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TITLE

Non-isochronous meter is not irregular. A review of theory and evidence

TEXT

In this brief survey paper, I make the following argument:

1. The quality of regularity is constitutive of the referential framework function that is at the core of theories of musical rhythm and meter. Most theories equate regularity with isochrony.
2. However, diverse and wide-spread forms of rhythm are structurally non-isochronous, yet nonetheless are conceived of and perceived as being metrically regular.

Therefore,

3. The assumption that metric regularity depends on isochrony is inconsistent with this evidence, which provides fascinating grounds for metric theory to scrutinize some of its most fundamental assumptions, such as iso-periodicity and hierarchical symmetry.

1 Meter requires regularity

The proposition that regularity is at the core of musical meter underlies a broad range of metric theories. I here focus on listener-oriented theories, which have emerged as particularly influential since the 1980s. Such theories suggest to conceive of meter as a perceptual activity. They propose meter is functional in allowing listeners to anticipate the timing of rhythmic events, to estimate and evaluate the actual timing of present events with reference to preceding metric anticipations, and to personally entrain to the perceived rhythms. Some of these approaches highlight subjective flexibility and conceive of a projective process that is typically fluctuating and inherently open-ended, while others emphasize the reliability that may emerge from attending and entraining to stable periodicities in the perceived rhythms.¹

¹ Hasty 1997 is the main exponent of the former, while Lerdahl und Jackendoff 1983 and London 2012 represent the latter; for a contextualization of these approaches in the history of theory of meter, see Johansson 2010.

The aspect of regularity typically is foregrounded in pulse/beat-based approaches to metric theory.² Speaking of a pulse-stream implies that its constituents, the single pulsations, recur at *regular* intervals and are categorically *equivalent*; it is their regular re-occurrence, one after the other, which makes the individual pulsations appear as a stream of same-order elements. The psychological theory of dynamic attending suggests that the perceptual system itself tends to entrain, that is, to attune itself to periodicities tracked in the rhythms of one's environment.³ This theory has been influential in conceptualizations of beat induction, musical meter, interpersonal entrainment, and their eventual biological underpinnings in neural oscillation.⁴

By contrast, other approaches such as Christopher Hasty's theory of metric projection argue that much of the musical interest and aesthetic appeal of metric experience is conditioned on that it can flexibly fluctuate from moment-to-moment, inseparably tied to the ever-changing flow of rhythm itself. This approach conspicuously does *not* emphasize regularity at musical and theoretical surface levels; by contrast, it highlights and values options for metric ambiguity or change through the articulated rhythms questioning or denying the active metric projective potentials. However, this does not at all mean that Hastian metric projection would not involve regularity. The mechanism of projection consists of the *throwing-forward* of some specific, determined duration.⁵ That is, the reference to which a present (just-completed) event-articulation is metrically measured results from a preceding expectation for immediate repetition of the *same* duration. The act of throwing forward some duration in time in and by itself amounts to the expectation of repetition of that duration, that is, of local periodicity.

In short, listener-oriented, psychologically and phenomenologically informed metric theory assumes meter to build on the universal tendency for recognizing and anticipating periodicity. Even in the case of metrically ambiguous or dissonant music that may provoke one to frequently change metric types in the course of the listening process, the act of metric perception is to compare an actual event-timing with a forecast that has emerged from the latent expectation for repetition of the same, i.e. metrically

² Africanist musicologists have first developed the concept of a perceptual metric beat or pulse as derived from, yet being partially independent from rhythmic figurations, beginning with Richard Waterman's seminal discussion of »metronome sense« 1952; see also Nketia 1963; Kolinski 1973; Blacking 1967; Chernoff 1979; Locke 1982, 2010; Dauer 1983; Arom 1984; Kubik 1988; Burns 2010; London et al. 2016. Some two decades later, Western music theory independently (re-)invented the rhythm-meter distinction and the concept of meter as nested pulse streams Yeston 1976; Lerdahl und Jackendoff 1983; Krebs 1999; London 2001, 2012; Temperley 2001. Mirka 2009, p. chapt. 1 discusses late 18th century German theorists as conceptual forerunners.

³ Jones und Boltz 1989; Large und Jones 1999. In a seminal article, Mary Riess Jones 1976 situated this approach in the context of James Gibson's 1966 ecological psychology of perception, which emphasizes that humans actively and dynamically scan their environment for perceptual *invariants*, in the framework of which we meaningfully perceive change. In the temporal dimension, Jones conceives of periodicity as perceptual invariant in the Gibsonian sense.

⁴ See London 2012, Clayton et al. 2005; Clayton 2013; Large und Kolen 1994; Snyder und Large 2005; Large 2008.

⁵ Hasty 1997, 84.

equivalent timing. Meter thus is seen as a perceptual referencing of latent virtual isochrony, a view which prevails also in music psychology, musical neuro-science and biomusicology.⁶

2 Non-isochronous meter exists

Descriptions of rhythmic structures that resist being directly mapped to isochronous (ISO) pulses abound in musicology, particularly in comparative musicology/ethnomusicology. Specific types of non-isochronous (NI) meter appear to be typical of large culture-geographic areas. Manifold particularities and combinations aside, we may distinguish between NI durational patterns at the *beat* versus the *beat subdivision* level.

Beats of different duration can periodically alternate within a metric measure. For instance, after two beats of equal duration there may follow one that is longer by about one half of the short beat durations. In case this pattern repeats, the measure as a whole is iso-periodic, but the pulse at the beat level is not. Rhythmic structures that suggest NI beat cycles of this sort are prominent in Scandinavia, the Balkan, Turkey, the Near East, southern Asia, as well as in Euro-American art music of the 20th century.⁷

Uneven, »swung« beat subdivisions in the framework of ISO beats occur in parts of Africa and its diverse American diasporas.⁸ Both the cycle and the beat levels are iso-periodic here, while a pulse at the rhythmic surface level is NI.

The two basic types (NI beat and NI subdivision cycles) engender a plurality of particular forms. For instance, some music from North Africa shows systematic metric transformations from NI to ISO subdivision anchored to structural tempo acceleration.⁹ Or, there exist drastically NI or »ovoid« forms of rhythm, to borrow a term from Jean During, for instance in Scandinavia and Central Asia, which may have to do with double non-isochrony at the beat *and* the subdivisions level, both at the same time.¹⁰

Can we safely assume that the NI durational structures in performed music, addressed above, do indeed suggest and afford the perception of (NI) meter? An alternative understand has NI timings as

⁶ Among many others, see Longuet-Higgins und Lee 1982; Lee 1991; Essens und Povel 1985; Large und Jones 1999; Snyder und Large 2005; Desain und Honing 1999; Grahn und Brett 2007; Merchant et al. 2015; Fitch 2013; Madison und Merker 2002; Merker et al. 2009.

⁷ See, among others, Blom und Kvifte 1986; Kvifte 2007; Johansson 2009; Haugen 2014; Brăiloiu 1984; Goldberg 2015; Cler 1994; Bates 2011; Holzapfel 2015; Clayton 2000, 1997; Marcus 2007.

⁸ On samba from Brazil, see Gerischer 2003; Gerischer 2006; Lindsay und Nordquist 2007; Guillot 2011; and Haugen und Godøy 2014; on jazz, see Benadon 2006; Friberg und Sundström 2002; Honing und Haas 2008; Dittmar et al. 2015; on dance-drumming from Mali, see Polak 2010; Polak und London 2014; Polak et al. 2016.

⁹ Jankowsky 2010, 2013.

¹⁰ During 1997; Kvifte 2007; Johansson 2009.

expressive variations of some underlying ISO structure.¹¹ For example, the unequal beat durations of the Viennese waltz, patterned short–long–medium,¹² may be theorized as representing a performance timing deviation from a structurally ISO triple meter. One indication typically put forth in support of such view is the flexibility (not consistency) of the performed timings. In historical recordings of urban popular Viennese waltz from the early 20th century, you can indeed hear that the contra-guitar dedicated to accenting the second and third quarter notes in each measure (the so-called »Wiener Nachschlag« or Viennese afterbeat) effects a strikingly NI, short–long–medium or short–long–long timing of the three quarter notes in each measure. By contrast, the melodies played by the accordion and violins do not at all systematically follow this NI timing pattern.¹³ Importantly, however, such flexibility is far from generally characterizing all of the NI rhythmic practices surveyed above. For instance, in Malian drumming, uneven beat subdivision timings can be extremely stable.¹⁴ Furthermore, the performance timings of NI beat patterns, for instance in Balkan percussion, are clearly structural; no underlying ISO beat is anywhere close to feasible here. Recent work has empirically shown that in some styles of folk dance from Norway, NI beat patterns that had been found in the respective fiddle music also pertain in both the fiddlers' foot-tapping and the dance-couples' vertical oscillation of their bodies center of gravity.¹⁵ In sum, while it is plausible to assume that some NI timing structures can be understood as performance deviations from some metric isochrony, this view does not hold for the many and diverse NI structures addressed above. Earlier efforts to marginalize NI meters as exotic derivatives of »originally« ISO meters represent a speculative, probably Western-biased thought-figure.¹⁶

Next to the lack of sufficient alternative explanations, a second indication of the plausibility of the idea of NI meter is the existence of indigenous theoretical concepts of rhythmic mode, which clearly conceive of NI durational structures in perspectives that share aspects of what I here conceive of as NI meter. The most prominent among these concepts are Balkan *aksak*, Turkish *usul*, Arabic *iqa*, and Indian *tala*.¹⁷

A third type of indication stems from a small yet growing body of research that tries to experimentally operationalize and empirically measure metricality in musical and quasi-musical behaviors, such as tapping along to simple rhythms, perceiving manipulations (differences and changes/errors) in

¹¹ See Clarke 1985, 1987.

¹² Bengtsson 1975; Bengtsson und Gabrielsson 1983, 1977; cf. also Stockmann 1977.

¹³ Listen to tracks #15, #16, and #19, recorded 1908–1910, of the CD *The Best of Schrammelmusik Instrumentals–Soul Music of Old Vienna* (München: Trikont, US-0223).

¹⁴ Polak et al. 2016.

¹⁵ Haugen 2014, 2015, forthc.

¹⁶ For the case of »irregular« meter in Bulgarian folk-dance music, see Rice 2000b.

¹⁷ See Brăiloiu 1984; Bates 2011; Clayton 2000; Marcus 2007.

listening to simple rhythms, and ensemble synchronization in live performance of real music. These studies suggest that metric performance in NI meters does not fall behind analogous task performance in ISO meters.¹⁸

Finally, ethnographic observations indicate that NI meters are experienced, by encultured listeners, as perfectly normal, easily accessible and simply natural. For instance, both NI beat and NI subdivision sequences are regularly embodied, without particular complication, in vernacular folk dance in Bulgaria, Scandinavia, Mali, and Brazil, respectively.¹⁹

3 Metric theory needs to integrate evidence on non-isochronous meter

To summarize the above, ample evidence suggests that non-isochronous (NI) meter is widespread and appears as a normal and everyday practice in many musical styles and practices. Evidently, the theoretical assumption of meter fundamentally building on virtual isochrony is false. Moreover, it appears misleading to conceive of NI meter as irregular. While one can certainly understand the mathematical aspect of such qualification, it is irrelevant from perceptual, cognitive and experiential viewpoints: if you are familiar with NI meter, it can feel as regular and is as reliably functional as ISO meter.

Let me finally consider five of the many issues that the evidence on NI meter provokes thinking about.

3.1 The extent of non-isochrony in NI metric pulse-streams

Justin London proposed that, to be »regular enough« for metric functionality, the degree of unevenness amongst the metric beats in a cycle must be constrained by some upper limit: the long:short-ratio of beat classes must be smaller than 2:1.²⁰ On the other hand, there must be some lower limit (minimal degree) of non-isochrony for a pulse to be perceivably distinguishable from isochrony. Considering the upper and lower limits for unevenness help explain why the long and short beat classes in NI meters are often coordinated by ratios in the range of 3:2 (1.5) or 4:3 (1.33).²¹ London's mathematical formulation of these proportional relations refers to the principle of maximal evenness, which requires the cardinal relation of the two pulse classes in an NI pulse-stream to be based on a common fast denominator; for instance, $3:2=(1+1+1):(1+1)$. This is applicable for NI pulses at the beat level in case the related subdivisions are categorically isochronous (which they not always are, however; more on that later), but not for NI pulses on the subdivision level itself. The latter tend to be too fast and too proportionally irrational to be based on a faster common denominator. However, London's consideration of upper and lower limits for unevenness is relevant for NI

¹⁸ Repp, London, and Keller 2008; Hannon et al. 2012; Polak et al. 2016.

¹⁹ Rice 2000a, 1994, pp. 98–103; Polak 2010; Polak und London 2014; Haugen 2014; Haugen und Godøy 2014.

²⁰ London 2012, p. 128.

²¹ London 2012, p. chapt. 8.

subdivisions, too, which would let it appear worthwhile to rephrase their description in more inclusive terms.

3.2 The extent of asymmetry in NI metric hierarchies

The conventionally assumed isochrony of pulse streams conditions that the nesting of pulse streams of different tempos constitute metric hierarchies of symmetrical structure. Symmetry therefore is implicitly assumed in much metric theory. By contrast, NI beat cycles, say a measure of one long and two shorter beats subdivided by three and two fast pulses, respectively (3+2+2), clearly generate an asymmetric hierarchy. Polak proposes that the co-presence of swung binary and ternary subdivisions in some African and African-diasporic forms of music, too, constitutes asymmetric metric hierarchies.²² Taken together, this and the above point 3.1 suggest that a realistic concept of metric regularity would need to allow for a certain degree of structural (not »deviant«) asymmetry in both horizontal (sequential) and vertical (hierarchical nesting) dimensions, the typology of which would profit from being flanked by a description of its limitations in a Londonian perspective what is »regular enough.«

3.3 The categorical status of pulse and/or projection

As described in Section 1, metric pulse involves that its individual constituents all be categorically perceived as temporally equivalent; next to their following one after the other, it is their being of the same class that makes pulsations pulse. If we assume two different pulse classes to make part of the same metric cycle, however, these pulse classes are categorically distinct. Theory needs to engage with this contradiction: At any given level of meter, one can have more than one pulse-class, yet nonetheless perceives a *stream* of pulsations. In the framework of Hastian-projection theory, we would need to ask how one can possibly gain a metric projection the potential duration of which is *different* from the completed duration the experience of which has occasioned that potential?

3.4 Processual orientation

In experiencing an NI metric pulse, to know or feel whether the upcoming pulse is of either the long or the short class, I must know the periodic pattern of alternation and I must continuously feel where exactly in the period I am presently. It appears to me that, to reliably achieve this in the context of NI meter, what needs to be thrown forward in time is not virtual periodicities alone (as suggests the concept of beat induction, for instance), but more fully integrated *patterns* of durations.

3.5 The functional relationships between layers of pulse in a metric hierarchy

It has been suggested that the complexity of non-isochrony on one metric level needs to be balanced by isochrony on some neighboring level.²³ In the case of NI beat cycles, the subdivision level suggests

²² Polak 2010; Polak und London 2014; Polak 2016 (in review).

²³ London 2012, chapt. 8.

itself as a referential anchor, and while perhaps true when the subdivision is isochronous, this is not always the case, however.²⁴ Moreover, the assumption of a fast subdivision as elementary reference level is inconsistent with that, typically, a pulse at some medium (beat, tactus) level of the metric hierarchy provides the core metric reference.²⁵ Finally, some performances based on NI beat cycles and most performances of NI subdivision cycles are too fast and too mathematically irrational to be advantageously framed by reference to some still faster layer of periodicity. Tellef Kvifte provides a lucid diagnosis of the impossibility to understand NI meter in Scandinavian folk dance music in the framework of a model of meter that requires all levels to be derived, from bottom upwards in the metric hierarchy, as multiples of a common fastest denominator. Building on this, he offers the alternative model of a common slow pulse. He fills this idea with suggesting that it may be the embodiment of motional gestures, such as dance moves in the case of music for dance, which make up the structural contents of such slowest common pulse.²⁶ This is inspiring, yet appears to overstretch the use of the term pulse, in my view. If metric experience consists of feeling durational structures in terms of corresponding dance moves that we anticipate to continue and periodically recur, what we throw forward in time is not a single pulse (however high in a layered hierarchy of pulses), or a single projection (however complex in accumulatively encompassing active potentials), but a whole *pattern* of latent durations and durational relations.

3.6 Conclusion

To conclude, the study of NI meter provides fascinating grounds for ongoing and future research in metric theory. It encourages us to continue the increasingly productive, recent trend to transcend compartmentalization in terms of disciplines (music theory, ethnomusicology, systematic musicology, music pedagogy, etc.) and area-studies (music theory of Western art music, African music, Balkan music, etc.), and prioritize cross-cultural and inter-disciplinary perspectives instead.

References

- Arom, Simha, »Structuration du Temps dans les Musiques d’Afrique Central«, in: *Revue de Musicologie* 70/1 (1984), pp. 5–36.
- Bates, Eliot, *Music in Turkey. Experiencing music, expressing culture* (Global music series), New York 2011.
- Benadon, Fernando, »Slicing the Beat«, in: *Ethnomusicology* 50 (2006), pp. 73–98.
- Bengtsson, Ingmar, »Empirische Rhythmusforschung in Uppsala«, in: *Hamburger Jahrbuch für Musikwissenschaft. Bd. 1*, eds. Constantin Floros, Hans Joachim Marx und Peter Petersen, Karl Dieter Wagner, Hamburg 1975, pp. 195–219.

²⁴ Kvifte 2007; Goldberg 2015; Polak 2015.

²⁵ This point is claimed both by general theories of meter (see London 2012, 30–32) and by repertoire-specific ones. Among the latter are Western theories of ISO meter (see Lerdahl and Jackendoff, 1983, 21) as well as treatises of NI meter in music from Scandinavia (Kvifte 2007) and the Balkan region (Goldberg 2015).

²⁶ Kvifte 2007.

- Bengtsson, Ingmar and Alf Gabrielsson, »Rhythm Research in Uppsala«, in: *Music, Room, and Acoustics* (1977), pp. 19–56.
- Bengtsson, Ingmar and Alf Gabrielsson, »Analysis and Synthesis of Musical Rhythm«, in: *Studies of music performance. Papers given at a seminar organized by the Music Acoustics Committee of the Royal Swedish Academy of Music [October 23., 1982]* (Publications / Royal Swedish Academy of Music, 39), ed. Johan Sundberg, Royal Swedish Acad. of Music, Stockholm 1983, pp. 27–59.
- Blacking, John, *Venda children's songs. A study in ethnomusicological analysis*, Johannesburg 1967.
- Blom, Jan-Petter and Tellef Kvifte, »On the problem of inferential ambivalence in musical meter«, in: *Ethnomusicology* 30/3 (1986), pp. 491–517.
- Brăiloiu, Constantin (Hg.) 1984, *Problems of ethnomusicology*, Cambridge: Cambridge University Press.
- Burns, James, »Rhythmic Archetypes in Instrumental Music from Africa and the Diaspora«, in: *Music Theory Online* 16/4 (2010).
- Chernoff, John M., *African Rhythm and African Sensibility. Aesthetics and Social Action in African Musical Idioms*, Chicago 1979.
- Clarke, Eric, »Structure and expression in rhythmic performance«, in: *Musical structure and cognition*, eds. Peter Howell, Robert West und Ian Cross, Academic Press, London 1985, pp. 209–236.
- Clarke, Eric, »Categorical rhythm perception. An ecological perspective«, in: *Action and perception in rhythm and music*, ed. A. Gabrielsson, Royal Swedish Academy of Music 1987, pp. 19–33.
- Clayton, Martin, »Le mètre et le tāl dans la musique de l'inde du nord«, in: *Cahiers de musiques traditionnelles* 10 (1997), p. 169.
- Clayton, Martin, *Time in Indian music. Rhythm, metre, and form in North Indian rāg performance* (Oxford monographs on music), Oxford 2000.
- Clayton, Martin, »Entrainment, ethnography and musical interaction«, in: *Experience and meaning in music performance*, eds. Martin Clayton, Byron Dueck und Laura Leante, Oxford University Press, New York 2013, pp. 17–39.
- Clayton, Martin, Udo Will and Rebecca Sager, »In time with the music: The concept of entrainment and its significance for ethnomusicology«, in: *ESEM-Counterpoint* 1 (2005), pp. 1–82.
- Cler, Jérôme, »Pour une théorie de l'aksak«, in: *Revue de Musicologie* 80/2 (1994), p. 181.
- Dauer, Alfons, »Kinesis und Katharsis. Prolegomena zur Deutung afrikanischer Rhythmik«, in: *Musik in Afrika* (Veröffentlichungen des Museums für Völkerkunde Berlin, N.F. 40), ed. Artur Simon 1983, pp. 166–188.
- Desain, Peter and Henkjan Honing, »Computational Models of Beat Induction«, in: *Journal of New Music Research* 28/1 (1999), pp. 29–42.
- Dittmar, Christian, Martin Pfeleiderer and Meinard Müller 2015, *Automated estimation of ride cymbal swing ratios in jazz recordings*, in: *Proceedings of the 16th International Society for Music Information Retrieval Conference (ISMIR), Málaga, Spain*: Proceedings of the 16th International Society for Music Information Retrieval Conference (ISMIR), Málaga, Spain, pp. 272–277.
- During, Jean, »Rythmes ovoïdes et quadrature du cycle«, in: *Cahiers d'ethnomusicologie. Anciennement Cahiers de musiques traditionnelles/10* (1997), pp. 17–36.
- Essens, P. and Dirk-Jan Povel, »Metrical and non-metrical representations of temporal patterns«, in: *Perception & Psychophysics* 37 (1985), pp. 1–7.
- Fitch, W., »Rhythmic cognition in humans and animals: distinguishing meter and pulse perception«, in: *Front. Syst. Neurosci.* 7 (2013).
- Friberg, Anders and Andreas Sundström, »Swing Ratios and Ensemble Timing in Jazz Performance: Evidence for a Common Rhythmic Pattern«, in: *Music Perception* 19/3 (2002), pp. 333–349.
- Gerischer, Christiane, *O Suingue Baiano. Mikrorhythmische Phänomene in baianischer Perkussion*, Frankfurt 2003.
- Gerischer, Christiane, »Suingue Baiano«, in: *Ethnomusicology* 50/1 (2006), pp. 99–119.
- Gibson, James J., *The Senses considered as perceptual systems*, Boston 1966.

Polak, Rainer (in press) Non-isochronous meter is not irregular. A review of theory and evidence. Proceedings of the Annual Meeting of the Gesellschaft für Musiktheorie 2015, Berlin, edited by Aydin, Marcus, Florian Edler, Laura Krämer, and Roger Graybill. Hildesheim: Olms.

- Goldberg, Daniel, »Timing Variations in Two Balkan Percussion Performances«, in: *Empirical Musicology Review* 10/4 (2015).
- Grahn, Jessica and Matthew Brett, »Rhythm and Beat Perception in Motor Areas of the Brain«, in: *Journal of Cognitive Neuroscience* 19/5 (2007), pp. 893–906.
- Guillot, Gérald 2011, *Des objets musicaux implicites à leur didactisation formelle exogène. Transposition didactique interne du suíngue brasileiro en France*. Dissertation. Université de Paris Sorbonne, Paris.
- Hannon, Erin, Gaye Soley and Sangeeta Ullal, »Familiarity overrides complexity in rhythm perception: A cross-cultural comparison of American and Turkish listeners«, in: *Journal of Experimental Psychology: Human Perception and Performance* 38/3 (2012), pp. 543–548.
- Hasty, Christopher Francis, *Meter as rhythm*, New York 1997.
- Haugen, Mari, »Studying Rhythmical Structures in Norwegian Folk Music and Dance Using Motion Capture Technology: A Case Study of Norwegian Telespringar«, in: *Musikk og Tradisjon* 28 (2014), pp. 27–52.
- Haugen, Mari, »Asymmetrical Meter in Scandinavian Folk Music and Dance: A Case Study of Norwegian Telespringar«, in: *Proceedings of the Ninth Triennial Conference of the European Society for the Cognitive Science of Music (ESCOM)* (2015), pp. 432–436.
- Haugen, Mari, »Investigating Periodic Body Motions as a Tacit Reference Structure in Norwegian Telespringar Performance«, in: *Empirical Musicology Review* (forthc.).
- Haugen, Mari and Rolf Inge Godøy, »Rhythmical Structures in Music and Body Movement in Samba Performance«, in: *Proceedings of the ICMPC-APSCOM 2014* (2014), pp. 46–52.
- Holzappel, André, »Relation Between Surface Rhythm and Rhythmic Modes in Turkish Makam Music«, in: *Journal of New Music Research* 44/1 (2015), pp. 25–38.
- Honing, Henkjan and W. Bas de Haas, »Swing Once More: Relating Timing and Tempo in Expert Jazz Drumming«, in: *Music Perception* 25/5 (2008), pp. 471–476.
- Jankowsky, Richard, *Stambeli. Music, trance, and alterity in Tunisia*, Chicago 2010.
- Jankowsky, Richard, »Rhythmic Elasticity, Metric Ambiguity, and Ritual Teleology in Tunisian Stambeli«, in: *Analytical Approaches to World Music* 3/1 (2013).
- Johansson, Mats 2009, *Rhythm into Style. Studying Asymmetrical Grooves in Norwegian Folk Music*. PhD thesis. University of Oslo, Oslo. Department of Musicology.
- Johansson, Mats, »What is musical meter?«, in: *Musikk og Tradisjon* 24 (2010), pp. 41–59.
- Jones, Mari, »Time, our lost dimension«, in: *Psychological Review* 83/5 (1976), pp. 323–355.
- Jones, Mari and M. Boltz, »Dynamic Attending and Responses to Time«, in: *Psychological Review* 96/3 (1989), pp. 459–491.
- Kolinski, Mieczyslaw, »A Cross-Cultural Approach to Metro-Rhythmic Patterns«, in: *Ethnomusicology* 17/3 (1973), pp. 494–506.
- Krebs, Harald, *Fantasy pieces. Metrical dissonance in the music of Robert Schumann*, New York 1999.
- Kubik, Gerhard, »Einige Grundbegriffe und -Konzepte der Afrikanischen Musikforschung«, in: *Zum Verstehen afrikanischer Musik. Ausgewählte Aufsätze* (Reclams Universal-Bibliothek), ed. Gerhard Kubik, Reclam, Leipzig 1988, pp. 52–113.
- Kvifte, Tellef, »Categories and timing«, in: *Ethnomusicology* 51/1 (2007), pp. 64–84.
- Large, Edward, »Resonating to musical rhythm: theory and experiment«, in: *Psychology of time* (2008), pp. 189–232.
- Large, Edward and Mari Riess Jones, »The dynamics of attending«, in: *Psychological Review* 106/1 (1999), pp. 119–159.
- Large, Edward and J. F. Kolen, »Resonance and the perception of musical meter«, in: *Connection Science* 6 (1994), pp. 177–208.
- Lee, Christopher, »The perception of metrical structure: Experimental evidence and a model«, in: *Representing musical structure* (Cognitive science series, 5), ed. Peter Howell, Acad. Press, London [u.a.] 1991, pp. 59–127.
- Lerdahl, Fred; Jackendoff, Ray, *A generative theory of tonal music*, Cambridge, Mass. 1983.

Polak, Rainer (in press) Non-isochronous meter is not irregular. A review of theory and evidence. Proceedings of the Annual Meeting of the Gesellschaft für Musiktheorie 2015, Berlin, edited by Aydintan, Marcus, Florian Edler, Laura Krämer, and Roger Graybill. Hildesheim: Olms.

- Lindsay, Ken and P. Nordquist, »More Than a Feeling—Some Technical Details of Swing Rhythm in Music«, in: *Acoustics Today* 3/3 (2007), pp. 31–42.
- Locke, David, »Principles of Offbeat Timing and Cross-Rhythm in Southern Ewe Dance Drumming«, in: *Ethnomusicology* 26/2 (1982), pp. 217–246.
- Locke, David, »Yewevu in the Metric Matrix«, in: *Music Theory Online* 16/4 (2010).
- London, Justin, »Rhythm«, in: *The new Grove dictionary of music and musicians. 2nd edition*, eds. Stanley Sadie, John Tyrrell und George Grove, Macmillan; Grove, New York 2001, pp. 277–309.
- London, Justin, *Hearing in time. Psychological aspects of musical meter*, Oxford u.a. 2012.
- London, Justin, Rainer Polak and Nori Jacoby, »Rhythm histograms and musical meter: A corpus study of Malian percussion music«, in: *Psychonomic Bulletin & Review* (2016), pp. 1–7.
- Longuet-Higgins, H. and Christopher S. Lee, »The perception of musical rhythms«, in: *Perception* 11/2 (1982), pp. 115–128.
- Madison, Guy and Bjorn Merker, »On the limits of anisochrony in pulse attribution«, in: *Psychological Research* 66/3 (2002), pp. 201–207.
- Marcus, Scott Lloyd, *Music in Egypt. Experiencing music, expressing culture*, New York 2007.
- Merchant, H., J. Grahn, L. Trainor, M. Rohrmeier and W. T. Fitch, »Finding the beat: a neural perspective across humans and non-human primates«, in: *Philosophical Transactions of the Royal Society B: Biological Sciences* 370/1664 (2015), p. 20140093.
- Merker, Bjorn, Guy Madison and Patricia Eckerdal, »On the role and origin of isochrony in human rhythmic entrainment«, in: *Cortex* 45/1 (2009), pp. 4–17.
- Mirka, Danuta, *Metric manipulations in Haydn and Mozart. Chamber music for strings, 1787 - 1791* (Oxford studies in music theory), New York NY u.a. 2009.
- Nketia, Joseph H. Kwabena, *Folk songs of Ghana*, Legon 1963.
- Polak, Rainer, »Rhythmic Feel as Meter«, in: *Music Theory Online* 16/4 (2010).
- Polak, Rainer, »Pattern and Variation in the Timing of Aksak Meter: Commentary on Goldberg«, in: *Empirical Musicology Review* 10/4 (2015).
- Polak, Rainer, »Binary meets ternary: Open shuffle, nested subdivisions, and swing-based meter in African rhythm«, in: *Analytical Approaches to World Music* (2016 (in review)).
- Polak, Rainer, Nori Jacoby and Justin London, »Both isochronous and non-isochronous metrical subdivision afford precise and stable ensemble entrainment: A corpus study of Malian jembe drumming«, in: *Front. Neurosci.* 10 (2016), p. 285.
- Polak, Rainer and Justin London, »Timing and Meter in Mande Drumming from Mali«, in: *Music Theory Online* 20/1 (2014).
- Repp, Bruno, Justin London and Peter E. Keller, »Phase Correction in Sensorimotor Synchronization with Nonisochronous Sequences«, in: *Music perception* 26/2 (2008), pp. 171–175
- Rice, Timothy, *May it fill your soul. Experiencing Bulgarian music* (Chicago studies in ethnomusicology), Chicago 1994.
- Rice, Timothy, »Béla Bartók and Bulgarian Rhythm«, in: *Bartók perspectives. Man, composer, and ethnomusicologist*, eds. Elliott Antokoletz, Victoria Fischer und Benjamin Suchoff, Oxford University Press, Oxford, New York 2000a, pp. 196–212.
- Rice, Timothy, »Bulgaria«, in: *Europe* (The Garland encyclopedia of world music, Vol. 8), eds. Timothy Rice, James Porter und Chris Goertzen, Garland Publishing, New York 2000b, pp. 890–910.
- Snyder, Joel and Edward W. Large, »Gamma-band activity reflects the metric structure of rhythmic tone sequences«, in: *Cognitive Brain Research* 24/1 (2005), pp. 117–126.
- Stockmann, Doris, »Some Aspects of Musical Perception«, in: *Yearbook of the International Folk Music Council* 9 (1977), p. 67.
- Temperley, David, *The Cognition of Basic Musical Structures*, Cambridge 2001.
- Waterman, Richard, »African Influence on the Music of the Americas«, in: *Acculturation in the Americas*, ed. Sol Tax, University of Chicago Press, Chicago 1952, pp. 207–218.

Polak, Rainer (in press) Non-isochronous meter is not irregular. A review of theory and evidence. Proceedings of the Annual Meeting of the Gesellschaft für Musiktheorie 2015, Berlin, edited by Aydin, Marcus, Florian Edler, Laura Krämer, and Roger Graybill. Hildesheim: Olms.

Yeston, Maury, *The stratification of musical rhythm*, New Haven, Conn. 1976.