21.8$) whose family origin was Indian ($n = 21$), Chinese ($n = 16$), North American ($n = 17$), Arabic ($n = 2$), and Macedonian ($n = 1$). Formal musical training (years of music lessons), which was limited to Western music, ranged from 0 to 11 years ($M = 2.7$) and was similar for participants of different origin. Participants of Indian and Arabic origin had periodic exposure to traditional Indian music, which features complex meters, but regular exposure to Western music. The adult of Macedonian origin participated in Macedonian folk dancing, which features complex as well as simple meters, but he was most familiar with Western music. Participants of Chinese origin had exposure to Western music only. Thus, there were 24 participants who had exposure to complex meters and 33 who had exposure to simple meters only. Participants with exposure to two musical cultures could be considered bi-musical, although they were clearly dominant in Western music, in contrast to the others who were mono-musical. Of the 33 mono-musical participants, 23 were born in North America. For foreign born mono-musical participants, age of arrival in North America was 5-20 years ($M = 12.4$). Of the 33 bi-musical participants, 9 were born in North America. Age of arrival of foreign-born bi-musical participants ranged from 2 to 22 years ($M = 12.1$). No participant was familiar with Turkish music.

2.2 Apparatus

Testing took place in a double-walled sound-attenuating booth (Industrial Acoustics Corporation), which was 3 m × 2.5 m. A Dell computer controlled stimulus presentation and response recording by means of customized software. Stimuli were played through two GSI loudspeakers located in front of and to either side of the seated participant. Participants entered their responses on a touch-sensitive monitor (NEC multisync LCD 1760 NX).

2.3 Stimuli

The stimuli were instrumental excerpts from four traditional Turkish folk songs (composers unknown). Two of the songs were in simple meter, with each four-note measure subdivided into two groups of two notes. The other two songs were in complex meter, with each five-note measure subdivided into groups of two and three. Familiarization stimuli were 2 min in duration and featured 8-11 repetitions of the selected excerpts. Test stimuli consisted of 16 measures. All excerpts were arranged as MIDI performances by means of Finale 2009 software (Eden Prairie, Minnesota). The instrumentation for all excerpts was a combination of seven melodic instruments (pan flute, bagpipe, banjo, dulcimer, ocarina, agogo, and shakuhachi) and a percussion instrument (taiko drum).

Most inter-onset intervals (IOIs) were 250 ms, but shorter IOIs (125 ms) occurred in one excerpt with simple meter and in one excerpt with complex meter. Moreover, longer IOIs (500 and 750 ms) occurred in one excerpt with simple meter and in one excerpt with complex meter. A combination of bright and dark timbres of the percussion instrument was used to emphasize the metrical pulse. Specifically, dark timbre was used at strong metrical positions, and the pulses were presented at higher amplitude (MIDI velocity of 127) than the main melody (MIDI velocity of 90) (see Figure 1). The drum accompaniment consisted of long-short-short patterns for simple-meter excerpts, and long-short-short-short patterns for complex-meter excerpts. These patterns were repeated in every measure.

For each familiarization melody, which was roughly 20 s in duration, there were two test stimuli that were created by the addition of a single 250-ms note (see Figure 1). The pitch of the

added note was the same as that of the immediately preceding note. For the meter-reserving version, the duration of the next note was reduced by 250 ms, which meant that two 250-ms notes replaced one 500-ms note. In the meter-violating version, each measure increased in overall duration as a result of adding the 250-ms note. The structure- or meter-violating change to simple-meter excerpts resulted in a complex meter (5/8), whereas the structure-violating change to complex-meter excerpts resulted in simple meter (6/8). The test stimuli, which were 20-23 s in duration, were presented at the same amplitude as the familiarization stimuli (velocities of 127 for pulses and 90 for the melodic instruments). Two test foils were included: the original familiarization stimulus and an alteration involving the addition of two notes--one at the beginning and one at the end of each measure."

Figure 2. One-measure examples of the timing of the familiarization stimulus (Fam), the meter- preserving alteration (MP), and the meter-violating alteration (MV), for both simple meter (top) and complex meter (bottom).

2.4 Procedure

Participants were tested individually. Before entering the sound-attenuating room, each participant completed a questionnaire about their cultural background and musical experience, including their exposure to traditional music from different cultures (e.g. Arabic, Bulgarian, Indian, Turkish). Initially, participants received oral instructions, which were repeated on the monitor in the test room. The experimenter was present during the practice phase, which was designed to familiarize participants with the task. After listening to an instrumental version of *Twinkle, Twinkle, Little Star*, participants received two test trials (1) a meter-preserving version that had extra notes and (2) an obvious meter-violating version. Only participants who rated the meter-violating version of *Twinkle* as more discrepant from the original than the meter-preserving version proceeded to the main test phase of the experiment. Four participants who failed to respond in the expected manner, even after repeated training trials and additional explanation, were excluded from the sample. The experimenter left the room before the onset of the test phase.

Stimuli were presented in four blocks corresponding to the four different songs (two with simple meter, two with complex meter), and the order of blocks was randomized. Each block consisted of the presentation of one of the four familiarization stimuli for 2 min followed by four test stimuli in random order: the meter-preserving alteration, the meter-violating alteration, and the two foils (shortened and distorted). After listening to each test stimulus, participants were required to rate how different each test rhythm sounded from the original rhythm on a 7-point Likert scale ranging from 1 (rhythm sounds the same as original) to 7 (rhythm sounds very different from original). Participants were told that our interest was in their sense of the rhythm of the stimuli, so their answers could not be considered right or wrong.

Chapter 3

3.Results

Sensitivity scores were calculated by subtracting ratings of meter-preserving alterations from ratings of meter-violating alterations. Positive values indicate that participants judged the meter-violating version to be more different from the original pattern than the meter-preserving

version. Values at or near zero indicate that participants judged the meter-preserving and meter-violating versions to be equally different from the original pattern. For each participant, these scores were averaged across the two excerpts with simple meter and the two with complex meter. Sensitivity scores for bi-musical and mono-musical participants on patterns with simple and complex meter are shown in Figure 1.

Figure 1. Mean sensitivity scores of bi-musical and mono-musical participants on Turkish music with simple and complex meter. Error bars are standard errors.

One sample *t*-tests revealed that mean sensitivity scores for the patterns with simple meter significantly exceeded chance levels for the bi-musical listeners ($M = 1.50$, $SD = 1.45$), $t(23) = 5.06$, $p < .001$, and for the mono-musical listeners ($M = 1.48$, $SD = 1.52$), $t(32) = 5.06$, $p < .001$. Mean sensitivity scores for the patterns with complex meter were significantly different from zero for the bi-musical listeners ($M = .77$, $SD = 1.25$), $t(23) = 2.99$, $p < .01$. For the mono-

musical listeners, sensitivity scores for the patterns with complex meter were marginally different from zero ($M = -.45$, $SD=1.34$), $t(32)=1.94$, $p = .06$, with these listeners reporting greater differences between meter-preserving and original versions than between meter-violating and original versions.

A two-way mixed-design analysis of variance (ANOVA) with meter (simple vs complex) as a within-subjects factor and musical background (bi-musical, mono-musical) as a between-subjects factor revealed significant main effects of meter, $F(1, 55) = 26.18$, $p < .001$, $\eta^2 = .30$, and musical background, $F(1, 55) = 5.20$, $p < .05$, $\eta^2 = .63$, and a significant interaction between meter and musical background $F(1, 55) = 5.38$, $p < .05$, $\eta^2 = .06$.

Independent sample t -tests indicated that the bi-musical participants had significantly higher sensitivity scores ($M = .77$, $SD = 1.25$) than the mono-musical participants ($M=-.45$, $SD=1.34$) on the patterns with complex meter, $t=3.49$, $p < .01$, but not on the patterns with simple meter. In short, bi-musicality or exposure to a musical system with complex metrical structure enabled listeners to detect metrical changes in the context of a different musical style with complex metrical structure.

Chapter 4

4. Discussion

The principal goal of the present study was to determine whether familiarity with the complex metrical patterns of one musical culture would facilitate the perception of complex metrical patterns in an unfamiliar musical culture. Adults whose exposure was limited to the simple metrical structures of Western music detected metrical changes in Turkish music with simple meter but not in Turkish music with complex meter. By contrast, adults with exposure to the simple meters of Western music and to the complex meters of another musical culture (Indian or Macedonian) detected both types of metrical changes in Turkish music. The findings extend the work of Hannon and Trehub (2005a), who found that exposure to Balkan music, which has complex as well as simple meters, led to enhanced perception of Balkan music with complex meter. Unlike Balkan listeners, who performed as well on Balkan music with complex

meter as on simple meter (Hannon & Trehub, 2005a), bi-musical as well as mono-musical listeners in the present study performed better on simple than on complex meter. It is unclear whether the more difficult task or the use of foreign music in the present study contributed to the performance differences across studies.

In principle, the metrical processing advantages of individuals with exposure to complex musical patterns could stem from familiarity with two musical cultures, or bi-musicality. Just as bilingual children and adults are more likely than their monolingual counterparts to attend to one stimulus attribute or dimension while ignoring another salient dimension (Bialystok, 2001, 2008), bi-musicality might enable adults to focus on the metrical structure of musical patterns while ignoring salient pitch changes. If bi-musicality was associated with similar advantages, then the bi-musical individuals in the present study should have shown enhanced processing on the simple as well as complex metrical structures. Instead, their advantage was limited to the complex metrical structures. In contrast to the bilingual participants in the studies of Bialystok and her associates (Bialystok, 2008; Bialystok, Craik, Raymond, & Viswanathan, 2004; Bialystok, & Viswanathan, 2009), who had daily or near-daily exposure to their two languages, the bi-musical participants in the present study had limited exposure to non-Western music, mostly at family weddings and community functions. It is possible, then, that bi-musical individuals with more balanced or equal exposure to two musical systems would outperform mono-musical individuals on simple-meter tasks involving foreign music. Wong et al. (2009) argue that some types of cognitive advantages arise from consistent exposure to two musical systems.

The context of bi-musical individuals' exposure to complex meters may contribute to or be responsible for their performance advantage for foreign musical patterns with complex meters. Two possibilities involve movement and perceptual flexibility in relation to metrical perception. Although people in all cultures can move synchronously to music (Wallin, Merker, & Brown, 2000), they often refrain from doing so, especially in some public contexts. In India, however, music is typically accompanied by movement, even in classical concerts (Clayton, 2000). The rhythmic and melodic complexity of traditional Indian compositions requires performers and audience members to clap or tap to the music to maintain the basic metrical structure (Jairazbhoy, 1995). In the present sample, the only bi-musical participant who was unfamiliar with traditional Indian music participated in Macedonian folk-dancing. Thus the bi-

musical individuals in the present study were accustomed to moving while listening to music, whether clapping, tapping or dancing. There is evidence that movement influences the encoding and retention of metrical patterns in infants (Philips-Silver & Trainor, 2005) and adults (Philips-Silver & Trainor, 2007), an effect that is thought to be mediated by the vestibular system (Trainor, Gao, Lei, Lethovaara, & Harris, 2009). The experience of moving to complex meters might have induced bi-musical individuals to move as they listened to the Turkish music or to have mental images of such movement. Perhaps mono-musical listeners who are required to tap or clap while listening to the musical patterns with complex meter would perform better than others who simply listen to the music. This hypothesis could be tested in future research.

Perceptual flexibility arising from exposure to different types of metrical organization may strengthen bi-musical individuals' sensitivity to metrical structure in general and to complex metrical structure in particular. Traditional Indian music and Balkan (including Macedonian) folk dance music feature a variety of complex meters (Morris, 1996; Vidya-Bhavan, 1993). For example, time signatures of 7/16, 11/15, and 15/16 are common in Balkan dance music (Morris, 1996). Different placement of accents results in diversification within each of these complex meters.

In traditional Indian music, a 5-beat rhythm can have a number of different modes, and a 7-beat rhythm can have 19 different modes (Vidya-Bhavan, 1993). Performers and audience members maintain the underlying meter despite temporal improvisations that another performer may produce at the same time. In some cases, musicians begin by using different metrical structures on different instruments, resulting in polyrhythmic music (Kiss, 2008; Vidya-Bhavan, 1993). Polyrhythms place additional cognitive and motor demands on both performers and listeners (Pressing, Summers, & Magill, 2002). This rich rhythmic context, which can include different complex meters and the simultaneous production of multiple rhythms, requires perceptual flexibility and special focus on the underlying meter so that listeners can synchronize their behavior (movement or singing) with the music they hear. It is possible, then, that bi-musical individuals, especially those with exposure to traditional Indian music, capitalized on this perceptual flexibility when they listened to the Turkish music with complex meter.

An alternative explanation is that exposure to the particular meter used in the present study rather than to complex meters in general accounts for bi-musical individuals' advantage on

Turkish music with complex meter. The complex meter in the present study had a 5-beat rhythm mode organized in a 2+3 pattern. One of the bi-musical participants, who had 2 years of vocal training on South Indian classical music, reported that the 2+3 mode was a common 5-beat rhythm mode in South Indian music. Indian classical music, however, has many complex meters, including 7-beat, 9-beat, and 11-beat rhythms. Moreover, other bi-musical listeners had exposure to North Indian rather than South Indian music. Thus, it is unclear whether these other Indian participants had exposure to the complex meter used in the present study. Most of the participants had no formal training in music and therefore little explicit knowledge of the temporal organization of Indian or Western music. Balkan folk-dance music features numerous complex meters (Morris, 1996). There is no indication in the available literature, however, that 5-beat rhythms are more common than other complex meters and that the specific 5-beat mode in the present study is used in Balkan music.

In summary, exposure to the complex meters of one musical culture was associated with enhanced perception of the complex meters in another musical culture. The generality of such cross-cultural transfer effects remain to be determined. By virtue to exposure to music that is metrically complex, individuals may become more analytic listeners, which could result in enhancement in various aspects of music processing including the perception of complex pitch patterns. Age of arrival in a new culture has important consequences for the acquisition of a second language (Flege, Yeni-Komshian, & Liu, 1999). Later age of arrival for individuals from a foreign musical culture would be associated with longer and more intense exposure to the foreign music. It is possible, then, that listeners of Indian or Balkan origin who arrived in North America as older children or adults would perform better on difficult tasks involving foreign music relative to those who arrived at earlier ages. It is also possible that the bi-musical advantage could stem from IQ differences favoring members of that group, many of whom were bilingual. One factor that argues against IQ or bilingualism as a mediating factor is the poor performance of Sino-Canadian participants, who were largely bilingual but mono-musical. Questions such as these could be resolved in future research.

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