Theoretical and Practical Aspects of Cross-Cultural Corpus Studies: Two Case Studies from Mali

Justin London, Nori Jacoby, and Rainer Polak

The Oxford Handbook of Music and Corpus Studies
Edited by Daniel Shanahan, John Ashley Burgoyne, and Ian Quinn

Subject: Music, Music Theory, Musicology and Music History
Online Publication Date: Apr 2022  DOI: 10.1093/oxfordhb/9780190945442.013.32

Abstract and Keywords

Corpus-based research has historically consisted primarily of data that can best be represented in Western musical notation, often with an American/Eurocentric bias. In this chapter, the authors present a corpus of live performances of jembe-drum ensemble music from Mali and two analytical studies that make use of it. These studies help us to understand and appreciate a musical style of considerable rhythmic subtlety and complexity, and, because they shed additional light on issues of rhythm perception and performance, they also increase the cultural diversity of empirical musicological research. The authors’ findings demonstrate the usefulness of a cross-cultural perspective for both general, scientifically informed theories of rhythm and meter and for ethnomusicologically informed theories of rhythm and meter in African (sub-Saharan) music-cultural contexts.

Keywords: Malian drumming, meter, rhythm, performance data, cross-cultural

Introduction

Lurking in the background of all analytical studies of music is the problem of representation: How are the musical structures of interest to be rendered into a form which allows for inter- and intra-opus comparison, categorization, and analysis? Ethnomusicology, as a discipline, has labored since its inception to deal with this problem because one of the first issues and most problematic challenges for those who would analytically study music in oral/aural traditions is to develop a system, or style-specific systems, of representation so that patterns of musical practice could be recognized and discussed (Ellingson 1992; Nettl 1983; Seeger 1958).

When corpus-based analytical studies of music first appeared, their creators looked to notated musical sources and collections (e.g., Barlow and Morgenstern’s [1948] redoubtable Dictionary of Musical Themes) as the compilation of a corpus of music from a written tradition finesses (or appears to finesse) the problem of representation: the system of notation in which that music is written is presumed to be an adequate representation of its es-
sentential musical features. For more recent corpus studies that involve computer-searchable and statistically analyzable corpora, the problem became translating one form of symbolic notation (i.e., Western staff notation) into another (e.g., KERN or MusicXML), so that various forms of analysis could be performed more thoroughly and conveniently.

Yet one obvious problem is that even in written music traditions, musical scores and score-based representations fail to capture many important and salient aspects of musical structure—the problematic “structure versus expression” dichotomy (Clarke 1985). With the advent of performance-based (i.e., MIDI) and audio-based music data collection and analysis, this problem can be finessed. Indeed, the computer-aided analysis of audio and MIDI recordings has exploded since the 1980s, concurrent with the rapid development of accessible digital music archives. For example, such studies have enormously enriched our understanding of performance timing patterns (Benadon and Zanette 2015; Cook 2014; Dittmar et al. 2017; Ohriner 2012; Wesolowski 2015; Benadon 2006; Bengtsson and Gabrielson 1983; Collier and Collier 2002; Ellis 1991; Friberg and Sundström 2002; Honing and de Haas 2008; Johansson 2009; Kilchenmann and Senn 2011; Repp 1990, 1997; Shaffer 1984). Working from audio or MIDI data, performance timings can be compared directly or sorted without any a priori presumptions regarding inherent rhythmic or metric categories (e.g., one need not address the “swing ratio” in jazz as inherently duple or inherently triple).

However, a second problem remains in that these studies retain an American/Eurocentric bias because most of these studies have focused on recordings of Western classical, jazz, and popular musics; not a single major timing study of any African repertoire was published before 2010. Likewise, two special editions of Music Perception (2013, volume 31, issue 1 and 2014 volume 31, issue 3) on corpus-based methods provided examples of use exclusively from the fields of European art music and North American jazz. This is symptomatic of the larger American/Eurocentric bias still present in the academic world in general (e.g., see Henrich et al. 2010 on the biased sampling of participants in psychological experimentation) and musicology in particular (for a recent overview, see Ewell 2020).

There are, of course, practical reasons for this lag beyond intentional or implicit America/Eurocentrism. As with the corpora created from notated sources, audio-based corpora were first formed from collections of recordings that were ready at hand: that is to say, commercially available recordings (what one in psychology might call a “convenience sample”). To expand the range of study of musical styles and practices, one has to curate corpora (see five eminent recent examples at http://compmusic.upf.edu/), which may involve going into the field to collect and assemble the recordings from scratch. This is true whether one is studying the local music scene in a large city or the musical tradition of a remotely located indigenous people. In all cases, one must collect recordings with the aims of one’s data analysis in mind: How much sonic detail is required (separate tracks for each performer)? How ecologically valid does the performance need to be? And so forth. While extra effort (and time and funding) is required, music from these otherwise understudied repertoires not only provides data which can refine and challenge
Theoretical and Practical Aspects of Cross-Cultural Corpus Studies: Two Case Studies from Mali

and hypotheses of music theory, musicology, and music psychology; they also allow one to examine aspects of musical structure, performance, and performer dynamics that are not possible in other repertoires.

In this chapter, we present a corpus of live performances of jembe-drum ensemble music from Mali and two analytical studies which make use of it. We note the issues it raises for both cross-cultural musicological studies and for corpus-based studies of music more generally.

A Corpus of Malian Drum Ensemble Performances

A variety of drum ensembles are common in Mali, such as the duo of one jembe (a goblet-shaped hand drum) and one dundun (a cylindrical drum played with a stick), a trio of two jembes and one dundun, and the quartet of two jembes and two dunduns. Repertoire is not specific to a particular ensemble size; rather, pieces are played with whatever group of musicians has been assembled for a given occasion. Malian drumming music is, first and foremost, music for dancing, and it is almost always heard in the context of a community dance event.

In Malian drum ensembles, each player is assigned one of three musical roles. The first/lead jembe directs the ensemble and controls the pacing of the musical form, coordinating the interaction between drummers, dancers, and audience. The first dundun plays a catchy, repertoire-specific timeline figure or “hook,” whose mostly cyclic-repetitive performance provides temporal orientation to all participants—the drum ensemble, dancers, singers, and audience. The second jembe (and the second dundun, if present) plays a short and simple ostinato accompaniment pattern which reinforces the basic beat and meter (in our corpus, it is always a four-beat measure with ternary subdivisions of the beat); in duo performance, the ostinato is absent. The interlockings among the individual parts create composite polyrhythms, with nearly every beat and subdivision in the metric cycle articulated by a stroke of at least one of the drums in the ensemble (see Appendix 1).

Our corpus comprises a total of fifteen recordings of the core repertoire of jembe celebration music from Bamako: “Manjanin” (four recordings) “Woloso” (five recordings), and “Maraka” (six recordings). For each piece we include different ensemble sizes (duo, trio, and quartet), and four different players alternate in the role of the first jembe (see Appendix 2). All ensemble members are experienced urban professional drummers. Though these recordings were not made in the context of an actual dance-drumming event, all recordings show a strong, almost continuous accelerando (start tempos range from 100 to 140 bpm, end tempos from 160 to 200 bpm) that is typical of dance-based performances.
To study the timing of individual drummers as well as their interaction, multitrack recordings which captured the sound of each drum separately were required. This had to be done in an improvised studio setting “in the field.” Clip-on microphones on the edge of each drum were fed to a mobile digital four-track studio. The individual tracks were recorded with little crosstalk from the neighboring instruments. This made the detection of event onsets in the waveform in each track relatively straightforward. The audio editors Soundforge, Wavelab, Cubase, and Sonic Visualizer provided semi-automated marking of all onset timings, which were then checked by hand. We exported data of approximately 42,000 marked onsets into Matlab for further processing and analysis. We rejected approximately 2 percent of the originally marked attacks by trimming at the beginning and end of the pieces. Another 2 percent were ornaments in the first jembe part (flams, rolls) which do not allow metric assignment. The remaining nearly 40,000 metrically annotated attack times constitute the finished corpus.

Figure 32.1 displays the nearly 3,000 data points from a trio performance of “Manjanin.” The lead jembe is on the bottom, the ostinato jembe is in the middle, and the “hook” dundun is on top. Successive measures occur as one moves up in each column of data points. One particular challenge in the analysis of these data is establishing a reference point for the timing of events in each metric cycle, given that there is no click track and that there is a sustained accelerando over the course of each piece. This problem was solved in two steps. First, the start/end-points of each four-beat metric cycle were initially approximated from the ostinato drum(s). In a second step, we refined the beginning of each four-beat cycle as the average of the onsets of all instruments that articulate the provisionally determined beat. We then calculated all attacks in relation to the duration of each metric cycle, from which we are able to define the precise beat and subdivision timing pattern in the form of histograms. In each recording, the histograms of the onset timings show twelve succinct clusters of distribution in the metric cycle (see Figure 32.1, bottom). Each cluster is well-separated from its neighbors, and thus most of the attacks were reliably assigned to a particular metric position.
Figure 32.1 Example of a recording of about 3:15 minutes duration (“Manjanin” 3, just under 3,000 onsets). The upper section shows the data separated by ensemble parts (Jembe 1, Jembe 2, Dundun). While the x-axis represents the time position of the plotted times within the four-beat metric cycle, the y-axis shows the time course from cycle to cycle. The lower area aggregates the data points of all cycles and instruments in a histogram. The dashed gray lines show the boundaries of twelve discrete onset clusters that articulate twelve metric positions. In the Jembe 1 part, crosses mark rhythmic ornaments that were excluded from the analysis.

Study 1: Rhythm Histograms, Statistical Learning, and Meter-Rhythm Relationships

Many theories of rhythm and meter treat the relationship between rhythm and meter as a close correspondence. Lerdahl and Jackendoff’s (1983) metrical preference rules derive metrical organization from patterns of melodic and rhythmic grouping, and Hasty’s (1997) derives the potentials for metric projection from rhythmic durations. Indeed, most approaches to rhythm and meter assume humans have a cognitive disposition to minimize syncopation and maximize the alignment of rhythmic and metrical accent (Lee 1991; Longuet-Higgins and Lee 1984; Temperley 2001). Lerdahl and Jackendoff (1983, p. 42) speak of metric structure as a “best-fit interaction between stimulus cues and internalized regular patterns,” and this assumption is shared in cognitive-psychological approaches to beat induction (Desain and Honing 1999; Honing 2012), dynamic attending theory (Jones and Boltz 1989; Large and Jones 1999), algorithms for automatic beat and tempo detection (Ellis 2007; Jehan 2005), and neuroscientific studies of rhythm (Large and Snyder 2009; Nozaradan et al. 2011; Tal et al. 2017; Vuust and Witek 2014).

Corpus studies of European repertoires have tested and largely confirmed this assumption. A basic form of statistical rhythm analysis involves a counting of the frequency with which rhythmic events occur in a given metric position (i.e., the distribution of rhythmic events in the metric cycle). Several such studies have shown that in European forms of both art and folk music, event frequency and metrical accent are closely correlated.
Theoretical and Practical Aspects of Cross-Cultural Corpus Studies: Two Case Studies from Mali

(Huron and Ommen 2006; Palmer and Krumhansl 1990; Temperley 2010); an example is given in Figure 32.2. These studies give support to both music-theoretic definitions of metrical weight or accent as well as to how listeners without musical training develop a sense of meter and metrical accent. The stable relationship between onset distribution and metrical position/accent provides a reliable context for processes of statistical/implicit learning which can be assumed to underpin meter learning. Statistical learning is not dependent on pedagogical contexts or explicit instruction and is regarded as a fundamental means of human knowledge acquisition—among other things, for the acquisition of language by children (e.g., Reber 1967; Vapnik 2000).

Not all musics display this correspondence, however. Waterman (1952) founded a meter-theoretic tradition within Africanist ethnomusicology which acknowledged that our sense of “subjective meter” is not in all musical styles/cultures articulated by the rhythmic surface of the music. Similarly Kolinski (1973) characterized rhythmic figurations that feature offbeat phrasing and cross-rhythms as “contrametric.” A majority of Africanist authors today considers a metric main beat to be an unambiguous cognitive reality for enculturated listeners, even in musical contexts marked by systematically offbeat and cross-rhythmic structures that seem to intentionally mask or even contradict that beat (see, e.g., Agawu 2006; Anku 2000; Arom 1991; Burns 2010; Kubik 1994; Locke 1982; but compare Chernoff 1979; Koetting 1970; Stone 1985).

Holzapfel (2015) examined the relationship between event frequency and meter in a corpus of more than 900 pieces of Turkish modal (makam) vocal art music. In this musical form, each melody is constructed in the context of a specific rhythmic mode or usul; note that an usul is not a meter but a rhythmic prototype that occurs in a particular metrical context. Holzapfel found that the frequency of events in the latter correlates quite closely with the usul patterns (see Figure 32.3). The usul concept thus shapes the rhythm of melodies even in the absence of drum accompaniment. Metric hierarchies of nested lay-

![Figure 32.2](image-url)
ers of pulse occur in conjunction with some rhythmic modes (e.g., usul semai; see Figure 32.3d), but not all. For example, the sixteen-stroke usul düyek articulates the second basic metric beat (position 5) much less frequently than those in positions 3 and 7, which lie at a lower level of the metric hierarchy whose primary beats are at locations 1, 5, 9, and 13 (see Figure 32.3c).

![Figure 32.3](image)

**Figure 32.3** Distribution of the event onset frequency in relation to the metric cycle in a corpus of Turkish makam music, grouped by rhythmic mode (usul). The x-axis shows the metric cycles, the y-axis the event frequency. The columns that mark the main articulations of the usul are gray shaded.

Source: Holzapfel 2015, figure 5.

Following Holzapfel, we performed a similar analysis on the pieces in our corpus (London et al. 2017). Figure 32.4 gives the frequency distributions of rhythmic events within each measure for each of the three pieces in our corpus. Of the four main beats, only the first—the beginning/end-point of the metric cycle in all of the rhythms—displays a high frequency which corresponds to music-theoretic notions of metrical accent. Beats number 2, 3, and 4 consistently are marked by fewer attacks than the metrically “weak” subdivision locations which precede them (Beats 1.3, 2.3, and 3.3). The positions marked by the particular dundun pattern characteristic of each piece have a high number of articulations. While the second of three subdivisions per beat in general receives comparatively few rhythmic onsets (Beats *.2), this is always true only for the piece “Woloso,” whereas “Manjanin” (Beat 4.2) and “Maraka” (Beats 2.2 and 3.2), due to their specific dundun timelines, have some second subdivisions with at least moderate degrees of rhythmic articulation.
Figure 32.4  Histogram of event onset distribution in relation to the metric position, separated by pieces; the 2–4 ensemble parts per recording and 4–6 recordings per piece are aggregated. Asterisks within the bars mark metric positions articulated by the repertoire-specific dundun (timeline) strokes; the timeline in the piece “Woloso” spans two cycles and therefore has two rows of asterisks. Dashed vertical lines mark the boundary between the beat ranges. The hierarchical structure of the metric type (four basic strikes with three subdivisions per cycle), which is subject to all three pieces, is shown below the histograms in the form of a dot graph.


Figure 32.5 is the rhythmic histogram for our entire corpus. While this aggregation masks the divergent piece-specific structures realized by the different patterns of the dundun, the style-specific general pattern emerges all the more clearly: The metric cycle’s beginning/ending point (Beat 1) is marked by frequent rhythmic accentuation, but the locations of the main metric beats within the measure (Beats 2, 3, and 4) are not.
The primary finding of the distributional analysis of our corpus is that, as in Holzapfel’s study but to a stronger degree, event frequency does not proportionally correlate with beat location/metrical accent. This is inconsistent with the widespread assumption that metric structure can be directly inferred from phenomenal patterns of onsets and/or accents. This is not to say that statistical learning cannot occur in these contrametrical contexts. The percussion ensemble rhythms we have analyzed are embedded in both polyrhythmic and timbral/melodic figures and appear in multisensory performance contexts, where participants also sing, dance, clap, etc. In such aesthetically, socially, and culturally rich environments, active teaching and music-pedagogic interventions, which do not play any considerable role in the respective musical tradition, may not be necessary to perceive the periodicity of the beat span and to learn how the metric framework relates to the melo-rhythmic musical surface.

Study 2: Sources of Swing

As is well known, jazz musicians don’t play the music as it is written: according to a widespread assumption, they alter the notated rhythms to give the music a sense of “forward propelling directionality” (Schuller 1968), or, as is commonly known, “swing.” With the advent of recording-based studies of performance timing and dynamics, one important aspect of swing has been studied under the labels of “expressive microrhythm,” “microtiming,” and “participatory discrepancies.” Empirical studies of the “swing ratio” (the relative duration of the long vs. short elements in a swung rhythm) have found values ranging from 1.2:1 to beyond 3:1 depending on the particular performer, style (e.g., big band vs. bop), and tempo (Friberg and Sundström 2002; Benadon 2006; Honing and de Haas 2008; Dittmar et al. 2017; Butterfield 2011; Prögler 1995; Wesolowski 2015). Underlying all of these approaches is the distinction between rhythmic structure and expression (Clarke 1985), grounded in the psychological mechanism of categorical rhythm perception and
reinforced by the durational concepts of Western notation. From this perspective, “swung” rhythms are performance-dependent alterations of the underlying durational categories (e.g., a “long” vs. a “short”). It is the underlying categories that constitute rhythmic structure, and it has been widely presumed that these underlying categories are based on the smallest integer ratios, such as 1:1 (isochrony) and 2:1 (Fraisse 1982; Povel and Essens 1985; Clarke 1987). Similar views were developed by theorists of African rhythm who claimed that a fast, isochronous pulse at the level of beat subdivision functions as the basis of higher level metrical structure, what has been called the “elementary pulse” or “density referent” (Arom 1991; Burns 2010; Kaufmann 1980; Koetting 1970; Kubik 1994; Locke 1982; Stone 1985).

But are swung notes “deviations” from an underlying isochronous pulse or simple-integer ratio rhythm? What if the swing ratio is the metric reference structure? That is, what if the so-called “expressive” timing is instead an integral part of the meter for a particular piece, genre, or performance style, what London has put forth as the “Many Meters Hypothesis” (London 2012, pp. 171–189)? This may appear unlikely in view of the many jazz studies which have described swing ratios to be extremely variable across several parameters, including substyle, tempo, musical ensemble role, individual performer, and specific melodic and rhythmic patterns. By contrast, the metric status and function was claimed to be true for three different styles of Malian percussion music which show non-isochronous patterns of beat subdivision to be amazingly stable across all the named parameters (Polak 2010, Polak and London 2014).

To address the expressive deviation versus structure question, the following hypothesis can be examined:

If uneven timing of beat subdivision is a deviation from an isochronous reference structure, pieces with highly uneven subdivision timings should involve higher degrees of timing variability (measured by the standard deviation of durations and/or onset locations) than one finds with categorically isochronous (1:1) or simple-integer ratio (2:1, 3:1) rhythms. This higher variability should be manifest in both the timing ratios of the rhythms performed by each player, as well as by larger and more variable asynchronies among players. However, if “swing” timings are temporal reference structures in their own right, then their respective variabilities should be the same or similar to those found in “straight” rhythms.

The three pieces in our corpus are based on cycles of four isochronous beats with ternary beat subdivision. Figure 32.6 shows histograms of the distribution of all onsets in all recordings per piece normalized to the beat span (to account for the systematic accelerando that occurs in each performance). Two pieces (“Manjanin” and “Woloso”) feature a strongly non-isochronous pattern, short-medium-long, with average timing ratios of about 24:34:42 and 24:36:40, respectively, for each of the ternary subdivisions. The third piece (“Maraka”), by contrast, shows an average ratio of about 36:29:35, which deviates from isochrony to a much smaller degree. To put it another way, “Manjanin” and “Woloso” are performed with a strongly “swung” ternary rhythm while “Maraka” is not.
Theoretical and Practical Aspects of Cross-Cultural Corpus Studies: Two Case Studies from Mali

Figure 32.6 aggregates the timing of various individual players, ensemble parts, instruments, and phrase types in different recordings at different tempos. The narrowness of distributions indicates the high degree of consistency in the musicians’ performances; the standard deviation of the averages is 2.5 to 3.5 percent of the local beat span. There is no statistically significant difference in durational variability between the pieces “Maraka” and “Woloso” (t (31) = 0.47, p = n.s.); the values for “Manjanin” are higher (“Manjanin” and “Woloso”: t (25) = 3.05, p = 0.016; “Manjanin” and “Maraka”: t (28) = 3.46, p = 0.005).

To capture the characteristics of timing not only within the aggregate performance, but also between ensemble members, one also can measure the magnitude and variability of the average asynchronies that occur between the onsets of different players in the same metric position. We first calculate the mean location of all onsets (from all performers) for each subdivision and then calculate the average distance of each ensemble member’s onset from that virtual reference time point. The average asynchrony in the entire corpus is only about 2–3 percent of the beat span, which corresponds to an absolute duration of only 6–12 milliseconds, depending on the tempo. Despite this very small magnitude, the asynchronies show a consistent pattern of alignment among the instruments: the first jembe’s onsets on average occur slightly before the mean, the first dundun plays on top of the virtual reference, whereas the accompanying instruments (second jembe and second dundun) slightly lag behind. A similar pattern, where the leading instrument plays slightly ahead of other ensemble parts, is also found in European chamber music and has been addressed as “melody lead” (Keller 2014); by contrast, soloists in jazz music have been reported to slightly play “laid back” relative to the rhythm section (Prögler 1995; Butterfield 2010). As expected, the first jembe shows somewhat higher values than the other in-
Theoretical and Practical Aspects of Cross-Cultural Corpus Studies: Two Case Studies from Mali

Instruments, because the lead part has more different and more variable phrases at its disposal, which involve a slightly higher variability of its subdivision timings.

Importantly, however, the three pieces do not show any statistically significant differences in the magnitude of occurring asynchronies; a two-way ANOVA (Piece X Instrument) shows neither a significant main effect for Piece ($F(2,34) = 0.59, p = 0.55$), nor for Instrument ($F(3, 34) = 1.47, p = 0.24$), nor is there an interaction ($F(6,34) = 0.42, p = 0.85$) between the two variables. Thus both the stability of the durational ratios and the precision of ensemble synchronization in the performance of jembe music emerge as independent of the degree of (non)isochrony in the beat subdivision. The timing of the beat subdivision in our corpus is highly precise and stable, and the synchronization of ensemble parts is much tighter than what previous research found in European chamber music and in jazz (cf. Butterfield 2010; Friberg and Sundström 2002; Goebl and Palmer 2009; Keller 2014; Prögler 1995; Rasch 1988; Rose 1989; Timmers et al. 2014). There are no quantitative differences among the three pieces concerning the degree of variability in the individual timings and synchronization among ensemble members. This is inconsistent with the hypothesis that the uneven subdivision timings one finds in “Manjanin” and “Woloso” are deviations from an underlying isochronous reference structure.

Malian musicians, dancers, and listeners perceive both isochronous and non-isochronous subdivisions as equally accessible, reliable, and “natural.” Malian children use uneven subdivisions in their playful performances without ever starting from (allegedly) simpler, isochronous realizations. Ensembles of unexperienced junior players use the same timing patterns as their adult role models, albeit with somewhat higher variability, but never with a tendency toward isochrony (Polak and London 2014).

Conclusion

The two corpus-based studies reviewed here analyze a form of traditional Malian dance drumming. While they are interesting in their own right because they help us understand and appreciate a musical style of considerable rhythmic subtlety and complexity and because they shed additional light on issues of rhythm perception and performance, they also increase the cultural diversity of empirical musicological research. Our findings demonstrate the usefulness of a cross-cultural perspective both for general, scientifically informed theories of rhythm and meter as well as for ethnomusicologically informed theories of rhythm and meter in African (sub-Saharan) music-cultural contexts.

Both studies reported here depend on the use of audio data as this repertoire is not composed or transmitted in notation. Yet what is a necessity for this repertoire can also be useful and, indeed, advantageous for other repertoires. Our approach and analysis did not require the creation of or reference to any forms of symbolic representation, and thus we were able to proceed without a priori assumptions regarding the structure of metrical categories and their associated timing patterns. Our agnosticism rendered the “structure versus expression” question moot as we did not make this presumption in the first place. Likewise, assembling this corpus required extensive fieldwork, but it also allows us to
move beyond convenience samples to repertoires that are based on different syntactic principles, different sociocultural practices and institutions, different modes of performance, and different modes of reception.

Study 1 challenged tacit assumptions for statistical learning processes for rhythm-meter relationships in music and cues for metrical expectation and accent. In some contexts the "best" meter for a given rhythm is the one which yields the least amount of "syncopation" or rhythm-meter incongruence. In the context of musical styles where contrametrical rhythmic organization is a rule rather than an exception, however, a minimization of syncopation/incongruence will not give the correct result. Our study demonstrates that such congruence is not characteristic of Malian drum music, with its typical offbeat phrasing, cross-rhythms, and asymmetric timelines, even though the music in our corpus does involve a metrical framework (a four-beat cycle with ternary beat subdivision) that is comparable to common Euro-American meters (i.e., 12/8).

More broadly, our findings are consistent with the possibility that the assumption of rhythm-meter congruence in the cognitive sciences of music may reflect a Euro-American cultural bias, and this bias may mask more complex aspects of rhythm-meter alignment and thus, in turn, oversimplify the ways in which statistical learning mechanisms may be involved in acquiring tacit knowledge of those aspects. We would note that our rhythm histograms, like those used in the other studies cited earlier, represent the marginal distributions of events in our corpora; higher-order statistics of event configurations (e.g., rhythmic motifs, instrument-to-instrument transitions) could serve as the basis for statistical learning processes for rhythm-meter relationships that are not evident in the lower-order distributions.

Study 2 presented evidence from performance timing data that non-isochronous timing patterns of beat subdivision may constitute metrical functional temporal reference structures in their own right, contrary to the assumption that isochrony is a prerequisite for the basic metric processes such as beat induction and pulse. This conclusion from our corpus study has inspired an experimental study of categorical rhythm perception in cross-cultural perspective, which elicited further support of the hypothesis (Polak et al. 2018).

Note that while the findings of Study 1—the strong contrametricity of the rhythms in our corpus—were in agreement with common views in Africanist ethnomusicology but in conflict with Euro-American theories of rhythm and meter, the finding of Study 2 is also in conflict with Africanist ethnomusicology, in which the presumption of categorically isochronous pulses is as deeply rooted as it is in Euro-American music research. The cultural area of the Sahel and Savannah zones of West and Central Africa, where non-isochronous beat divisions are structurally relevant, is underrepresented in African music research; by contrast other regions, such as coastal West Africa, are comparatively over-represented (Gerstin 2017), and, in these very well researched regions, isochronous subdivisions alone do play a structurally relevant role. This suggests a conclusion which is interesting in terms of disciplinary politics: namely, that cross-culturally comparative re-
search perspectives help to acknowledge cultural diversity and contribute to counterbal-
ancing existing cultural biases both within and across music-related fields of research
and disciplines. Cultural bias evidently is a rather deep-seated problem in both the sci-
ences and the generally more culturally sensitive humanities and is not limited to Ameri-
can/Eurocentrism.

Appendices

Appendix 1: Basic Rhythms Used in the Corpus
Theoretical and Practical Aspects of Cross-Cultural Corpus Studies: Two Case Studies from Mali

<table>
<thead>
<tr>
<th>A. Manjanin</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Beats</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>B</td>
<td>S</td>
<td>B</td>
<td>S</td>
<td>S</td>
<td>T</td>
</tr>
<tr>
<td>S</td>
<td>T</td>
<td>S</td>
<td>B</td>
<td>S</td>
<td>T</td>
<td>S</td>
</tr>
<tr>
<td>O</td>
<td>O</td>
<td></td>
<td>O</td>
<td>O</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O</td>
<td></td>
<td>O</td>
<td>O</td>
<td></td>
<td>O</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B. Woloso</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Beats</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>T</td>
<td>S</td>
<td>T</td>
<td>T</td>
<td>S</td>
<td>S</td>
</tr>
</tbody>
</table>
Typical melo-rhythmic patterns for (A) Manjanin, (B) Woloso, and (C) Maraka. The top row marks the locations of each of the four beats in the measure. Through various types of attacks, the jembe are able to elicit three basic sounds from which tone color melodies are formed: B(ass) = deep, T(one) = medium, and S(lap) = high/bright; the Dundun allows two sounds: O (pen) = low/dark and stopped (°) = high/bright.

<table>
<thead>
<tr>
<th></th>
<th>S</th>
<th>B</th>
<th>S</th>
<th>T</th>
<th>S</th>
<th>B</th>
<th>S</th>
<th>Jembe 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>O</td>
<td>°</td>
<td>O</td>
<td>°</td>
<td>O</td>
<td>Jembe 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>°</td>
<td>Dundun 1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

C. Maraka

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Beats</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>S</td>
<td>T</td>
<td>T</td>
<td>S</td>
<td>Jembe 1</td>
</tr>
<tr>
<td>S</td>
<td>T</td>
<td>S</td>
<td>B</td>
<td>S</td>
<td>Jembe 2</td>
</tr>
<tr>
<td>O</td>
<td>°</td>
<td>°</td>
<td>O</td>
<td>O</td>
<td>Dundun 1</td>
</tr>
</tbody>
</table>
Appendix 2: Corpus Details: Performers, Ensemble Size, and Recording Length for Each Performance in the Corpus
## Theoretical and Practical Aspects of Cross-Cultural Corpus Studies: Two Case Studies from Mali

<table>
<thead>
<tr>
<th>Recording</th>
<th>Jembe 1</th>
<th>Dundun 1</th>
<th>Jembe 2</th>
<th>Dundun 2</th>
<th>Playing time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manjanin-1</td>
<td>D. Kone</td>
<td>M. Jakite</td>
<td>S. Balo</td>
<td>A. Traole</td>
<td>5:00</td>
</tr>
<tr>
<td>Manjanin-2</td>
<td>D. Kone</td>
<td>M. Jakite</td>
<td>D. Kone</td>
<td></td>
<td>4:20</td>
</tr>
<tr>
<td>Manjanin-3</td>
<td>S. Balo</td>
<td>M. Jakite</td>
<td></td>
<td></td>
<td>3:15</td>
</tr>
<tr>
<td>Manjanin-4</td>
<td>I. Coulibaly</td>
<td>M. Jakite</td>
<td>D. Kone</td>
<td>A. Traole</td>
<td>5:40</td>
</tr>
<tr>
<td>Woloso-1</td>
<td>D. Kone</td>
<td>M. Jakite</td>
<td>S. Balo</td>
<td></td>
<td>3:45</td>
</tr>
<tr>
<td>Woloso-2</td>
<td>D. Kone</td>
<td>M. Jakite</td>
<td>S. Balo</td>
<td>A. Traole</td>
<td>3:20</td>
</tr>
<tr>
<td>Woloso-3</td>
<td>D. Kone</td>
<td>M. Jakite</td>
<td></td>
<td></td>
<td>3:10</td>
</tr>
<tr>
<td>Woloso-4</td>
<td>S. Balo</td>
<td>M. Jakite</td>
<td>D. Kone</td>
<td></td>
<td>2:40</td>
</tr>
<tr>
<td>Woloso-5</td>
<td>J.M. Kuyate</td>
<td>M. Jakite</td>
<td>D. Kone</td>
<td></td>
<td>2:00</td>
</tr>
<tr>
<td>Maraka-1</td>
<td>D. Kone</td>
<td>M. Jakite</td>
<td>S. Balo</td>
<td></td>
<td>3:00</td>
</tr>
<tr>
<td>Maraka-2</td>
<td>D. Kone</td>
<td>M. Jakite</td>
<td>S. Balo</td>
<td></td>
<td>2:15</td>
</tr>
<tr>
<td>Maraka-3</td>
<td>S. Balo</td>
<td>M. Jakite</td>
<td>D. Kone</td>
<td></td>
<td>2:30</td>
</tr>
<tr>
<td>Maraka-4</td>
<td>J.M. Kuyate</td>
<td>M. Jakite</td>
<td>D. Kone</td>
<td></td>
<td>2:15</td>
</tr>
</tbody>
</table>
## Theoretical and Practical Aspects of Cross-Cultural Corpus Studies: Two Case Studies from Mali

<table>
<thead>
<tr>
<th>Room</th>
<th>Presenters</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maraka-5</td>
<td>J.M. Kuyate, M. Jakite</td>
<td>2:00</td>
</tr>
<tr>
<td>Maraka-6</td>
<td>I. Coulibaly, M. Jakite, D. Kone, A. Traole</td>
<td>4:50</td>
</tr>
</tbody>
</table>
References


Theoretical and Practical Aspects of Cross-Cultural Corpus Studies: Two Case Studies from Mali


Theoretical and Practical Aspects of Cross-Cultural Corpus Studies: Two Case Studies from Mali


Theoretical and Practical Aspects of Cross-Cultural Corpus Studies: Two Case Studies from Mali


Theoretical and Practical Aspects of Cross-Cultural Corpus Studies: Two Case Studies from Mali


Notes:

(1) A movie document recording the audio sample 1-A can be found at https://tinyurl.com/Polak-Video-Manjanin; for audio sample 1-B, see https://tinyurl.com/Polak-Video-Woloso; Audio example 1-C: https://tinyurl.com/Polak-Video-Maraka. Polak 2010 provides a complete transcription and detailed analysis of Audio Example 1-A (http://www.mtosmt.org/issues/mto.10.16.4/mto.10.16.4.polak.html).

Justin London

Nori Jacoby
Nori Jacoby is a group leader at the Max Planck Institute for Empirical Aesthetics.

Rainer Polak
Rainer Polak, Research Fellow, Max Planck Institute for Empirical Aesthetics, Frankfurt am Main.