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Theory and Practice of Long-form Non-isochronous Meters: The Case of the North Indian *rūpak tāl* *

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ABSTRACT: This paper addresses important issues in the theory of meter by means of a detailed study of a particular form of non-isochronous (NI) meter, the North Indian *rūpak tāl*. *Rūpak tāl* is described as comprising 7 equal *mātrās* (time units), organized into three groups (3+2+2 *mātrās*), and is therefore non-isochronous at the group rather than the beat or subdivision level. The term "long-form non-isochronous meter" is introduced to describe the phenomenon of metrical structures including a non-isochronous pulse level with IOIs >1000ms, of which this is an example. This phenomenon is explored with the aid of empirical analysis of a corpus of recordings of *rūpak tāl* performances, focusing particularly on vocal performances in *khyāl* style. This empirical data is considered in light of extant literature on Indian metrical organization, on ethnomusicological theories of *aksak*, on psychological theories of rhythm perception in NI-meters, and on metrical theory more broadly.

The implications for a general theory of musical meter are then considered, leading to an argument that (a) while theorization is not a necessary condition of metrical perception, a recognized metrical pattern must be treated not only as a form of perception based on the entrainment of attention (London 2012), but as a form of culturally-shared knowledge contributing to top-down processing of meter; and (b) the theorization and representation of aspects of metrical structure means that metrical cycles are not limited to the extent of the psychological present.

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Introduction

[1] This article discusses the implications for metrical theory of the practice of a temporal structure known as *rūpak tāl*,[(1)] used in North Indian (Hindustani) *rāga* music.[(2)] *Rūpak tāl* is commonly described as a rhythmic cycle of 7 *mātrās* (time units), which are organized into three groups: 3+2+2.[(3)] It therefore appears to be an example of what Justin London (2012) calls non-isochronous or NI-meter, or of what Curt Sachs (1953) had earlier referred to as additive rhythm, and is closely related to the phenomenon Constantin Brăiloiu (1951) dubbed *aksak* ("limping," after the Turkish). However, *rūpak tāl* is unusual in that it comprises a regular and stable 3+2+2 pattern even at slow tempi. It therefore allows us to extend and adapt London's theory of NI-meters to long-duration cycles.

[2] The first aim of this article is to establish the existence of what I term "long-form non-isochronous meter," distinguishing it from other forms of meter in which the beat or subdivision level is non-isochronous. Long-form non-isochronous meter is defined here as having at least four pulse levels, listed below from the fastest to the slowest:

- Subdivision (at least 2x the pulse rate of the beat)
- Beat (IOI > c. 400 ms)[(4)]
- Group (groups comprise a number of beats, normally 2 or 3; this group level is non-isochronous by virtue of the fact that it includes groups of different numbers of beats)
- Cycle (comprising at least one each of two different beat groups; the minimum cycle is therefore a 5-beat pattern comprising groups of 2 and 3 beats)

[3] *Rūpak tāl* is used here as an example of such metrical structures and is described in detail with the aid of empirical study of natural performances. This study focuses first on tempo ranges, patterns of tempo variation, *tablā* (drum pair) accompaniment patterns, and composition structures in a selection of forty-two audio recordings in various genres: *khyāl* vocal performances (and instrumental renderings in *khyāl* style), instrumental *gats*,[(5)] and *tablā* solos. Secondly, a smaller sample of ten multitrack recordings for which event onset data is available is explored in further detail to give a more complete picture of *rūpak tāl* as it is practiced in its most common (and slowest) genre, *khyāl*. This analysis includes variations from isochrony of the beat (*mātrā*) durations and variations in stroke density in the *tablā* accompaniment.

[4] The second aim of this paper is to explore the implications of the phenomenon of long-form NI-meter for metrical theory. Viewing *rūpak tāl* through the twin lenses of North Indian *tāla* theory and London's (2012) approach to NI-meter reveals some tensions that are relevant to slow tempo *tālas* in general, not just those with non-isochronous temporal levels. Crucially, while London regards meter as a perceptual phenomenon and thus limits the extent of a metrical cycle to a few seconds, due to the extent of the psychological present (5–6 seconds) (27), many North Indian *tālas* have cycles extending well beyond this limit. This tension can be resolved in a number of ways. For example, we might view Indian *tālas* as a distinct phenomenon outside the scope of meter; although if we do so, we nonetheless need to explain how it relates to meter. Alternatively, while acknowledging the distinctive features of the *tāla* system, we might regard it as a form of meter, in which case we would need to explain why the theoretical limit on cycle length may be ignored.

[5] This article will argue that *rūpak tāl* should be regarded as instantiating a particular metrical structure, with the support of theory and explicit representation allowing otherwise plausible limits on metrical duration to be transcended. Although such a "long-form meter" is unlikely to be perceived in a purely bottom-up fashion, the combination of top-down knowledge and bottom-up perception allows for a robust metrical pattern to be maintained well beyond that durational limit. The most important argument made here, therefore, is that meter should be regarded as a perceptual phenomenon in which bottom-up processing may be supported by top-down priors informed by theoretical knowledge. Although made possible by innate cognitive processes, in practice most metrical perception relies on knowledge acquired through past listening and music-making. That meter cannot be a purely bottom-up phenomenon is of course recognized also by London (2012, 4); the specific challenge to London's theory here is to propose that the learned nature of metrical patterns may allow the upper durational limit for metrical cycles to be overcome.

[6] London's approach has come to represent an important nexus between music theory and music psychology, and between theoretical and empirical approaches to meter. Although his book has relatively little to say about non-Western musical traditions, his approach has inspired research beyond Western tonal music (see, for instance, Goldberg 2017; Polak and London 2014). If aspects of London's theory offer important possibilities for the development of a general theory of musical meter—which I believe is attainable—it is also inevitable that aspects of the theory will need to be significantly amended and extended as part of such a programme. *Rūpak tāl* is presented here as an example of this.(6) To be clear, this article does not present a case *against* psychological approaches to meter, or *against* London's theory, but it does ask critical questions about these approaches.

[7] In order to make this argument, I need to introduce the reader to the practice of *rūpak tāl* in some detail. The rationale here is to provide enough detail and sufficient examples to (a) illustrate some of the richness and variety of practice, particularly for readers unfamiliar with the musical tradition; and also (b) introduce some novel methods of empirical rhythmic corpus analysis that both strengthen my argument and offer tools for others to adapt; while not getting bogged down in very fine details of performance practice. *Rūpak tāl* exists not only as a simple theoretical formula but as a range of practical possibilities. I suggest here that aspects of practice, such as the variability of *mātrā* durations or the preference for subdividing certain *mātrās* more than others, give us indications of the form of knowledge that *rūpak tāl* represents. I contend that any such aspect of practice may contribute to an individual's model of *rūpak tāl*, and thus in principle influence its top-down perception. Demonstrating the impact of specific features of performance practice on metrical perception, however, is beyond the scope of this study.

Non-isochronous meter, aksak, and 7-beat meters

[8] A distinct type of metrical pattern comprising groups of 2 and 3 time units was first recognized by literate European music culture in the late 19th century: the first transcriptions not to be "crammed. . . into the nearest commonly-available Western meter" date from 1886 (Rice 1980, 62). From the early decades of the 20th century, Bulgarian scholars began to theorize this type of meter in more appropriate terms. Stoyan Djoudjeff (1931), for example, outlined a categorization of Bulgarian meters in which he coined the term "heterogenous compound meter," according to which the main beats were divided into either 2 or 3 parts. Some twenty years later, when Curt Sachs ([1936] 1952) coined the term "additive rhythm," Constantin Brăiloiu (1951) proposed that the Turkish term *aksak* be adopted as a general term for this form of rhythmic organization and enumerated the various possible types at length.

[9] More recently, the general theory of *aksak* first discussed by Brăiloiu has resurfaced as a theoretical topic. Significantly for my purposes in this article, Jérôme Cler (1994) seems to have been the first to discuss slow tempo *aksak*-type patterns. In southwestern Turkey, he noted that *aksak* patterns, in which the ratio between short and long units is 2:3, are found in a wide range of tempi, the slowest given in his charts being 35 beats per minute (bpm). Cler argues that if we regard all fast and strictly co-metric patterns comprising unequal units as *aksak*, then the same patterns slowed down, retaining the co-metric character, should also be considered a variety of *aksak*.

[10] As for 7-cycles in particular, Simha Arom's (2004) theory allows for the seven to be divided into units of 2, 2 and 3 in any permutation (i.e., 223, 232 or 322). His list of published examples includes all three possibilities, although 223 and 322 are much more widely documented than 232.(7) Nice Fracile (2003), on the basis of a study of 6,000 extant transcriptions, lists 322 and 223 varieties but not 232. In Alice Singer's (1974) analysis of music and dance steps in Macedonian dances, two varieties of 7-beat patterns are listed, 322 and 223 (in her terms, SQQ and QQS, where S and Q refer to "slow" and "quick" steps respectively). Her consideration of the corresponding dance steps shows an interesting feature that had not been spotted by earlier musicologists: that the two short or quick units can be danced either as two short steps or one long step. In other words, from a dancer's point of view the pattern is either 322 or 34 ("Sarakinskoto" dance) (395–96).(8) Rice (1980, 63) cites 223 and 322 varieties, as well as a four-unit pattern, 2212, in Bulgaria. The two most common patterns are therefore clearly 322 and 223.(9) Although noted only by Singer

(1974), there is no reason to assume that the flexibility in dance to shift from 22 to 4 and back is limited to Macedonia. In fact, if we consider the two basic types as 34 and 43, with the 4 optionally decomposing into 2+2, then the relative lack of 232 patterns is not surprising. These different divisions of the 7-cycle are illustrated in **Example 1**.

[11] Daniel Goldberg's recent work discusses the common Bulgarian dance rhythm *rŭchenitsa* (223) extensively,[(10)] defining it as a "class of dance done individually or in small groups without holding hands. In a simple form of the dance, dancers take small, sometimes shuffling steps on the three beats in the fast SSL sequence" (2017, 69–70). Goldberg's study addresses many aspects of *rŭchenitsa* in performance, particularly its timing patterns; patterns are typically reckoned in two-cycle units (223223) lasting on average 1615 ms (fastest level IOI = 115 ms), and the relative frequency of onsets occur on different beats. While some of this work is relevant to the present study, tempo is a key difference between *rūpak* and *rŭchenitsa*. As we shall see, *rūpak tāl*'s 7-pulse level is played more than twice as slowly as this, and sometimes more than twenty times slower.

[12] In Western music theory, as distinct from comparative musicology or ethnomusicology, these *aksak* patterns were until recently little considered, despite the interest of Bela Bartók ([1938] 1981) (see discussion in Rice 2000), Sachs ([1936] 1952, 1953), and others. Fred Lerdahl and Ray Jackendoff (1983, 98) noted their existence, citing Singer as their source. Their metrical well-formedness rules explicitly exclude these structures, but they implicitly admit that for repertoires other than Western tonal music, these rules need not hold. *Aksak* patterns are considered in far greater detail by London, labelled at different times as "complex" and "non-isochronous," rather than as "additive." In a 1995 article on complex meter, London introduced some of the ideas foundational to *Hearing in Time* (2012). For London, complex meters rely on an isochronous pulse (SD for Subdivision); pulses at the beat (B) level may be categorised as either long (L) or short (S), comprising 3 and 2 subdivisions, respectively. Thus, these complex meters are non-isochronous at the B-level, while an isochronous subdivision (SD) level must be present, whether articulated or inferred by the listener (1995, 72). He proposed that "complex meters require explicit specification of their invariant features through the patterns of duration and organization on the musical surface, and once established, these patterns can be varied only within extremely narrow limits" (69). Or as Cler (1994) would have it, they are strictly co-metric. London (1995, 73) argued further that a peculiar feature of such patterns is that all levels of the meter "must come into being together and be maintained together, in order for the integrity of the meter to be preserved," and that the sense of beat and tempo is in effect based on a non-isochronous pulse.[(11)]

[13] London's theory is developed in more detail in *Hearing in Time*, but its basic features are retained. As for tempo, he notes that having two distinct beat classes (the L and S) means that NI-meters are more highly constrained in terms of tempo than I(sochronous) meters (2012, 136, 141). 7-cycles are not dealt with in detail in *Hearing in Time*; London simply notes that the subcycle must comprise one long and two shorts, or one 3 and two 2s, which can be arranged in any of three possible rotations (322, 223, 232). Indeed, according to the principle of maximal evenness developed in London's book, a 7-cycle would need to be split into one of the possible rotations of 34 (two beat), 322 (three beat) or 2221 (four beat)—nine varieties in total.

[14] Based on London's theoretical apparatus, then, we can describe a typical 7-cycle as comprising three non-isochronous time units forming an irregular beat (tactus) level, supported by seven isochronous pulses (SD). **Example 2** is an illustration of a 7-cycle with a 3+2+2 non-isochronous subcycle, analogous to those presented by London. **Example 3** illustrates the same structure in a linear meter diagram in the style of Lerdahl and Jackendoff (1983), with the levels marked up as subdivision, beat, and measure, as per London (1995).

[15] Typical durations for each level in such a pattern would be subject to general constraints on metrical structures, as outlined in **Example 4**. Taking as the basis for these calculations London's (2012, 121) suggestion that beat rates should fall between 400 and 1200 msec, the maximum range of subdivision rates is 150–300 bpm, and of cycle lengths, 1400–2800 msec.[(12)] Some published estimates of tempo ranges in *aksak* meters are higher: Bartók insisted that a fast tempo was one of the essential criteria for "Bulgarian rhythm" (Rice 2000, 206–7) and gave a range from 200–400 bpm, although he also describes what he names "hyperbulgarian" rhythms at up to 600 bpm

(Bartók [1938] 1981). London's interpretation of a 7-beat meter as non-isochronous at the beat level with the 7-cycle as a subdivision is compatible with the great majority of examples in the literature from Turkey and the Balkans. It does not, however, fit the Indian *tāl* well: the slowest example analyzed in this study has a beat rate of 22 bpm and a cycle of about 18,600 msec, an order of magnitude slower than a "typical" *aksak* or predictions based on London's model of durational constraints.

[16] The *aksak* phenomenon has been the subject of empirical and cognitive studies in recent decades, including Goldberg's (2015, 2017) work. Dirk Moelants (2006), for example, studied performance timing in Bulgarian traditional tunes as well as in Bartók piano compositions. Tempo was generally fast, with cycle lengths in the region of 1–2s. Erin Hannon and colleagues have explored the implications of these metrical types for rhythm processing. Bulgarian and Macedonian participants performed differently from their North American counterparts in rhythm-processing tasks between "simple" and "complex" meters—the North Americans being unable to detect structural violations of a 7-beat meter (fastest IOI = 250 ms) that Bulgarians and Macedonians could detect. But infants were equally able to process both types, indicating the effect of enculturation on rhythm processing ability (Hannon and Trehub 2005). Ullal-Gupta, Hannon, and Snyder (2014) tested a similar idea using a 7-beat meter (again, IOI = 250 ms), showing differences in performance between Indian and North American participants when the 7-beat meter is involved. A number of studies have explored the learning of such complex metrical patterns. For instance, Tillmann, Stevens, and Keller (2011) show an effect of learning an unfamiliar pattern of durations in a 223 relationship over short-term exposure (the pattern length of 1050 ms for a three-element pattern, equivalent to a 7-pulse IOI of 150 ms). Overall however, while fast *aksak*-type non-isochronous metrical patterns have been explored in recent years in music theory and cognition, slow-tempo versions of these patterns—such as those I term "long-form non-isochronous meters"—are rarely taken into account.

[17] As noted above, music psychologists have explored the implications of *aksak*-type rhythms for the role of learning and enculturation in rhythm processing. This raises questions in relation to metrical perception. Models based on the entrainment of endogenous rhythms produced by neural oscillators—consistent with London's explanation—currently represent the dominant explanation for metrical perception. Neural resonance theory, as discussed for example by Large, Herrera, and Velasco (2015), could be described as a bottom-up theory of metrical perception: given an auditory stimulus with a periodic component, computational models of banks of neural oscillators become entrained and output a beat structure very close to the way a human listener extracts such a structure from the musical surface. While this provides an elegant description of many examples, results to date with *aksak*-type patterns are mixed (Goldberg 2017, 194). Long-form non-isochronous meters present a further challenge, in that existing models assume that the longest metrically-significant intervals are in the region of 2000ms (London 2012). Large et al.'s (2015) models of neuronal oscillation show output down to a frequency of 0.4Hz, with periodicities in this range linked to a slow "sub-delta" band of neural rhythms. It seems highly improbable that a physiologically plausible model of neural resonance can reproduce a *rūpak tāl* pattern of over 10 secs in duration.(13)

[18] A common challenge in modelling rhythm perception is to understand the place of learning, knowledge, and anticipation. As London recognizes, metrical structures are learned; papers on the perception of NI meter cited above illustrate short-term learning of *aksak*-type patterns. In many kinds of music, changes in tempo, meter, or rhythmic emphasis can also be anticipated based on prior knowledge, training, notation or cueing in performance. The role of prior knowledge in metrical perception is nonetheless given relatively little attention. London's theory draws, like Neural resonance theory, on Dynamic attending theory (Jones 1976, 2019), which is a predominantly bottom-up theory in that perception of meter depends on the entrainment of endogenous rhythms to an auditory stimulus. This entrainment then allows for prediction of the timing of future events, since the established pattern is presumed to continue by default. Such a system might account for the fact that individuals *learn* musical meters, if the connections in the neural oscillator populations can be modified by the stimuli encountered. Although the idea of structural representation is alien to much thinking in dynamical systems theory, some recent

approaches introduce top-down processes within a non-linear model of temporal perception under the rubric "active sensing" (Schroeder et al. 2010; Morillon and Schroeder 2015), which allows "any available source of top-down priors" (Rimmele et al. 2018, 876) to influence metrical perception.[(14)]

[19] The following sections address this issue from a music-theoretical angle, asking what *rūpak tāl* is and how it is represented, and thus conveying something of the "knowledge" that may be learned. I argue that the reason *rūpak tāl* (and other Indian *tālas*) can be perceived even with cycles extending well over 10 seconds is precisely that its perception is not a purely bottom-up process: perceptual mechanisms are able to draw on a robust body of learned knowledge and, by doing so, can overcome the proposed 5–6-second limit on metrically-salient periods. From the perspective of Western music theory, this may seem to be an extreme example, in that *rūpak tāl* is a very long, asymmetrically divided cycle and thus not the kind of structure many theorists would take into account. However, metrical knowledge may take many different forms, and I argue that perceptually-based metrical theory in general should give greater consideration to the ways in which top-down processes play a role in perception and the ways in which they interact with bottom-up processes.

[20] Theoretical knowledge and performance practice contribute to rich representations of the metrical pattern, which include embodied elements. This study demonstrates some of the richness and complexity of *rūpak tāl*. My contention is that *rūpak tāl*, particularly when performed at a slow tempo as in *khyāl*, exceeds accepted temporal limits for the perception of meter; the estimated limit of the perceptual present does not however present a barrier to its perception, and the reason that this is possible is that musicians and listeners have acquired rich representations of the structure that inform perception.

[21] The next two sections first describe *rūpak tāl* and then present the results of an analysis of a corpus of recorded performances. A summary of this material can be found in the Discussion section for readers who prefer to jump to the conclusions.

Rūpak tāl: An introduction

[22] *Rūpak tāl* is one of the core metrical cycles employed in the Hindustani classical music tradition.[(15)] It is described as a pattern of 7 *mātrās*, grouped 3+2+2 (the groups are called *vibhāg*). The first *mātrā* of the group of three is always regarded as *sam* (the "one"), around which composition and improvisation are oriented. It is described with reference to both a clapping pattern and an archetypal drum pattern known as a *ṭhekā*. The clap pattern comprises a gesture at the start of each group: the first is a wave (*rūpak* is the only *tāl* to feature a wave on *sam*), followed by two claps at the start of the other two groups. *Ṭhekās* vary according to context, as we will see, but **Example 5** and **Video Example 1** illustrate the simplest version of *rūpak tāl's ṭhekā*. A noteworthy feature is the use of a light stroke *tin*, without a resonant bass sound, on *sam* and throughout the first group. This corresponds to the wave gesture, and the initial group of 3 *mātrās* is called a *khālī vibhāg* ("empty group") (Naimpalli 2005, 119).

[23] *Rūpak tāl* is not the only 7-cycle used in Hindustani music. In the *dhrupad* vocal genre, a 7-cycle called *tīvrā tāl* (or *tevra*) is sometimes used, which features the same 3+2+2 division but not the initial *khālī* section or wave gesture. Similarly, when classical singers sing *bhajans* (devotional songs) they sometimes use a drum pattern called *sātvā*, which again divides the 7 into 3+2+2 but has a different drum pattern and does not have the first section *khālī*. Other 7-beat patterns that might be heard in classical or related contexts include *paśto* and *mughlāī*, both names suggesting an origin in regions now lying within Afghanistan or Pakistan. James Kippen (2006, 91) suggests that historically, *rūpak* may have developed as a fusion of *paśto* (*ṭhekā*: *ti – tirakita / dhi – na na/*), which is used in *ghazal* (sung poetry) accompaniment, and *tīvrā tāl* (*ṭhekā*: *dha din ta/ tita kita/ gadi gana/*). Elaborating on this view, *rūpak tāl* may represent a synthesis of a folk-derived 7-cycle with a light first beat (*paśto*), with aspects of Indian classical time theory embodied by *tīvrā tāl*, a synthesis that resulted in the anomalous *sam-is-khālī* (light beat one) phenomenon. Both *paśto* and *tīvrā tāl* are played relatively briskly. The slow tempo that has become typical of *rūpak tāl* is part of a wider

process of deceleration that took place in the 20th century and affected many *tāls*, some even more dramatically than *rūpak tāl* (Clayton 2000, 50–52).

[24] In south Asian music traditions, groups of 7 are always divided 3+4, and groups of 5 2+3. The fact that 7-beat Indian *tāls* are described as 322 rather than 223 is consistent with this preference (Clayton 2000, 161). Although the description of *rūpak* as 322 is normative, however, earlier theoretical accounts and current oral tradition attest to a degree of ambiguity, with an alternative interpretation of the same structure as 223. In some recordings it is perhaps easier to hear *rūpak*'s cycle as 223 than 322. Listen, for example, to the conclusion of Alla Rakha's *tablā* solo on the album *Music of India: Ragas and Talas* (1959) (**Audio Example 4**). In fact Gurudev Patwardhan, a prominent drummer and pedagogue of the early twentieth century, notated *rūpak* beginning on what is now considered the fourth *mātrā* (i.e., as 223; Kippen 2006, 104), asserting that *rūpak* "does not begin from *sam*" (Patwardhan 1903; translated in Kippen 2006, 277). Magriel notes that similarly, the singer Krishnarao Shankar Pandit's book *Rag Pravesh* (1953–54) describes *rūpak tāl's sam* as falling on the third group (i.e., the *starting* point is the fourth *mātrā*; Magriel and du Perron 2013, vol. 1, 64). This relates to a story of *rūpak tāl*'s origin attributed to the master *tablā* player Suresh Talwalkar by my interviewee (and Talwalkar's student) Vishwanath Shirodkar. According to this account, an unidentified singer was performing an older version of *rūpak tāl* with the structure 2+2+3, but became confused and inadvertently started placing the *sam* of his composition on the fifth *mātrā*. Since the result sounded good, musicologists discussed the issue subsequently and agreed that this should be the new form of *rūpak tāl* (interview, May 5, 2014).(16)

[25] Relatively little has been written about *rūpak* in published works on *tāl* or in those on the *tablā* and its repertory. Many works contain brief descriptions of *rūpak tāl* similar to that at the beginning of this section. Some develop this with practical examples. Sadanand Naimpalli (2005, 178–84), for instance, includes elaborated *ṭhekās* that would actually be played in accompaniment, as well as a brief selection of compositions for *tablā*. In general though, the number of *tablā* compositions described is very limited. *Tablā* repertoire is dominated by *tīntāl* (4+4+(4)+4 = 16), and a lot of what is played in other *tāls* is, in practice, derived from *tīntāl* compositions (Vishwanath Shirodkar, interview, May 5, 2014).

[26] Musicologist Subhadra Chaudhary describes *rūpak* in terms of a contrast with *tīvrā tāl*: "[*tīvrā tāl*] has a steady, firm gait whereas [*rūpak tāl*] has a liquid, unsteady, springy flow" (1997, 421). According to Chaudhary, this binary relationship is not restricted to 7-cycles but is common to several other pairs of *tāls*. My earlier description focuses instead on the effect of the alternation of groups of different lengths being "a continual alternation of speeding up and slowing down, tension and relaxation" (Clayton 2000, 67–68).(17) Although it is not unusual to hear musicians affirm that *tāls* each have their own character, it is much less common to hear verbal descriptions of these characters, and aside from one interview with Vishwanath Shirodkar exclusively on *rūpak tāl*, from which I have already quoted, my own enquiries in interview contexts have been only modestly productive. In an earlier conversation, however, Shirodkar drew attention to the different *tāl* used in different *gharānās* (teaching lines or schools), with *rūpak* played somewhat slower in Jaipur *gharānā* than in other schools (interview, May 19, 2005). A well-known Jaipur *gharānā* singer Manjiri Asanare-Kelkar, who is represented in the core corpus with three separate *rūpak tāl* performances, suggested that she would often use *rūpak tāl* for the second *rāga* in a concert: the usual convention—not only for Jaipur style singers—is that the longest, most serious and slowest piece comes first and the second *rāg* will both contrast in terms of pitch material and often be slightly faster and shorter (interview, Feb 12, 2010).(18) Manjiri also pointed out that due to the relatively short cycle (short, that is, in comparison to slow 12- and 14-cycles that can last up to a minute), she would normally plan a passage of improvisation to last not one cycle but two or three.

[27] Patiala *gharānā* singer Sudokshina Chatterjee pointed out another consideration, which is that different *tāls* may be suited to the character of particular rāgs. In the case of *rūpak tāl*, she cited a composition in *Rāg Kauśī Dhānī*, which is the same one included in Nicolas Magriel and Lalita du Perron's 2013 collection of *khyāl* songs (which will be discussed further below) as performed by the great Patiala singer Bade Ghulam Ali Khan. She suggested that since *Kauśī Dhānī* is difficult to sustain for a whole hour and would normally be sung for about twenty minutes at most, it is suited

to a shorter cycle such as *rūpak tāl* (interview, June 8, 2006). Looking at the lists of *rāgas* represented in my corpus of *rūpak tāl* performances (**Example 6**), there is perhaps a preponderance of such "second *rāgas*." Our corpus includes performances of well-known compositions also represented in Magriel and du Perron's collection: *Sūra saṅgat rāga vidya* in *Rāg Tilak Kāmod* (Magriel and Perron use the version sung by the great Jaipur singer Kesarbai Kerkar; our recording is performed by Manjiri Asanare-Kelkar) and *Mero pīyā rasiyā* in *Rāg Nāyakī Kānaḍā* (sung by another great Jaipur singer Mogubai Kurdikar in Magriel and du Perron, and in ours by published recordings of Ashwini Bhide Deshpande and Basavi Mukherjee). It is striking that four out of fifteen *gats* are similar pieces in the important afternoon *rāg*, *Bhīmpalāsī*.

[28] Two important themes emerged from interviews with *tablā* players. First, it is important to distinguish the playing style of *rūpak* (a *tablā tāl*) from a *tāl* such as *dhamār*, which is associated with the barrel drum *pakhāvaj* and its heavy, booming strokes (the *pakhāvaj* is used to accompany *dhrupad*). In other words, there is more to a *tāl* than the number of beats in the cycle (Abhijeet Banerjee, interview, Feb 8 2007). The other theme is that their overriding concern in playing *rūpak tāl* is the necessity in solo passages of dividing the *tāl* cycle into equal halves of 3½ *mātrās* each. *Tablā* solos in *rūpak tāl* therefore tend to be inherently contrametric.(19) This reinforces the notion that *tablā* players adapt material originally developed in the context of the binary pattern of *tīntāl*—where the symmetry between the two halves of the pattern is crucial—to very different structures, such as *rūpak*.(20) *Rūpak tāl*, as noted above, does not have an extensive solo *tablā* repertory of its own.

Rūpak tāl: Empirical description, first stage

Corpus

[29] As noted above, *rūpak tāl* is used principally in accompaniment of idiomatic instrumental *gat* performance (for example, of *sitār* or *sarod*) and of *khyāl* vocal performance, as well as occasionally in *tablā* solo.(21) In order to establish the main features of *rūpak tāl* as performed in these genres, I present a characterisation of the *tāl* in practice based on empirical investigation of a corpus of forty-two audio recordings (mean duration = 886 secs). This study establishes tempo ranges and patterns of tempo variation, and also discusses other aspects such as the usage of accompanying drum patterns (*ṭhekā*) and the rhythmic setting of composition melodies. These recordings fall into two groups:

- Core ("C" in Example 6). A selection of multitrack recordings made by the author and colleagues. These are particularly valuable because (a) the source is known (and thus we can be sure what editing has taken place), (b) using multitrack recordings individual instruments and voices can be isolated, and (c) video recordings of the same performances are also available (see Clayton, Leante, and Tarsitani 2019 for details).(22)
- Additional ("+" in Example 6). Other recordings, some published and some from private collections. Although lacking the advantages of the above, it is necessary to use a wider sample in order to make robust claims about some of the issues discussed here, especially for instrumental *gat* performances.(23)

Tempo ranges

[30] The tempo of the full corpus of forty-two recordings was established by manual tapping of the beats.(24) **Example 7** and **Audio Examples 1–4** illustrate a selection of four of these performances, chosen to show the range of tempo and the different patterns of variation: (1) a slow tempo *khyāl*, decelerating very slightly (MAK_Jaun); (2) a *khyāl* that accelerates in clear stages (ArunBh_Kedar); (3) a medium-fast *gat*, illustrating gradual acceleration (PrB_Jhin); (4) a fast *tablā* solo, which features an overall acceleration with a higher degree of tempo fluctuation (AllaR_Tabla). **Example 8** plots the starting and ending tempi for each of the forty-two recordings, and is colored by genre. This illustrates that *khyāl* recordings generally cover a lower tempo range than instrumental *gats* and that instrumental *khyāls* tend to occupy the upper range of the vocal *khyāls*. *Tablā* solos include the fastest performances of all. While a few *khyāl* performances remain at a constant tempo, some

even ending at a marginally slower tempo than that at which they begin, it is far more common for performances in all genres to accelerate, sometimes very considerably.

[31] Hindustani musicians do not generally concern themselves with quantifying tempo in terms of bpm. Terms used for tempi are quite simple: *vilambit*, *madhya* and *drut*, meaning slow, medium and fast, respectively, occasionally with the prefix *ati-*, meaning very, or hyphenated in terms such as *madhya-drut* ("medium-fast"). It is not clear how these terms should map onto absolute tempo measurements, however, as they are inconsistently used. It is also the case that typical bpm ranges are quite different for vocal and instrumental music, so what is "medium" for an instrumentalist may be "fast" for a vocalist (Clayton 2000, 86). In the case of *rūpak tāl*, the term *vilambit* ("slow") is sometimes used. But such tempo modifiers are often conspicuously absent, suggesting that *rūpak* is regarded as the same entity simply played faster or slower. Vishwanath Shirodkar's estimates of the minimum and maximum comfortable tempi, given in the form of *ṭhekā* recitation in interview, are c. 30–108 bpm.(25) Anything slower, he suggests, makes it difficult for the listener to follow, although he conceded that this might occasionally be justified (interview, May 5, 2014).

[32] Our corpus of recorded performances suggests a somewhat wider range in practice (see again, Example 8). The tempo density plots/ histograms in **Example 9** show that the *tablā* solos include the fastest tempi, although they also extend down to about 60 bpm. The overall range is 61–229 bpm. Next fastest are the *gats*, played on instruments such as *sitār*, *sarod*, guitar and *santūr*, which range from about 57–182 bpm. The *khyāl* vocal performances range from about 22–129 bpm. The instrumental versions of *khyāl* on *sāraṅgī*, flute, violin, and harmonium occupy a somewhat narrower range of 41–113 bpm.

[33] It is difficult to confidently separate out regions of these plots to be labelled slow, medium, and fast, although a few areas stand out: below 45 bpm in the vocal *khyāls*, for example, and below 65 bpm in the instrumental *khyāls*, which perhaps could be called *vilambit*. A less clear-cut possibility would be to label the area over 120 bpm in the instrumental *gats* as *drut*.

[34] The same data is converted to show cycle lengths in **Example 10.** These distributions confirm that the cycle duration spreads well beyond 5–6 seconds. The range is from under 2 seconds (in *tablā* solos only) up to over 14 seconds (in vocal *khyāl* only).

[35] Since slow tempi and long cycles are of particular interest here, and since a general deceleration at the slower end of the spectrum over the twentieth century is widely acknowledged, it is worth asking whether there is any evidence that the slowest tempo band (22–45 bpm) developed over the course of the twentieth century. Only one of Magriel and du Perron's examples goes below 45 bpm: Kesarbai Kerkar's *Rāg Tilak Kāmod*, which starts at 42.4 bpm and probably dates from the 1950s or '60s.(26) Recordings analyzed in this paper in the 22–45 bpm range date from later: Ashwini Bhide-Deshpande's *Nāyakī Kānaḍā* dates from 1997; Basavi Mukherjee's performance of the same composition, 2006; and our recordings of Manjiri Asanare-Kelkar, Ram Deshpande and Vijay Koparkar, the 2000s. Although not conclusive, this is consistent with the idea that tempi below 45 bpm may have come into common usage in the second half of the twentieth century, influenced by a wider trend of deceleration in Hindustani music.

Tablā accompaniment and *mātrā* subdivision

[36] As noted above, the simplest version of *rūpak tāl*'s *ṭhekā* is usually quoted as *Tin tin na/ dhin na/ dhin na*. Magriel notes some variations in early recordings: replacing the "*na*" stroke on 5 and 7 with "*dha*" (which adds bass resonance); replacing only the seventh *mātrā* "*na*" with "*dha*"; leaving *mātrā* 5 unsounded or weakly sounded; or replacing the "na" on *mātrā* 3 with *Tirakita*, a feature which he notes (after Kippen 2006) is derived from *paśto* (Magriel and du Perron 2013, vol. 1, 269). Naimpalli (2005, 180) prints two elaborated "*Thekas* for Solo and accompaniment," which share some features with these. **Example 11** summarizes these important variants.(27)

[37] A number of patterns emerge in the *ṭhekās* in our corpus. First, as noted by Magriel, there is a tendency to lose the *khālī* (bass-less) feel on *mātrā* 7, and more rarely *mātrā* 5. Only a few of the slowest performances (e.g., those of Basavi Mukherjee and Bhimsen Joshi) retain the *khālī bol* (*bol*,

meaning "stroke") on *mātrā* 7. The *Tirakita* pattern on *mātrā* 3 seems to have become an important reference point, although there are still some variations in use of this pattern: this can be rather different from slow *khyāl tāls* such as *ektāl* (12 *mātrās*), where this pattern tends to be played as a very clear and unelaborated sequence of four *tablā* strokes. In *rūpak tāl*, the *Tirakita* may be varied, either simplified (at fast tempi, *Ti-kita*) or decorated (at slow tempi, *Ti-ra-Tirakita*). In the majority of performances, there is at least a clear reference to this *bol* (and hence at least a 4:1 subdivision), with only a minority of performances avoiding it altogether.

[38] A selection of *tablā* audio extracts from our Core corpus illustrate some of these variants (described from slowest to fastest):

- **Audio Example 5** (*Tablā*: Milind Pote, first cycle = 31 bpm): simple *TinTin* on *mātrā* 3 rather than *Tirakita*; *khālī* retained on 5 but not 7; elaboration relatively simple (gentle *Kat* or *Tat* on sub-beats)

  Tablā track from: *Rāg Jaunpurī* performed by Manjiri Asanare-Kelkar (voice), Milind Pote (*tablā*) and Chinmay Kolhatka (harmonium). Pune, Maharashtra, 9/12/2006. Source: NIRP1_MAK_Jaun_Tabla.wav, 3'03"–3'46".

- **Audio Example 6** (*Tablā*: Milind Hingne, 39 bpm): clear articulation of *Tirakita* on 3;[(28)] *khālī* mostly retained on 5 but not 7

  Tablā track from: *Rāg Jhinjhotī* performed by Manjiri Asanare–Kelkar (voice), Milind Hingne (*tablā*) and Shubhash Dasakkar (harmonium). Nashik, Maharashtra, 13/2/2011. Source: NIRP1_MAK_Jhin_Tabla.wav, 3'04"–3'46".

- **Audio Example 7** (*Tablā*: Ajinkya Joshi, 40 bpm): clear articulation of *Tirakita* on 3; *khālī bols* not retained on 5 or 7

  Tablā track from: *Rāg Rāgeśrī–Kauns* performed by Vijay Koparkar (voice), Ajinkya Joshi (*tablā*) and Rahul Gole (harmonium). Pune, Maharashtra, 25/2/2010. Source: NIRP1_VK_RagKauns_Tabla.wav, 5'31"–6'06".

- **Audio Example 8** (*Tablā*: Vishwanath Shirodkar, 56 bpm): *mātrā* 3 varies between *Tirakita* and *Ta-Tit* (3rd cycle); *khālī* retained on 5 but not 7

  Tablā track from: *Rāg Hamsadhvani* performed by Veena Sahasrabuddhe (voice), Viswanath Shirodkar (*tablā*) and Seema Shirodkar (harmonium). Pune, Maharashtra, 15/12/2006.Source: NIRP1_VS_Hams_Tabla.wav, 3'31"–4'03".

- **Audio Example 9** (*Tablā*: Ajinkya Joshi, 60 bpm): taken from the same concert as VK_RagK, this faster piece uses *Tirakita* on 3 but not as consistently; *khālī bol* is retained on 5 but not 7; note the fills towards the end of *mātrā* 5, giving a greater sense of urgency

  Tablā track from: *Rag Hinḍol-Bahār* performed by Vijay Koparkar (voice), Ajinkya Joshi (*tablā*) and Rahul Gole (harmonium). Pune, Maharashtra, 25/2/2010. Source: NIRP1_VK_HinBah_Tabla.wav, 3'54"–4'22".

- **Audio Example 10** (*Tablā*: Vishwanath Shirodkar, 71 bpm): clear articulation of *Tirakita* on 3; *khālī* mostly retained on 5 but not 7

  Tablā track from: *Rāg Tilak Kāmod* performed by Manjiri Asanare-Kelkar (voice), Vishwanath Shirodkar (*tablā*) and Kaviraj Singh (harmonium). Durham, England, 30/4/14. Source: NIRP1_MAK_TilakK_Tabla.wav, 2'12.5"–2'44".

- **Audio Example 11** (*Tablā*: Gaurishankar Karmarkar, 74 bpm):[(29)] by way of contrast, in an instrumental example, the distinctive feature of the *ṭhekā* seems to be the two heavy strokes on *mātrās* 4 and 6, which give a very different feel to all of the vocal examples

  Tablā track from: *Rāg Jhinjhotī* performed by Prattyush Banerjee (sarod) and Gauri Shankar Karmakar (*tablā*). Kolkata, West Bengal, 28/1/2007. Source: NIR_PrB_Jhinjhoti_2Gats_Tabla.wav, 1'23.5"–1'53.5".

[39] These examples show a tendency for the *ṭhekā* to be more elaborated at slow tempi, at least in the sense that

Tablā track from: *Rag Tilak Kāmod* performed by Manjiri Asanare-Kelkar (voice), Vishwanath Shirodkar (*tablā*) and Kaviraj Singh (harmonium). Durham, England, 30/4/14. Source: NIRP1_MAK_TilakK_Tabla.wav, 14'29.5"–15.05".

the articulation of the ½ and ¼ *mātrā* subdivisions feels more consistent and less decorative in A5 and A6 than in the faster examples. However, *tablā* players are aware of the danger of over-elaboration: the more *bols* (strokes) are added, the more one risks losing the character of the *tāl*. So for some, at least, an important principle is that *bols* should be added only when it becomes impossible to sustain the sound of the *ṭhekā*'s main *bol* (Vishwanath Shirodkar, May 5, 2014). Nonetheless, at slower tempi the *ṭhekā* tends to be filled out more. At the slowest speed, as these examples show, at least two strokes are played per *mātrā*, with fills increasing the density to x4 or x8. At the fastest tempi, just one stroke per *mātrā* is frequently used (the *bol* on *mātrā* 2 is sometimes dropped altogether). In some performances, *tablā* players use a variety of fills towards the end of the cycle, including playing a 3:2 polyrhythm on the last 2 *mātrās*. In **Audio Example 12**, for example, we can hear 7 cycles in which *tablā* player Vishwanath Shirodkar uses a variety of elaborations in his accompaniment, including syncopations and cross-rhythmic patterns, particularly in the latter part of each cycle.

Compositional structures

[40] The only study of *khyāl* compositions in *rūpak tāl* of which I am aware is Magriel and du Perron's *The Songs of Khyāl* (2013). This two-volume compendium transcribes, translates, and describes a corpus of 492 compositions as recorded in the first three-quarters of the 20th century. Of the 492 songs, only eight are in *rūpak tāl*, confirming that it is relatively uncommon in this genre. [30] Magriel and du Perron nonetheless describe these performances in some detail, concluding that "*rūpak*, being infrequently performed compared to the main *khayāl tāls*, has afforded less opportunity for the establishing of conventions or standardized modes of presentation" (2013, 271).

[41] In brief, Magriel and du Perron found no consistent pattern in terms of the structure of the vocal compositions. This contrasts with *khyāls* in medium tempo *tīntāl* (16 *mātrās*), many of which feature an anacrusis (*mukhṛā*) of 5 *mātrās*, and therefore begin on *mātrā* 12; or those in slow *ektāl* (12 *mātrās*), where a similar *mukhṛā* pattern, due to the slow tempo, extends over roughly 1¼–1½ *mātrās* (cf. Clayton 2000, 119).

[42] A selection of *khyāl* audio examples from our corpus again illustrate some of the possibilities:

- **Audio Example 13** (*Tablā*: Vishwanath Shirodkar, first cycle = 37 bpm): this slow-tempo piece uses a *mukhṛā* of about 1½ *mātrās*

  Rāg Rāgeśrī-Bahār performed by Ram Deshpande (voice), Viswanath Shirodkar (*tablā*) and Anant Lakhe (harmonium). Nashik, Maharashtra, 13/2/2010. Source: NIRP1_RamD_RagBah_StereoMix.wav, 5'49"–6'23".

- **Audio Example 14** (*Tablā*: Milind Hingne, 39 bpm): this example uses a mukhṛā extending over 2½ *mātrās*; the syllable falling on *sam* is extended, sometimes over more than 4 *mātrās*, giving a sense of repose after a cadence

  Rāg Jhinjhotī performed by Manjiri Asanare-Kelkar (voice), Milind Hingne (*tablā*) and Shubhash Dasakkar (harmonium). Nashik, Maharashtra, 13/2/2011. Source: NIRP1_MAK_Jhin_StereoMix.wav, 3'02"–3'35.5".

- **Audio Example 15** (*Tablā*: Vishwanath Shirodkar, 56 bpm): this composition in the light *Rāg Hamsadhvani* has an unusual structure with a long, melismatic opening from *mātrā* 2.5

  Rāg Hamsadhvani performed by Veena Sahasrabuddhe (voice), Viswanath Shirodkar (*tablā*) and Seema Shirodkar (harmonium). Pune, Maharashtra, 15/12/2006. Source: NIRP1_VS_Hams_StereoMix.wav, 3'24"–4'05".

- **Audio Example 16** (*Tablā*: Ajinkya Joshi, 60 bpm): similar to RamD_RagBah (A13) in structure, this composition clearly divides into a single syllable first part (*mātrās* 1–3) and a second part (*mātrās* 4–7) from which a 1½ *mātrā mukhṛā* can be split off

  Rāg Hinḍol-Bahār performed by Vijay Koparkar (voice), Ajinkya Joshi (*tablā*) and Rahul Gole (harmonium). Pune, Maharashtra, 25/2/2010. Source: NIRP1_VK_HinBah_StereoMix.wav, 3'51"–4'24".

- **Audio Example 17** (*Tablā*: Vishwanath Shirodkar, 71 bpm): this composition is unusual in that it does not include a *mukhṛā*, but starts from *sam* (*mātrā* 1)

Rāg Tilak Kāmod performed by Manjiri Asanare-Kelkar (voice), Vishwanath Shirodkar (*tablā*) and Kaviraj Singh (harmonium). Durham, England, 30/4/14. Source: NIRP1_MAK_TilakK_StereoMix.wav, 2'12"–2'55".

[43] The ten *khyāls* show that a *mukhṛā* of 1½–2½ *mātrās*, followed by an extended articulation (syllable or stroke) on *sam*, is the most common pattern, but significant variations from this are not uncommon.(31) In the additional corpus examples, other structures are found. For instance, recordings of *Rāg Nāyakī Kānaḍā* by Basavi Mukherjee and Ashwini Bhide-Deshpande, the slowest performances in the corpus, manage to squeeze an eight-note melismatic *mukhṛā* (on the word "*mero*") into the last half-*mātrā* of the cycle. The version of this composition transcribed by Magriel and du Perron (2013, vol. 1, 470) from Mogubai Kurdikar's 1948 performance, for comparison, has this melisma on *mero* lasting for the full seventh *mātrā* (**Audio Example 18**). It seems clear in this case that in slowing the tempo from 60 bpm to less than 30 bpm, this gesture has been retained but now takes up only a half rather than a full mātrā (the phrase on *mero* begins the performance, and then recurs in its *mukhṛā* form, filling the last half mātrā at c. 20 secs) (**Audio Example 19**).

Rāg Nāyakī Kānaḍā performed by Mogubai Kurdikar. Source: Magriel and du Perron 2013. *Rāg Nāyakī Kānaḍā* performed by Basavi Mukherjee (voice), Debashish Sarkar (*tablā*), Ramesh Mishra (*sāraṅgī*), and Prosenjit Sengupta (harmonium). Source: Eclectic Expression, P&M Records PMR048 (2006), 1'26.5"–1'55".

Rāg Cārukeśī performed by Shahid Parvez Khan (*sitār*) and Hindol Majumdar (*tablā*). Source: Amazon.com Song ID: 243404211 (2013), 0'00"–0'30".

Rāg Bhīmpalāsī performed by Debashish Bhattacharya (Guitar) and Samir Chatterjee (*tablā*). Source: 'Hindustani Slide Guitar', India Archive Music IAM 1026 (1997), 0'23.5"–0'56.5".

[44] The structure of the instrumental compositions is somewhat different, given three factors. First, instruments such as the *sitār* cannot sustain a single syllable for as long as the voice can. Secondly, improvisations are more likely to conclude with *tihāīs* (triple repetitions) than simply returning to the *mukhṛā* as in *khyāl*. Thirdly, the *mukhṛā* cannot be identified by the words. A variety of structures is therefore encountered, often introducing an element of rhythmic interest. In Prattyush Banerjee's *Rāg Jhinjhotī*, for example (**Audio Example 3**), we can hear in the initial statement of the *gat* that the last 3 *mātrās* are split into 1½ + 1½, creating a simple cross-rhythm. Shahid Parvez Khan's *Rāg Carukeśī* (**Audio Example 20**) is more radical, starting the melodic line from *mātrā* 1.5, just half a *mātrā* after *sam*. At faster tempi, compositions often take up two cycles per section (Clayton 2000, 129; cf. Goldberg 2017, 155, on *rŭchenitsa*). In Debashish Bhattacharya's *Rāg Bhīmpalāsī* (**Audio Example 21**), the two lines can be disassociated and the first half of the *sthāyī* repeated alone.(32)

Rūpak tāl in Khyāl accompaniment: Further investigation

[45] Bearing in mind the theoretical questions set out in the introduction, the more detailed analysis in this section uses onset timing data and video recordings to explore the following issues in particular:

- *Consistency of mātrā duration and patterns of variation.* Are there any significant divergences from strictly equal *mātrā* lengths? *Mātrās* felt to be "stronger" or "heavier" might be expected to be slightly longer than the mean.
- *Drum patterns in tablā accompaniment (ṭhekā).* How is *rūpak tāl* actually played in accompaniment? How does practice relate to the theoretical *ṭhekā* patterns? *Mātrās* that serve as anacruses preparing for the stronger metrical positions may be expected to be more elaborated, and hence include more *bols*.
- *Gesture and movement.* What does the practice of *tāla*-marking gestures, especially the wave performed on the first beat, tell us about the nature of *rūpak tāla*? What is the significance of the normative "wave" on beat 1?

Through these analyses, we will build up a more detailed picture of *rūpak tāl* as it is used in practice in the *khyāl* genre.

Corpus

[46] The core corpus used for this section comprises ten *khyāl* recordings (nine vocal with *tablā* and harmonium accompaniment, and one *sāraṅgī* solo with *tablā*), recorded as multitrack audio and video between 2006 and 2014. *Tablā* onset data was extracted using a Matlab function created by Tuomas Eerola.[(33)] Original media files and onset annotations are freely shared for research purposes (see Clayton, Leante, and Tarsitani 2019), as are the data files and R scripts used to produce the figures. Each *mātrā* was annotated manually by tapping along with the audio file in Sonic Visualiser. Gross errors in these timings were corrected and then *tablā* onsets within specified intervals of those reference points were selected (the size of the window varying between examples). The resulting set of annotated *tablā* onsets was then manually checked. See **Example 12** for details of the recordings.

Tempo in *khyāl* accompaniment

[47] Tempo ranges and acceleration have been discussed in detail in the previous section. **Example 13** illustrates the tempo curves of all ten recordings used in this section. A reference line is added at 45 bpm to illustrate the division between slow/*vilambit* and other sections.

Consistency of *mātrā* duration and patterns of variation

[48] In this subsection, data relating to the durations of individual *mātrās* is considered, based on IOIs between annotated *tablā* onsets. It is worth pointing out that the position of the onset of a *tablā* stroke should not be taken unquestioningly as the position of "the beat": in a sense, the beat is constantly being negotiated between all of the musicians, and the drummer's performance is subject to his own human limitations in precision. Nonetheless, *tablā* onset data are important here for two reasons: (1) because any timing errors are those of the musician, not the researcher; and (2) because if *rūpak tāl* is characterized by regular deviations from isochrony at the beat level, then we should expect to find this manifested in the *tablā* accompaniment part most of all. **Example 14** shows that for these ten recordings, *mātrās* 1, 2, and 4 overall tend to be slightly longer and *mātrās* 3, 5, 6, and 7 slightly shorter, compared with the even subdivision of the cycle. The margins are small when we look at the mean deviations, however, the largest mean difference (*mātrā* 1) being about 1.5%.

[49] These patterns do vary somewhat between examples. To illustrate this in more detail, **Example 15** visualizes differences from isochrony across five different pieces. An underlying pattern of *mātrās* can be discerned— *mātrās* 1, 2, and 4 tending to be longer, and 3 shorter. There are differences, however: MAK_Jhin, RamD_RagBah, and VS_Hams all have a consistently shorter *mātrā* 3 but this is not apparent in MAK_TilakK, while MAK_TilakK also tends to have a longer *mātrā 5*. These examples were chosen to allow comparison between three recordings with the same singer (the top three), as well as between three recordings with the same *tablā* player (the bottom three). The visual differences do not group in any obvious way according to either singer or *tablā* player, so the differences must be accounted for elsewhere (i.e., the *rāga* or tempo could have an influence).

Tablā accompaniment and *mātrā* subdivision

[50] Having explored variations in the basic *ṭhekā* pattern used to accompany *rūpak tāl*, we can now explore practice in more detail using the *tablā* onset data. A number of previous studies have used the distribution of note or stroke onsets as an index of metrical strength (Goldberg 2017, 143ff). In these studies, the hypothesis is generally that stronger metrical positions (beats at slower pulse levels) have a higher probability of coinciding with note onsets. Palmer and Krumhansl (1990, 732) also find a higher incidence of onsets falling on anacruses.[(34)] In the current study, virtually every *mātrā* position is marked by a *tablā* stroke, and thus *tablā* event distribution *on* the *mātrās* tells us very little about the metrical structure. The subdivision of the *mātrā* is a different question, however. Since the logic of improvisation in this music tends to be an increase in tension and excitement leading up to a metrical downbeat, followed by relaxation, our hypothesis is that strong metrical positions in North Indian *tāla* will be associated with *lower* rates of subdivision, and *weaker* positions—particularly anacruses—with *higher* rates of subdivision.

[51] Across the whole corpus, the proportion of *mātrās* subdivided 2:1 by the *tablā* part was estimated by searching for drum onsets within +-50ms of the midpoint between two *mātrā* onsets. The result is plotted in **Example 16**. The *mātrās* most consistently subdivided (more than 95% of the time) are those at the end of the *vibhāgs*, namely 3, 5, and 7. The *mātrā* least subdivided is 1 (28%). Note that this could not have been surmised from the published notations of *ṭhekās* used for *rūpak tāl*, and nor was attention drawn to this phenomenon by *tablā* players in interview.

[52] The rate of subdivision by the *tablā* part was explored further by counting the number of extracted onsets in each pair of *tablā* onsets between successive *mātrā*. It is clear in **Example 17** that *mātrā* 3 is the densest on average, surely related to the prevalence of the 4:1 subdivision in the common *Tirakita* stroke pattern. Breaking this down by performances, the variability of practice is clear: while *mātrā* 1 is sparsely played and 3 relatively densely across the board, we see, for example, that MAK_Jaun features particularly dense subdivision of *mātrā* 7, while VS_Hams and MurA_DhaniK are much sparser on the same *mātrā*.

[53] Another way of visualizing practice in *tablā* accompaniment is by representing more densely subdivided *mātrās* in a darker color, as in **Example 18**, which compares the same five recordings illustrated in Example 15, featuring three by singer Manjiri Asanare Kelkar and three with *tablā* player Viswanath Shirodkar. In a comparison between three performances of the same singer, we can see that in MAK_Jaun, *mātrā* 7 becomes denser as the performance proceeds and *tablā* player Milind Pote plays more fills at the end of the cycle. *Mātrā* 3 is quite dense throughout. In MAK_Jhin (*tablā*: Milind Hingne), this increase in density is less marked and more focused on *mātrā* 6. MAK_TilakK (*tablā*: Vishwanath Shirodkar) features less subdivision overall.

[54] The different performances featuring the same *tablā* accompanist Vishwanath Shirodkar illustrate the fact that he varies his style according to circumstances (the *rāga*, tempo, and singer's style could all play a part). His playing on VS_Hams features increasing subdivision of *mātrā* 3, while on RamD_RagBah, he increases density on both *mātrā* 3 and elsewhere in the cycle, especially 2, 5, and 7. The latter case evidences a more active accompaniment style and rhythmic interplay with the singer (**Audio Example 22**), which has *tablā* on the left channel and vocal on the right).

Tablā and vocal tracks from: *Rāg Rāgeśrī-Bahār* performed by Ram Deshpande (voice), Viswanath Shirodkar (*tablā*) and Anant Lakhe (harmonium). Nashik, Maharashtra, 13/2/2010. Source: NIRP1_RamD_RagBah_Tabla.wav (L) / NIRP1_RamD_RagBah_Vox.wav (R), 19'35"–20'47".

[55] If we plot the density in strokes *per second* for the same five performances (**Example 19**), we can see that in MAK_TilakK the stroke density increases, thanks to an increase in tempo. VS_Hams maintains a low stroke density throughout, apart from *mātrā* 3, while in RamD_RagBah, the density increases substantially across the cycle.

[56] Another way of illustrating the interaction of *mātrā* subdivision and tempo is plotted in **Example 20**. If we explore the subdivision of *mātrās* by tempo range, unsurprisingly we find higher rates of subdivision at slower tempi: they only go above 8:1 in sections below 45 bpm (*mātrā* > 1333 ms), although they are still frequently around 4:1 even at 120–130 bpm (*mātrā* < 500 ms). Consistent with the result reported above, *mātrās* 1 and 2 show up as less densely subdivided. It is also striking that the fastest subdivisions (10:1–15:1) fall almost exclusively on *mātrā* 7 in the slowest example MAK_Jaun.

Movement

[57] Video recordings offer the opportunity to look at the way musicians and audiences move in the course of *rūpak tāl* performances. In particular, the use of *tāl*-related manual gestures provides additional clues as to the perceived structure and feel of the *tāl*. All musicians are taught the basic wave-clap-clap pattern, but it is rarely performed as such in live concerts. Rather, this is a pattern that can be referenced as and when needed. For example, if the singer feels that the *tablā* player is finding it difficult to grasp the structure of a composition, he or she might use a wave to indicate where *sam* falls. For most singers, the majority of hand gestures will relate to melodic flow or contour, or to dynamics, rather than to tempo or metrical structure (Clayton 2007). Gestures relating to the *tāl* tend to occur at the beginning of the performance, when they indicate the

required tempo to the *tablā* accompanist, and in the course of improvisation, when a range of gestures are used to indicate that *sam* has been reached (especially on cadential downbeats).

[58] In starting the performance, the singer's focus is on the correct tempo and feel. Therefore, at slow or medium tempi the singer will often start with a sequence of taps of the right hand on the knee, sometimes indicating not only the *mātrā* beats but also the ½ or ¼ *mātrā* level. Subsequently, some singers will use a gesture that clearly indicates the *sam*—most often at the end of a passage of improvisation while singing the *mukhṛā* (refrain), but sometimes also in the middle of their improvisatory flow, indicating that they remain conscious of the *tāl*. In many cases, this gesture will be related to a "wave"—for instance, a sharp movement of the hand will be made with the palm facing upwards. It can also be observed that *sam* gestures in this corpus often include an opening of the arms and/or a relaxation of one or both arms, and thus contribute to a sense that *sam* is a point of relaxation.

[59] Five video clips, featuring one male singer, two female singers, and one *sāraṅgī* solo, illustrate the variability in manual gestures. Brief descriptions are given below:

- In Ram Deshpande's *Rāgeśrī-Bahār*, *sam* is indicated initially with a tap of the right hand on knee (0:08), then typically with a combination of flicks of right and left hand (0:19, 0:30, 1:16); but also with a pointing gesture with the left index finger (1:27), or as a rapid rotation of the fingers of the left hand (2:01) or of the left index finger (2:24) (**Video Example 2**)
- In Manjiri Asanare-Kelkar's *Rāg Jhinjhotī*, she begins by indicating the *sam* to her accompanists with a pointing gesture of the right hand (0:07). This is replaced by a gentle wave of the left hand (0:18) and then by a downward movement of both hands (e.g., [1:12]), which appears to suggest the action of making an offering. This gesture is sometimes elaborated into four downward steps coinciding with the preceding half-*mātrā* points (1:53–1:57) (**Video Example 3**)
- In the same singer's *Rāg Jaunpurī*, she indicates *sam* with a more perfunctory, gentle grasping gesture of the left hand (e.g., [0:28]) or an equally gentle release of the fingers of the left hand (1:46). This difference from her *Jhinjhotī* may be accounted for in at least one of two ways: (1) the *Jhinjhotī* was performed for a large, communicative audience, whereas the *Jaunpurī* was recorded privately with a much smaller group of listeners; (2) in the *Jaunpurī* she plays the *tānpūrā* with her right hand, whereas for the *Jhinjhotī* she is not playing the *tānpūrā*. It is not clear whether the difference is due to one or both of these factors, or to a difference in mood between *Jaunpurī* (a late morning *rāg*, contemplative in character) and *Jhinjhotī* (evening, more lively and romantic) (**Video Example 4**)
- Veena Sahasrabuddhe begins her rendition of *Rāg Hamsadhvani* with very *tāl*-focused gestures, striking both her knees on the first *sam* (0:08) and continuing to mark a basic version of the *tablā's* rhythm with her own hands for several beats. At 0:23 she gives a subtle gesture with the left hand, which suggests "release" (cf. both hands at [1:00]). At (0:38), *sam* is marked with a more flowing left-hand gesture (**Video Example 5**)
- Murad Ali Khan's scope is obviously highly constrained, in contrast, but it is worth observing the way he and *tablā* player Gurdain Rayatt mark *sam* with coordinated downwards nods of the head (e.g., [0:17] and [0:27]) (**Video Example 1**)

[60] As can be seen from this selection of video clips, manual gestures are by no means used in a standardized fashion. Soloists use them when they are salient—at the start of a performance when coordination with *tablā* accompanists needs to be secured, and then at cadential points when improvisatory episodes are concluded. Tāla gestures are part of a mixture of gesture types, with other referents including the shape of the melodic line often being more prominent. Where they do occur, the wave may be a useful referent, but the range of movements is quite varied, including a range of flicks, points, grasps and other gestures. It is difficult to say definitively which of these *tāl*-related gestures is *rūpak*-specific without carrying out a similar survey of other *tāl*s. But the prominence of gentle movements with an open hand, often palm upwards, and relative rarity of forceful downward hand-strokes and claps does concur with theoretical descriptions of the *tāl*'s character. Most of the gestures here are consistent with a description of the *sam* as "light" or "gentle" and with a sense of relaxation or release, rather than of an energetic coming together. In any case, Manjiri Asanare-Kelkar's downward-moving open-handed gestures in *Rāg Jhinjhotī* are not simply generic *rūpak tāl* gestures; rather they are specific to the singer and *rāga*, and perhaps even to the specific composition or concert performance.

Discussion

Rūpak tāl

[61] *Rūpak tāl* is an important metrical pattern in the Hindustani tradition. It seems to have developed through a combination of fast 7-beat patterns used in North-western India, Pakistan, and Afghanistan with principles from India's very different historical *tāla* system, but is played more slowly than any of its progenitors. It has a distinctive drum pattern (*ṭhekā*) and clapping pattern, and its own distinctive "feel" characterised by a light first beat. In Hindustani classical music, it is used in three distinct genres: in *khyāl* vocal, in *gat*, and in *tablā* solo, as a means to create rhythmic variety.[(35)] Particularly in *khyāl*, *rūpak tāl* is often played rather slowly; the *mātrā* (basic time unit) can extend to well over 1500 msec in duration, creating a very long metrical cycle and necessitating subdivision of the *mātrā*, so that the tactus may shift from the *mātrā* to the half-*mātrā* level. Even at tempi less than 30 bpm, the 7-cycle is remarkably stable.[(36)]

[62] In both vocal and instrumental music, *rūpak tāl* is favored by particular musical lineages or individuals. Most of those who perform *rūpak tāl* tend to regard it as in some sense "secondary," suited to the second *rāg* of a concert or to a *rāg* of "limited scope." Being performed much less often than some other *tāls*, its practice is less standardised, with a wide range of composition structures and a fair amount of quirkiness in evidence. As practice has developed over the 20th century, the adoption of the *Tirakita bol* elaborating *mātrā* 3 has also become all but standard, and the use of *khālī bols* (without bass) on *mātrā* 7, and to a lesser extent *mātrā* 5, almost entirely abandoned. This has implications for our interpretation of the structure. In practice, *tablā* players tend to fill out the last *mātrā* of each group significantly more than the others, especially *mātrā* 1, which is played the most sparsely. The length of *mātrās* 1, 2, and 4 tend to be very slightly extended, and 3, 5, and 7 slightly shortened compared to an isochronous division of the cycle. This finding about the variation in *mātrā* subdivision and the small variations from isochrony in *mātrā* lengths is summarized in **Example 21**.

[63] The structure is unusual in the Indian context, not because it is a 7-cycle, but because the *sam* is *khālī* (indicated with a wave or played with a light drum beat). This is remarkable enough to deserve an explanation. Although the heavier drum beats thus fall on *mātrās* 4 and 6, the cycle is nowadays universally described as 322 rather than its rotation 223. The significance of this is that the main point of emphasis and release in compositions falls at the start of the group of 3 *mātrās*, and improvisation is oriented with respect to this point in the cycle.

[64] This suggests a balance between two main points of emphasis, either of which can be perceived as the strongest. *Mātrās* 1 and 4 are therefore the two most important time points in the cycle. The *Tirakita* pattern that has now become all but standard (with variations) on *mātrā* 3 enhances a sense of driving to *mātrā* 4, which balances the emphasis on *sam* which is created or supported by the structure of vocal and instrumental compositions. This interpretation is supported by the variations to the *bols* on *mātrā* 3 and the slight shortening and increased stroke density of *mātrās* 3 and 7. On the other hand, the change of practice in *tablā* accompaniment of *mātrās* 4–7, where the standard *ṭhekā*'s alternation of heavy and light strokes is often abandoned in favor of four "heavy" strokes, means that the perceived structure may tend towards 34 rather than 322. **Example 22** illustrates an interpretation of the structure as oriented around this alternation between the two main downbeats on *mātrās* 1 and 4. This division of the cycle into two unequal halves contrasts with the conception of *tablā* soloists, for whom it is necessary to divide any cycle *equally* into halves and quarters.

Metrical theory and long form NI meter

[65] The description of *rūpak tāl*'s structure in the previous section makes some reference to tempo-related differences—for example, in the maximum subdivision levels revealed by the empirical analysis. What is more striking, however, is the extent to which *rūpak tāl* is conceived as the same structure over a tempo range of about 30–130 bpm (a factor of more than 4:1), and up to a cycle length of over 15 secs. (For the additional corpus, the range across all genres is about 22–229 bpm,

or >10:1.) This is not to say that the difference in tempo is not perceived, of course, but that the *tāl* is conceived and *represented as invariant*, and that, as a result, its identity is much more strongly perceived than one might expect over such a wide tempo range. I argue that the theoretical knowledge of *rūpak tāl*'s structure is activated regardless of tempo, that it influences perception in a top-down manner, and that this enables a cycle of >15 secs duration to function as a part of the metrical structure.

[66] I suggest that this is the case for most metrical cycles in most musical traditions. Listeners' metrical perception is never a "raw" perception based simply on neurological entrainment to quasi-periodic events. In practice, metrical perception always involves reference to knowledge acquired over a lifetime's listening. This can include a sense of how quasi-periodic patterns are produced and how one might typically participate in or respond to such patterns (for example, by dancing), as well as how one might match perceived patterns against learned models. I suggest that what happens in a case such as *rūpak tāl* is that a knowledge of the structure and its representation in clapping pattern and typical drum patterns becomes essential for the 7-cycle to be perceived as such, because the learned structure of the pattern, represented in practice by archetypal drum patterns and hand gestures, provides priors to support top-down perception of the pattern.

[67] In all aspects of the metrical structure of *rūpak tāl*, we can see an interaction between general principles of meter as underpinned by cognitive constraints, and more local factors such as the preference for certain kinds of structures, and the use of explicit knowledge to fix these structures and to try to maintain them as "the same" over a very wide tempo range. I have argued that this application of explicit knowledge means that it makes sense to regard structures lasting well over 15 seconds as being metrical units. For someone with access to this knowledge, it is just as much a pattern of 7 beats at 22 bpm as it is at 180 bpm. This interaction of bottom-up and top-down factors is by no means unique to *rūpak tāl*. What the particular features of *rūpak tāl* afford us, however, thanks to their accidental contrast with elements of metrical theory developed in a very different musical tradition, is the opportunity to expand our understanding of the kinds of structures and representations that may contribute to top-down metrical perception, and to acknowledge that the psychological present does not impose an absolute limit on metrically-significant timescales.

Conclusion

[68] The general points that I have discussed in this article regarding metrical theory can be summarised as follows: (1) certain metrical structures employ a level between the beat and the cycle with a distinct function, labeled here as the group level. I have termed such structure "long-form meter." Just as beat and subdivision levels can be non-isochronous in other musical traditions, so too can the group level, as is the case with *rūpak tāl*—what I have termed an example of "long-form non-isochronous meter"; further, (2) metric cycles that extend well beyond any commonly-accepted limit for the psychological present are understood by musicians and listeners in the same way as analogous structures within this limit, and in these cases, metric theory should recognize that explicit knowledge structures make it possible for meter to extend well beyond 5–6 seconds.

[69] Beyond the specific argument made in these pages regarding metrical theory, the approach taken here introduces an approach to empirical analysis of *tāl* that could be further developed in the future. The idea of empirical analysis of rhythmic and metrical structures *per se* is not new. This article has pioneered the exploration of large openly-shared annotated corpora of natural music performances, combining statistics, data visualization, and musical analysis in order to build a picture of canonical *tāl* structures in performance. This characterization includes significantly more information about the *tāl* than is present in any written or oral theory, because it takes into account the variability of practice, with the *tāl* figuring not simply as an abstraction but as a range of possibilities accepted under the same label. Understanding why, for example, a drum pattern might be played differently according to the tempo, the melodic content, the relationships between performers, or other factors, amounts to a complex musicological issue, but the availability of empirical data can usefully feed into that analysis alongside historical, ethnographic and other sources. Expanding this approach to other *tāls* would add significantly to our understanding of the

system as a whole, and this approach could be adapted to other musical traditions or to aspects of Indian music other than the *tāl* system.

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Footnotes

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1. This article transliterates Hindi terms according to the Library of Congress romanization table (http://www.loc.gov/catdir/cpso/romanization/hindi.pdf). For those unfamiliar with the system, the most important elements are that the macron sign indicates a long vowel (ā, ī, ū), <h> indicates an aspirated consonant, <c> indicates an unaspirated <ch> sound and <ś> a <sh> sound.
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2. "North Indian" and "Hindustani" are both commonly-used labels for the same art music tradition, increasingly commonly abbreviated to HCM (Hindustani Classical Music) and NICM (North Indian Classical Music). "North Indian" is preferred in this article, as is the term *rāga* (the

system of melodic modes that characterizes the tradition) over "classical."
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3. This article will retain the term *mātrā* for the basic time unit in this paper, since translating it as "beat" would create problematic ambiguities: at slow tempi the perceived beat of the music may move to the half-*mātrā* level. Nonetheless, the default position of this article is that the *mātrā* maps onto the beat level.
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4. The abbreviation IOI stands for "inter-onset interval" (i.e., the time interval between the start of two events, such as beats or drum strokes).
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5. *Gats* are idiomatic compositions based on stroke patterns, as opposed to instrumental versions of vocal compositions.
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6. It would be instructive to explore *tāla* in light of the full range of extant metrical theories. Unfortunately, space does not allow such an extensive treatment.
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7. The 232 example is from Swets (1958, 394), who gives a Serbian example but also suggests that it "occurs very seldom." One of Bartók's ([1938] 1981, 143) examples is also a 232.
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8. Timothy Rice (1980) took a somewhat different approach in a paper discussing the emic categories used by Bulgarian musicians. In this account, musicians "did not traditionally discuss their songs, tunes, or dances in terms of the number of beats per measure" (62), but were more likely to conceive the patterns in terms of the number of *units* in a measure ("unit" here refers to a group of 2 or 3 short pulses or subdivisions); the only aspect of rhythm to be discussed explicitly by performers was tempo. Rice uses the term "beat" here to refer to the upper figure in a time signature (e.g., the 7 in 7/8), and he uses "unit" for the level London describes as a non-isochronous beat. Thus, according to Rice, 322 = 7/8 would be described by Bulgarian musicians as having three units.
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9. According to Swets 1958, the 322 pattern is most characteristic of Greece, where it is known as *Kalamatianós*. In Greece and Albania, it is "moderately fast," and it is also found in Macedonia (cf. Singer 1974) and in Bulgaria, where it is exclusively played fast. In terms of the 223 pattern, Swets 1958 noted that it is common in the Turkish Black Sea region (cf. Singer 1974 on Macedonia, once again).
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10. Transliterated *rŭchenitsa* by Goldberg (2017) and *rûchenitsa* by Rice (1980), and elsewhere as *račenitca*.
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11. While subsequent research has demonstrated that metrical patterns in general need not be based on a fast isochronous referent (Kvifte 2007; Polak and London 2014), this need not concern us here if we circumscribe the present topic to cover only those patterns where long and short are subdivided into 3 and 2 pulses respectively.
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12. A more generous range of possible beat rates would be 250–2000 msec, that between tempos considered respectively too fast and too slow "to be useful" in music (London 2012, 28).
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13. Although evidence has been reported of entrainment of slow-tempo brain oscillations (periods in the order of seconds) by sound stimuli (Gao et al. 2009), much more research would be needed

to demonstrate the significance of this mechanism for metrical perception.
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14. Alternative models of rhythm perception and synchronization face similar challenges in incorporating learning and representation. Linear models that assume that listeners keep track of a beat through a process of continuous error correction that maintains phase alignment do not have to face such a strong principled objection as dynamical systems approaches, and in some cases do include an element of anticipation (see, for instance, van der Steen and Keller 2013), although much remains to be explored in terms of what may be anticipated. Vuust and Witek (2014) take a somewhat different approach to the same problem, arguing for a mechanism of "predictive coding" by which the brain seeks to minimize the difference between sensory information and prediction based on statistical processes. According to these authors, such an approach needs to take account of the fact that "neural structures underlying musical expectation are influenced by culture, personal listening history, musical training, mood, listening situation, and biology" (5).
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15. The word *rūpak* comes from the Sanskrit *rūp*, meaning shape or form, face, or beauty (i.e., beautifully formed). It has a variety of other usages in the performing arts.
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16. Hindustani music also features several 14-beat meters, which can be regarded as 322 or 34 patterns doubled in various ways:

- *dīpcandī* and *jhūmrā tāls*: 3+2+2+(3)+2+2 or 3+4+(3)+4, where only the second 3-group is *khālī*; or
- *ada cautāl*: 2+2+(2)+2+(2)+2+(2), which can be regarded as an elaboration of 6+4+4, or 3+2+2 with each *mātrā* divided into two; or
- *dhamār tāl*: clapped 5+2+(3)+4, which can be regarded as an idiosyncratic way of indicating a 3+2+2+(3)+2+2 pattern, omitting two of the gestures

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17. The description is of the 322 pattern and thus would also apply to *tīvra tāl*.
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18. In this respect, *rūpak* is often bracketed with *jhaptāl* (10 *mātrās*, 2+3+(2)+3). The difference between the two, apart from the number of *mātrās*, is that *jhaptāl* has a longer documented history and an association with the *dhrupad* vocal genre, so its performing style is usually somewhat different to *rūpak*'s.
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19. We have also observed the *tablā* master Suresh Talwalkar's class when he was teaching advanced students to improvise in *rūpak tāl*, and his emphasis was precisely on the art of splitting the cycle into equal halves and then into equal quarters (interview, Nov. 15, 2013).
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20. According to Kippen (2006), Gurudev Patwardhan used the term *vibhāg* (lit. "section") in a very different sense to its modern usage, to indicate a half cycle. Thus *rūpak* comprises 2 x 3½ beats. He shares this interpretation with the legendary singer, musicologist, and educator Vishnu Digambar Paluskar. This suggests that the principle in *tablā* composition and improvisation of dividing even asymmetrical cycles into equal halves was well established by the early 20th century at the very latest.
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21. See Example 6, items AllaR_Tabla, LatifAKh_Tabla and SS_Tabla.
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22. In one case, SAbh_Chandra, we have the singer's permission to release only a portion of the recorded media.
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23. Private recordings include the author's recording of sitarist Deepak Choudhury, taken on stage in the UK in 1991 using a portable cassette recorder (recordings DCh_Bhim & DCh_TilakK), and solo harmonium recordings kindly provided by Dr. Arawind Thatte (AraTh_Bihag & AraTh_NatBh; see also Thatte 2010).
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24. As indicated in Example 6, some performances are taped from beginning to end and others only for a couple of minutes each at the start and end.
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25. Shirodkar specialises in *khyāl* accompaniment, so it is not surprising that this is closer to the observed *khyāl* range than the instrumental *gat* range.
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26. Kesarbai died in 1977, and the recording was released posthumously in 1985. The sound of the recording suggests a date well before that, although the fact that a 28-minute piece was preserved suggests that it was most likely recorded onto magnetic tape in the 1950s or later. Magriel and du Perron also describe a 78 rpm performance of the same composition dating from 1954 (which begins at 110 bpm), commenting that this wide divergence indicates that "Kesarbai was exceedingly flexible, adjusting tempo to suit the situation or her mood of the moment" (2013, 270). This is surely true. It may also be the case that, faced with a recording medium that allowed only a short performance, artists tended to start their performances somewhat faster than they would have done in a live concert (the 42.4 bpm performance was a concert).
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27. Sushil Saxena (1979, 119–20) refers to the *tirakita bol* but is clear that it does not form part of *rūpak*'s *ṭhekā*.
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28. It may be noticed that references to *Tirakita* in the *tablā* parts of these performances are subject to variation, both between and within examples. The detail and significance of these variations is beyond the scope of this paper.
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29. The recording can be found in another published corpus. See Clayton, Leante, and Tarsitani 2018.
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30. Similarly, Bonnie Wade (1984) cites only one *rūpak tāl* composition in the whole of her study of the genre.
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31. In this section I refer only to the structure of the first section or *sthāyī* of each composition. *Khyal* and *gat* compositions usually comprise two main parts, called *sthāyī* and *antarā*. The *sthāyī* is sung at the start of the performance: it often comprises two lines of text, the first of which can be repeated on its own over one cycle or alternated with a second text line covering two or more cycles. The second part, the *antarā*, is often not sung until much later in the performance: it is therefore much less important in defining the artist's approach to the *tāl*.
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32. For a discussion of *gat* structures, see Clayton 2000, 28–29. Shahid Parvez discusses and demonstrates in *Rāg Yaman* two-cycle *rūpak tāl* compositions from 44'12" in a published interview, stressing the importance of the two-cycle (and thus 14-beat) pattern to the conceptualization of the *gats*: https://www.youtube.com/watch?reload=9&v=gs6KeyzdGBw (in Hindi/Urdu).
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33. Onsets were extracted based on envelope characteristics using MIR Toolbox (Lartillot, Toiviainen, and Eerola 2008). First the audio signal is band-pass filtered, and the envelope of the filtered signal is then extracted and subjected to low-pass filtering and half-wave rectification before applying peak-picking algorithms with three parameters. This approach generates onset annotations for the *tablā* with a high degree of timing accuracy, catching >95% of drum strokes and creating few false positives. For more information and onset data, see Clayton, Leante, and Tarsitani 2019.
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34. Although Goldberg (2017, 244) notes regional variation, his analysis in Bulgarian *rŭchenitsa* recordings shows the highest probability of a drum stroke on sub-beats 1, 3, 5, and 7—the three main beats plus the upbeat.
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35. *Rūpak tāl* is also sometimes used in *kathak* dance performance. This is not discussed in this article.
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36. One might suppose that performing such a cycle is very challenging, and indeed it is. But our recordings show that it is a challenge many professional musicians who attempt it can meet with some comfort. Although rare, musicians occasionally make errors in performance, such as adding or dropping beats. In the ten core performances, there are a total of four such errors—three in one performance, and one in another. It is unusual to hear as many as three *tāla* errors in one piece. Otherwise, added or dropped beats happen extremely rarely, apparently due to momentary lapses of concentration.
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