Developmental Science

Developmental Science 14:4 (2011), pp 865–872 DOI: 10.1111/j.1467-7687.2011.01036.x

PAPER

Constraints on infants′ musical rhythm perception: effects of interval ratio complexity and enculturation

Erin E. Hannon,[1] Gaye Soley[2] and Rachel S. Levine[3]

1. *Department of Psychology, University of Nevada, USA*
2. *Department of Psychology, Harvard University, USA*
3. *Department of Environmental Conservation, University of Massachusetts-Amherst, USA*

Abstract

Effects of culture-specific experience on musical rhythm perception are evident by 12 months of age, but the role of culture-general rhythm processing constraints during early infancy has not been explored. Using a habituation procedure with 5- and 7-month-old infants, we investigated effects of temporal interval ratio complexity on discrimination of standard from novel musical patterns containing 200-ms disruptions. Infants were tested in three ratio conditions: simple (2:1), which is typical in Western music, complex (3:2), which is typical in other musical cultures, and highly complex (7:4), which is relatively rare in music throughout the world. Unlike adults and older infants, whose accuracy was predicted by familiarity, younger infants were influenced by ratio complexity, as shown by their successful discrimination in the simple and complex conditions but not in the highly complex condition. The findings suggest that ratio complexity constrains rhythm perception even prior to the acquisition of culture-specific biases.

Introduction

Music is a profoundly human activity that has been observed in virtually all known cultures. Despite this universality, most human musical behaviors and capacities arise from a complex interaction between intrinsic constraints and culture-specific experience. For example, infants' and children's cognitive representations of musical pitch structures such as scale, key, and harmony undeniably change with exposure to culture-specific conventions (Koelsch, Fritz, Schulze, Alsop & Schlaug, 2005; Krumhansl & Keil, 1982; Schellenberg, Bigand, Poulin-Charronnat, Garnier & Stevens, 2005; Trainor & Trehub, 1992, 1994), but preferences and processing advantages for consonant pitch combinations are evident shortly after birth (Masataka, 2006; Schellenberg & Trehub, 1996; Trainor & Heinmiller, 1998; Trainor, Tsang & Cheung, 2002; Zentner & Kagan, 1996). Even though rhythm is central to human musicality, only recently has a rich understanding of the development of rhythm perception begun to emerge, and very little is known about the mechanisms underlying and constraining young listeners' processing of rhythmic patterns.

One of the most integral functions of music is to facilitate coordinated movement. Listeners around the world effortlessly clap, tap, dance, or otherwise move in time with music and with each other, presumably because listeners are sensitive to musical rhythm and meter. The term *rhythm* refers to the patterning of temporal intervals that have varying durations (such as *short-short-long*), whereas *meter* is the periodic temporal structure which gives rise to a sense of alternating strong and weak beats (such as the regular ***strong****-weak-weak*, ***strong****-weak-weak* pattern of a waltz) (Lerdahl & Jackendoff, 1983; Trehub & Hannon, 2006). Music consistently elicits rhythmic behaviors in infants 9 months or older (Zentner & Eerola, 2010), but it is not until childhood that listeners are capable of accurate reproduction of rhythms and precisely timed, synchronous movement to the meter of music (Drake, Jones & Baruch, 2000; Kirschner & Tomasello, 2009; McAuley, Jones, Holub, Johnston & Miller, 2006; Provasi & Bobin-Bégue, 2003). Despite production limitations, evidence from perceptual tasks and electrophysiology suggests that infants are highly sensitive to rhythm and meter. For example, 2- to 7-month-old infants readily discriminate and categorize simple auditory sequences on the basis of rhythm (Chang & Trehub, 1977; Demany, McKenzie & Vurpillot, 1977; Lewkowicz, 2003; Trehub & Thorpe, 1989) and meter (Hannon & Johnson, 2005; Phillips-Silver & Trainor, 2005). Even 2- to 3-day-old newborns exhibit discriminative brain responses to violations of metrically regular rhythmic patterns (Winkler, Haden, Ladinig, Sziller & Honing, 2009), indicating that a basic sensitivity to musical rhythm and metrical pulse may be present at birth.

Address for correspondence: Erin E. Hannon, Department of Psychology, University of Nevada, Las Vegas, 4505 Maryland Parkway Box 455030, Las Vegas, NV 89514-5030, USA; e-mail: erin.hannon@unlv.edu

Newborns and young infants may grasp basic aspects of rhythm and meter, but their listening experiences rapidly influence how they respond to such structures. Rhythmic auditory stimulation is abundant even prior to birth (Sansavini, 1997), and it is presumably because of early experience that newborns and young infants exhibit robust preferences for their native language (Moon, Cooper & Fifer, 1993; Nazzi, Bertoncini & Mehler, 1998), and the musical meter of their own culture (Soley & Hannon, 2010). As culture-specific preferences emerge, perceptual biases also dramatically change in response to culture-specific input (Hannon & Trainor, 2007).

Cross-cultural investigations highlight the fundamental role of culture-specific musical experience. Western musical meters typically contain beats that are evenly spaced over time, or *isochronous*, a feature that gives rise to a predominance of rhythmic patterns having 2:1 and 1:1 ratios (Lerdahl & Jackendoff, 1983; London, 2004). It is perhaps because of prolonged exposure to Western rhythm and meter that Western adults have difficulty perceiving, producing, and synchronizing their movements to rhythmic patterns with non-isochronous beats (Fraisse, 1982; Essens, 1986; Essens & Povel, 1985; Hannon & Trehub, 2005a; Povel, 1981; Repp, London & Keller, 2005; Snyder, Hannon, Large & Christiansen, 2006). For example, when asked to reproduce or detect disruptions within rhythms that contain long and short durations having a complex interval ratio such as 3:2, Western adults tend to distort and assimilate the ratio to a simpler 2:1 ratio (Essens & Povel, 1985; Hannon & Trehub, 2005a; Povel, 1981; Snyder *et al*., 2006). Because 2:1 ratios are more consistent with Western meter than are 3:2 ratios, such biases could be the result of culture-specific experience.

Unlike Western listeners, non-Western adult listeners (from Bulgaria and Macedonia) accurately detect disruptions to rhythms having either 3:2 or 2:1 ratios, presumably because music in their culture can contain both isochronous and non-isochronous metrical levels (Hannon & Trehub, 2005a). For example, a typical Balkan meter such as 7/8 contains isochronous temporal units at the slowest (measure) level and at the fastest (eighth-note) level, yet at the intermediate, most salient level it contains alternating, non-isochronous groups of two and three eighth notes (in a 3:2 ratio). Six-month-old Western infants, who have far less exposure to music than adults, discriminate rhythmic disruptions in either a 3:2 or 2:1 context, whereas by 12 months of age Western infants only discriminate rhythms having 2:1 ratios, implying that culture-specific metrical representations begin to emerge and affect behavior some time between 6 and 12 months (Hannon & Trehub, 2005a, 2005b). Listening experiences are key to the acquisition of culture-specific biases, as evidenced by the finding that two weeks of at-home exposure to Balkan folk music containing non-isochronous meters can effectively reverse the culture-specific bias observed at 12 months (Hannon & Trehub, 2005b). Listening experience may even influence preferences and processing advantages for different types of meters within a culture. For example, North American 9-month-old infants are better at detecting disruptions to a duple-meter melody, which is far more common in Western music, than a triple-meter melody (Bergeson & Trehub, 2006), a trend that is accelerated among 7-month-old infants who receive greater exposure to duple than to triple meters through Kindermusik classes (Gerry, Faux & Trainor, 2009).

Culture-specific experience clearly influences how listeners process rhythm and meter by 12 months of age, but important questions remain about the mechanisms underlying sensitivity to rhythm and meter prior to that age. Is rhythm processing in young infants infinitely flexible until they acquire culture-specific biases? Or do basic constraints limit the types of rhythmic patterns that can be readily grasped by young infants? One likely possibility is that culture-specific experiences act upon and fine-tune capacities that are shared by listeners of all ages. General properties of the mammalian nervous system, such as those underlying prediction and movement, may bias human and non-human listeners towards some form of regularity. For example, anxiety-like behavior and sustained amygdala activity in mice and humans is greater in the presence of temporally unpredictable than predictable sequences, suggesting that irregularity might be aversive (Herry, Bach, Esposito, Di Salle, Perrig, Scheffler, Lüthi & Seifritz, 2007). Similarly, human infants prefer listening to the more regular of two rhythms, even when neither sequence is familiar (Nakata & Mitani, 2005; Soley & Hannon, 2010). Nevertheless, little is known about the extent to which rhythmic regularity affects young infants' perception and discrimination of auditory patterns. One recent study suggests that both adults and 6-month-old infants are better at detecting subtle disruptions to a conventional rhythm previously rated 'good' by a separate group of naïve adult listeners than to an unconventional rhythm previously rated 'bad' (Trehub & Hannon, 2009). These findings argue for the existence of developmentally stable processing biases that influence both subjective ratings of 'goodness' *and* discrimination performance. Other than suggesting that such biases may exist, however, it is not clear which aspects of the conventional and unconventional rhythms affected performance, nor the extent to which these biases interact with culture-specific experience, underscoring the need for further research on the nature of potential constraints.

It is reasonable to assume that any constraints on rhythm processing will influence both the structures that can be learned by infants *and* the types of rhythms and meters that exist in musical systems throughout the world. This approach is exemplified by developmental investigations of pitch perception in the context of foreign and familiar musical scales. In these studies, Western 12-month-olds and adults exhibit superior detection of mistuned notes in the context of familiar Western scales than in the context of unfamiliar Javanese scales, whereas young infants (< 7 months) detect mistuned notes in either context (Lynch, Eilers, Oller & Urbano, 1990; Lynch, Short & Chua, 1995). Despite performing comparably in the context of familiar and unfamiliar scales comprising unequal scale steps, young infants nevertheless fail to detect mistuned notes within an equal-step scale, suggesting that unequal steps facilitate processing of musical scales regardless of culture-specific experience (Trehub, Schellenberg & Kamenetsky, 1999). This finding is consistent with the more common occurrence of unequal-step than equal-step scales across cultures, and it implicates basic information-processing biases that can be observed prior to enculturation.

The present study takes a similar approach to determine whether or not rhythm processing is constrained prior to the emergence of culture-specific metrical biases. Using a standard habituation paradigm, we examine North American infants' discrimination of musical patterns on the basis of subtle rhythmic disruptions. Discrimination performance is compared across three conditions that vary in rhythmic and metrical complexity and familiarity: an isochronous, familiar meter with a simple 2:1 rhythmic ratio, a non-isochronous, unfamiliar meter with a complex 3:2 ratio, and a non-isochronous, unfamiliar meter with a highly complex 7:4 ratio. If young infants' discrimination of rhythms is unaffected by familiarity, we should replicate prior findings of comparable performance in Western (2:1) and Balkan (3:2) metrical contexts (Hannon & Trehub, 2005a). Moreover, because the complex (3:2) and highly complex (7:4) conditions present equally unfamiliar structures that differ only in ratio complexity, any differences in performance can be attributed to rhythm processing constraints based on ratio simplicity that operate independently of culture-specific familiarity.

A secondary goal of the present experiment was to examine more closely the developmental trajectory of enculturation to musical rhythm and meter. Although culture-specific declines in discrimination of foreign rhythms have been observed between 6- and 12-month age groups (Hannon & Trehub, 2005a, 2005b), American infants exhibit preferences for Western meter prior to 7 months (Soley & Hannon, 2010), suggesting that culture-specific experience may begin to affect rhythm processing shortly after 6 months of age. The present experiment therefore tested 5- and 7-month-old infants to characterize more closely the developmental trajectory of culture-specific rhythm processing.

Method

Participants

Participants were 78 healthy, full-term infants whose families volunteered in response to letters distributed in the community. Younger infants (21 girls, 18 boys, M_{age} = 5 months, 3 days, age range: 16–23 weeks) and older infants (23 girls, 16 boys, M_{age} = 6 months, 27 days, age range: 24–34 weeks) were each randomly assigned to one of three metrical conditions: simple, complex, and highly complex (thus, 26 infants participated in each condition). Twenty-two additional infants were tested but not included in the sample due to fussing (n = 10), parental interference (n = 4), equipment failure (n = 1), or failure to habituate (n = 7). A musical experience questionnaire was administered following the study, and no parents reported exposing their infants to complex-meter music. Parents reported no hearing problems or illness in their infants on the day of testing.

Stimuli

Habituation stimuli consisted of 12 computer-generated sound sequences created from one Bulgarian folk melody, shown in musical notation in Figure 1 (Geisler, 1989). The basic melody consisted of four cycles, or measures, and was accompanied by a long-short-short drum pattern, with each drum event corresponding to a metrically strong position. The long interval duration of the drum pattern was fixed at 756 ms, but the short interval duration varied across the three conditions. Figure 2 illustrates that for simple, complex, and highly complex conditions the short interval was 378 ms, 504 ms, and 432 ms, respectively, which resulted in long to short interval ratios of 2:1, 3:2, and 7:4 (corresponding to musical time signatures of 4/4, 7/8, and 15/8). All versions of the habituation stimulus were arranged in a MIDI sequencer and recorded to .aiff format using Quicktime MIDI instruments for the melodic (vibraphone) and drum (rim shot) components. To maximize infants' interest in the sound stimuli, we transposed the basic melody to four different pitch levels (349 Hz, 392 Hz, 440 Hz, and 493 Hz), which varied from trial to trial. On all trials, auditory stimuli were accompanied by a black and white checkerboard image.

Post-habituation trials consisted of one familiar habituation stimulus and one novel stimulus containing a 200-ms disruption to the long interval. Thus, the short duration remained constant but on novel test trials the long interval was increased by 200 ms. Because the long interval duration in all stimuli was 756 ms across simple, complex, and highly complex conditions, the absolute size of the disruption was also constant across

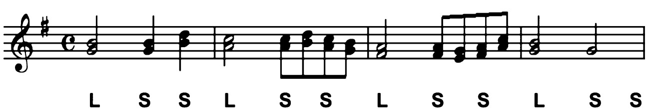

Figure 1 *One folk melody, adapted from Geisler (1989), was used in all conditions by adjusting the ratio between long and short intervals of melody and accompanying drum pattern ('L' indicates long intervals and 'S' indicates short intervals of drum pattern). In this example the melody is in the key of G (392 Hz) and the accompanying drum pattern is consistent with a simple isochronous (2:1) meter.*

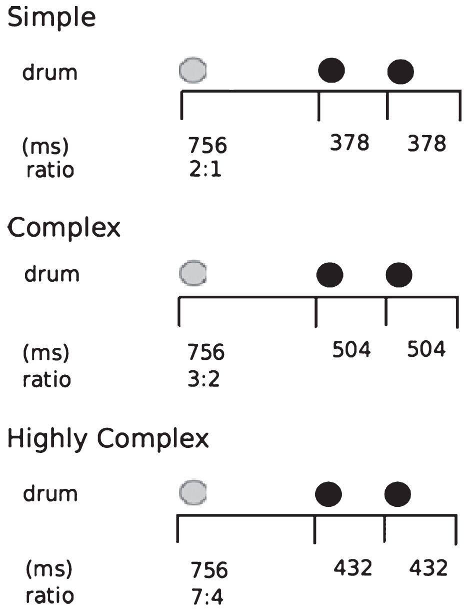

Figure 2 *Durations (in ms) of long and short intervals of the drum pattern in simple, complex, and highly complex conditions. As can be seen, the duration of the long interval remains constant across conditions (756 ms) but the short interval durations vary and thus form long-to-short ratios of varying complexity.*

conditions. Therefore any differences in discrimination performance across the three conditions could be attributed to the ratio between long and short intervals. The disrupted novel test stimuli were also transposed to four pitch levels as described above.

By using a fixed long interval and disruption duration across conditions, the present stimuli allow more control than was possible in prior studies (Hannon & Trehub, 2005a, 2005b; Trehub & Hannon, 2009). The stimuli nevertheless also differ from previously used stimuli in potentially important ways. For example, Hannon and Trehub (2005a) varied the instrumentation of stimuli from familiarization to test phases, which might have encouraged attention to relative rather than to absolute aspects of pitch and rhythm (and thus greater attention to ratios), whereas identical instrumentation at familiarization and test – as in the present case – might reduce salience of rhythmic ratios. Therefore prior to testing infants, it was important to replicate culture-specific biases previously observed among adults. Moreover, we wanted to confirm our suspicion that for adults, conformity to familiar Western meter, and not simplicity, would be the primary factor driving performance. We therefore collected pilot data from North American adults using a discrimination procedure (N = 25 per condition, between subjects). Adult listeners were presented with a standard (habituation) stimulus followed by a comparison stimulus that could either be the same (another habituation stimulus) or different (a test stimulus containing a 200-ms disruption). Adults were asked to indicate for each pair whether the standard and comparison were 'same' or 'different' over the course of 16 trials. Adults were significantly above chance in all three conditions ($p < .01$), but a one-way ANOVA yielded a significant main effect of condition, $F(2, 72) = 7.263$, $p < .001$). Post-hoc tests revealed that accuracy was significantly higher in the simple condition (M = 77%, SD = 8%) than in the complex (M = 61%, SD = 18%) or highly complex (M = 64.5%, SD = 17%) conditions ($p < .01$), and accuracy in the complex and highly complex conditions did not differ ($p > .40$). Thus, by replicating previously documented culture-specific biases among adults, we verified that the present stimuli were suitable for use with infants and for making developmental comparisons. Moreover, we confirmed that adults' discrimination accuracy was overwhelmingly influenced by familiarity and not by complexity, as shown by their nearly identical performance for two unfamiliar rhythms that differed in complexity.

Apparatus and procedure

Infants were tested individually while seated on a parent's lap in a dimly lit, double-walled sound-proof booth (Industrial Acoustics). A PowerMac Dual 2 GHz PowerPC G5 computer controlled the presentation of all stimuli. Visual stimuli were presented on a centrally placed 43.2 cm (17-inch) color monitor (Acer AL715) located 173 cm away from the infant, and auditory stimuli were presented via a central, hidden loudspeaker (Genelec 8020A). Infant visual fixations were recorded with a Sony DCR-HC32 infrared digital video camera (Tokyo, Japan), located above the monitor and focused on the infant. An experimenter who was blind to condition sat outside the booth and observed the infant over closed circuit television, coding visual fixations on-line and controlling the experiment using Habit X software (Cohen, Atkinson & Chaput, 2002). A second experimenter, also blind to condition, measured looking time by using Supercoder v.1.5 (Holich, 2005) to perform off-line frame-by-frame coding. To ensure that parents were blind to condition, they listened to classical music over noise canceling headphones (Sony MDR-NC6) throughout the experiment.

To initiate each trial, an attention-getting red flashing screen oriented the infant towards the monitor and loudspeaker. Once the infant was attending, the experimenter pressed a button to begin a trial. On each trial the melody repeated continuously until the infant looked away for more than 2 seconds or until 60 seconds had elapsed. During the habituation phase, each infant was presented with the familiarization stimulus at all four pitch levels, and order of presentation was quasi-random, with the restriction that all pitch levels had to be presented before a given pitch level could be repeated. The habituation criterion was defined as an average fixation decrement of 50% over four trials relative to the average fixation of the previous four trials. Immediately following habituation trials, infants were presented with six test trials consisting of one familiar stimulus (previously presented) alternating with one novel stimulus (containing a 200-ms disruption). The pitch level of each test stimulus was chosen quasi-randomly. Order of post-habituation test trials was counter-balanced in each condition, so half of the infants were presented with the familiar stimulus first, and half were presented with the novel disrupted stimulus first.

Results

Fixation times during novel and familiar post-habituation trials were averaged and submitted to a 2 × 2 × 3 (Test Stimulus [novel, familiar] × Age [5 months, 7 months] × Ratio [simple, complex, highly complex]) mixed-design ANOVA. This revealed main effects of Age, $F(1, 72) = 5.226$, $p < .05$, and Test Stimulus, $F(1, 72) = 7.677$, $p < .01$, as well as an interaction between Test Stimulus and Ratio, $F(2, 72) = 3.148$, $p < .05$. No other main effects or interactions were observed. As is evident from inspection of Figure 3, younger infants had longer fixation times (M = 12.86 s, SD = 9.6 s) than did older infants (M = 9.09 s, SD = 5.59 s), a common finding in studies of infant looking time (Johnson, 1996). Overall, fixation times were longer during novel test trials (M = 12.02 s, SD = 9.13 s) than during familiar test trials (M = 9.91 s, SD = 7 s), but this varied by condition, as shown by the significant Test Stimulus by Ratio interaction. Planned post-hoc 2 × 2 (Test Stimulus × Age) ANOVAs were conducted separately for each ratio condition. In the simple condition, both age groups discriminated familiar from novel stimuli, as shown by a main effect of Test Stimulus (e.g. longer looking to novel), $F(1, 24) = 9.816$, $p < .01$, but there was no interaction between Test Stimulus and Age, $F(1, 24) = 0.073$, $p = .79$ (see Figure 3). In the complex condition, infants oriented longer to novel than familiar test stimuli, as shown by a main effect of Test Stimulus, $F(1, 24) = 11.732$, $p < .01$, but this tendency was strongest among the young infants, as shown by a significant interaction between Test Stimulus and Age, $F(1, 24) = 4.835$, $p < .05$. Post-hoc t-tests confirmed that younger infants exhibited a significant preference for the novel test stimulus, $t(12) = 3.661$, $p < .01$, whereas older infants did not, $t(12) = 0.958$, $p = .36$. No main effects or interactions were found in the highly complex condition, $F(1, 24) < .12$, $p > .74$, suggesting that at neither age did infants discriminate novel from familiar test stimuli in the highly complex condition.

To depict age-related changes in discrimination performance, Figure 4 presents novelty preference (novel stimulus fixations minus familiar stimulus fixations) as a function of ratio condition, separately for each age group. Pearson correlations were also calculated between novelty preference and age (ranging from 16 weeks to 34 weeks), separately for simple, complex, and highly complex conditions. Consistent with the trends shown in Figure 4, correlations between age and novelty preference were small and non-significant for both simple and highly complex conditions, but a significant negative correlation was observed in the complex condition, $r(26) = -.58$, $p < .01$.

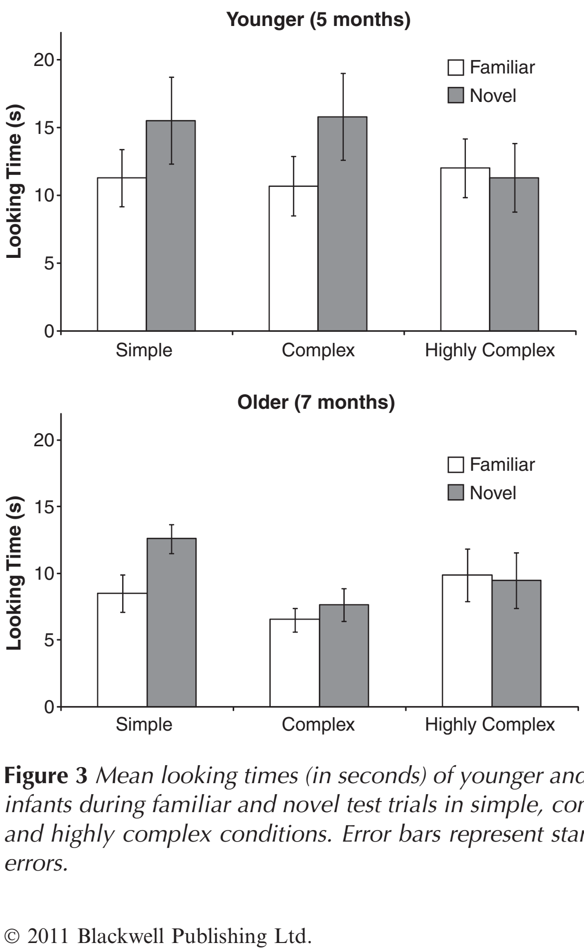

Figure 3 *Mean looking times (in seconds) of younger and older infants during familiar and novel test trials in simple, complex, and highly complex conditions. Error bars represent standard errors.*

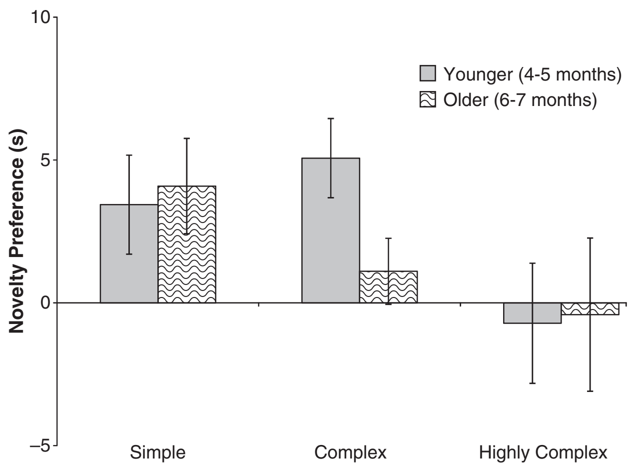

Figure 4 *Novelty preferences were computed by subtracting average looking time (s) during familiar trials from average looking time (s) during novel trials. Positive values larger than 0 indicate successful discrimination (novelty preference). Average difference scores are presented separately for each age group and ratio condition. Error bars represent standard errors.*

Discussion

The present findings replicate prior work by demonstrating differences between infants' and adults' rhythm processing. While adults' and older infants' performance is driven by familiarity, younger infants' performance appears to be minimally affected by culture-specific experience. This is evident from the finding that 5-month-old Western infants exhibited a post-habituation novelty preference in both simple (2:1, isochronous) and complex (3:2, non-isochronous) ratio conditions, even though the 3:2 ratio was less familiar than the 2:1 ratio.

Crucially, the present results suggest that rhythm processing is nevertheless constrained. Specifically, after habituation to a rhythmic pattern containing a highly complex 7:4 ratio which is relatively rare in music throughout the world (Clayton, 2001; London, 2004), 5-month-old infants failed to exhibit a preference for the disrupted stimulus. This failure is striking in light of the fact that infants at this age readily discriminated stimuli based on the same disruption size (200 ms) to the same long interval (756 ms) in conditions containing long and short intervals standing in 2:1 or 3:2 ratios. Together, results across these three conditions suggest that even at an age when infants are minimally influenced by familiarity and culture-specific perceptual experience, they nevertheless have difficulty processing highly complex ratios.

Why are 7:4 interval ratios less common, and why do they pose difficulty for even the youngest, least enculturated listeners? One possibility is that simple-integer ratios have a generally privileged status in music. Applied to the phenomenon of musical consonance and dissonance, this proposal dates back to the Greeks and is supported by evidence of universal and early developing preferences and processing advantages for simple-integer ratios between tones (Butler & Daston, 1968; Demany & Semal, 1992; Schellenberg & Trehub, 1996; Trainor & Heinmiller, 1998). While the basis for consonance and dissonance remains a subject of controversy (McDermott & Oxenham, 2008), a bias for simple-integer ratios could constrain both pitch and rhythm processing.

A second possibility is that adults and young infants alike tend to seek out isochronous, periodic structures by subdividing intervals and using their common denominator as the primary temporal pulse. For example, the 756-ms and 378-ms intervals of the 2:1 stimulus can be readily interpreted in terms of a single underlying 378-ms unit that occurs four times per measure. Although the 3:2 stimulus is non-isochronous at the level of the rhythm – which is typical of Balkan meters – it can nevertheless be subdivided into a regular, isochronous sequence of seven 252-ms intervals per measure. By contrast, the common denominator in the 7:4 stimulus is 108 ms, and intervals this short are notoriously difficult for adults to perceive and reproduce (Drake & Botte, 1993; Getty, 1975). Likewise, increasing the duration of the common denominator in the 7:4 stimulus would lead to an unusually long 15-unit measure that would probably tax auditory working memory (Grondin, 2001). Thus, optimal rhythm processing may only be possible when the intervals that comprise a rhythm are readily subdivided into manageable smaller units. This would be consistent with the notion that even in cultures where highly complex time signatures are theoretically possible, in practice longer intervals tend to be subdivided into smaller units of 2 and 3 (London, 2004). Future work is needed to systematically vary the duration of the common-denominator unit and the number of units per measure, to determine whether tempo constraints and/or working memory drive poor performance in the context of the 7:4 ratio.

A secondary goal of the present research was to examine the developmental trajectory of culture-specific biases. Although no effects of age were evident in simple or highly complex conditions, age-related changes were observed in the complex condition. Specifically, 5-month-old but not 7-month-old infants exhibited a novelty preference in the 3:2 ratio condition. The null preference among 7-month-olds is striking in light of prior evidence that 6-month-olds successfully discriminate complex-meter stimuli (Hannon & Trehub, 2005a). Because the disruptions in the present study were 50 ms shorter than in prior work, task difficulty might have made it easier to elicit culture-specific biases among older infants in the present study. Nevertheless, our results clearly indicate that such biases can be observed well before 12 months of age.

The present findings suggest that ratio complexity provides an important constraint on rhythm and meter perception, and likewise, on the types of rhythms and meters that are present in music throughout the world. Rhythm and meter perception arise from a complex interplay between exposure to culture-specific conventions and the emergence of metrical representations. By examining the structures that challenge even the youngest, least enculturated listeners, it is possible to gain insight into the starting points for musical learning.

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Received: 7 June 2010
Accepted: 1 November 2010