The social origins and functions of musical rhythm

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1. On the social origins of musical rhythm

> But the sounds of nature alone do not follow any rhythmic pattern. Rhythm is the product of social life. The individual by himself could not invent it. Work songs, for example, arise from regular repetition of like motions among cooperating workers. Were these motions rhythmic in themselves, the songs would not provide the service expected of them. The song offers a model to the cooperating workers; the rhythm flows from the song into their movements. Hence it assumes a prior collective agreement[…] At a very young age, we are familiarized with musical "beat". But society, not nature, has done this for us.[1]

As Maurice Halbwachs's essay 'The Collective Memory of Musicians' confirms, the social origins of musical rhythm is not a novel topic. For Halbwachs, work songs are a paradigm case: their rhythm may be intimately linked to the bodily movements necessary for the job at hand, but it is the song that bestows rhythmic organisation on the 'motions' (*gestes*) of work; the song's function is collectively to organise the movements of the group, and its existence "assumes a prior collective agreement". In this chapter I take inspiration from this fragment of Halbwachs' argument to outline a new approach to this issue, and in doing so to argue for a return to his concern with social interaction in theorising rhythm. The problem Halbwachs leaves unanswered is, if musical rhythm is social in origin, how does it come into being – how is his "prior collective agreement" reached? Alfred Schütz, although casting Halbwachs as the straw man in his famous essay 'Making music together', did not explicitly contest the latter's point about the social origin of rhythm.[2] Schütz's argument that all communication is made possible by what he called the 'mutual tuning-in relationship' in which individuals come to share their experience of inner time, does however contradict Halbwachs: for Schütz, rhythmic coordination is prior to any collective (social) agreement. In this chapter I argue that rhythm in fact emerges spontaneously both in individuals and (crucially) in interactions between them, and that it is therefore both natural (physiological) and social in origin.

Ever since Fred Lerdahl and Ray Jackendoff's seminal *Generative Theory of Tonal Music* in 1983, music theory has seen a decisive shift to explanations of rhythm in terms of the cognitive capacities of the human individuals who perceive it. Rhythm, for theorists of the late twentieth and early twenty-first centuries, is not an immanent quality of a musical work or performance. Rather, it is a quality that emerges in the individual's engagement with an auditory stimulus: thus, for example, the only rhythmic structures which can be successfully deployed in music are those capable of comprehension by human cognitive apparatus. Most current theorists would accept Justin London's premise, building on psychologist Mari Riess Jones' theory of attentional periodicity, that the perception of musical metre depends on the entrainment of an individual's attentional rhythms to regularities in an auditory stimulus.[3]

This understanding of metrical perception, which we can gloss with Ed Large as the entrainment of neurological oscillators,[4] does not preclude looking at a range of issues concerning the ways in which musical rhythm is actualised in the course of interactions between individuals engaged in music. Moreover, I will argue in these pages that although metre can be explained through a perceptual and cognitive theory, further development of such a theory necessarily takes into account recent perspectives on the inseparability of perception and action, the role of bodily movement in rhythm production, and thus an understanding of human joint action as inherently embodied and socially-situated.[5] Understanding rhythm as being generated in such situations offers a route to understanding

[1] Halbwachs (1980 [1939]), pp.171-2.
[2] Schütz (1951).
[3] Jones (1986), London (2012).
[4] Large (2010).
[5] Knoblich and Sebanz (2006, 2008).

the links between social situation, cultural context and rhythmic structure, an area which has suffered from being limited to simplistic homology theories.[6]

The position I will argue in this paper can be summarised as follows:
First, musical rhythm is possible only thanks to the existence of endogenous biological processes taking place in each individual human's body which are rhythmical in nature – that is, that are oscillatory and tend to produce quasi-periodic patterns in action and perception. Such rhythmical processes are, however, characteristic not of homo sapiens *per se* but of life in general: since most species do not make music, these processes are a necessary but insufficient condition for the emergence of music. What distinguishes homo sapiens is, rather, a flexible capacity to coordinate individual internal rhythms between members of a group. It is due to this capacity that rhythmical structures emerge in the course of entrainment between the endogenous rhythms of individuals. (By 'entrainment' is meant the mutual influence of, and potentially synchronisation of, independent rhythms).[7] In this sense, Halbwachs was right to argue that musical rhythm is irreducibly social in nature. My claim here is that musical rhythm is something which originated in and is sustained by interaction between individuals, and thus cannot be reduced to individual psychological functions. Of course, it remains possible to produce or to listen to music individually. There also exist forms of music that superficially seem to exist independent of any social interaction: for example, some music created through aleatoric or algorithmic processes. Although such cases are not my main focus, I nonetheless include them in my argument, since music made alone, enjoyed alone, or created through random or simple rule-based systems nonetheless manipulates musical concepts, structures, processes and/or materials whose origins remain social.

Music and its rhythms may (in evolutionary time) have emerged spontaneously in social interaction. However, such emergent structure is only a small part of the music-making of modern societies around the world. In practice, such emergent structures are sedimented into specific patterns which are transmitted between members of a given society. In some but by no means all cases, such structures are reflected on and represented – that is theorised – as rhythmical structure. In the rest of this chapter I will expand on this argument, and reflect on Hindustani classical music as a case study in interpreting rhythmic structure as an index of historically-sedimented human interactions.

2. The rhythmic individual: Endogenous rhythms

The living human body is replete with rhythmical processes: respiration, heartbeat, locomotion (e.g. walking and running), sleep-wake and menstrual cycles are some of the more obvious examples. Various theories have linked musical rhythm to those endogenous rhythms with periods in the range of a few seconds – respiration, heart rate and/or human locomotion. The tempo of music has often been linked to the heart beat, for instance, while Curt Sachs argued that the relationship to a normal walking gait was a more pertinent comparator.[8] A musical beat is not normally synchronised with walking, although most people can walk in time with music if requested to do so,[9] and of course related movements are frequently synchronised to music in dance. Hamish MacDougall and Steven Moore demonstrated a strong preference for locomotive movement at around 2 Hz/ 120 bpm across a range of subjects carrying out various everyday tasks, and noted the apparent relationship to spontaneous tempo (expressed in finger tapping) and to preferred musical tempi;[10] it seems that Sachs' intuition has been confirmed. Spontaneous motor tempo has been well studied by psychologists: Devin McAuley et al's study taking into account the age of subjects demonstrates that it tends to slow down significantly over the life course, but for most adults the preferred value tends to

[6] Clayton (2013).
[7] See Clayton et al (2005).
[8] Sachs (1953), pp.32-3, see Clayton (2000), p.82.
[9] Styns et al (2007).
[10] MacDougall and Moore (2005); see also Moelants (2002).

be a period of about 500-600 msec (1.67-2 Hz; 100-120 bpm).[11] There is plentiful and consistent evidence, therefore, for the existence of endogenous rhythms in the human brain and body that tend to be expressed most commonly in this range.

What is less often remarked on, but is particularly evident in musical contexts, is that individuals also tend to be able to switch between tempi, for instance between 150 bpm and 75 bpm (half as fast). Frederik Stynes et al show, indeed, that when asked to walk in time with music, subjects who are able to do so (the majority) nonetheless do so at different rates related to the nominal musical tempo: given a piece of music at 60 bpm, for example, the majority walk at this pace but some walk at 120 bpm and a few at 30 bpm.[12] Will et al hypothesize that the complex responses of listeners when asked to tap along to music without a clear beat can be explained partly through such switches in mode.[13] According to this view, someone who can produce a spontaneous tapping rate of 120 bpm can easily switch to half or double this rate, especially if the faster or slower rhythm more closely matches a stimulus in their environment. If Large's model of rhythm perception as effected by banks of interconnected neuronal oscillators is a reasonable approximation of the physiological structures underlying rhythmic behaviour, in fact, this is exactly what one would expect, since such oscillator networks tend to spontaneously generate hierarchical patterns of beats (i.e. a network that produces a 2 Hz oscillation is likely to also produce activity at 1 Hz and 4 Hz).

Furthermore, in line with an overarching perspective in cognitive science that sees action and perception as mutually implicated, brain structures capable of generating rhythmic behaviour at these time scales are also capable of entraining to rhythmic stimuli at the same time scales. Thus, an individual capable to producing a spontaneous 2 Hz tapping rhythm will normally be able to synchronise this underlying rhythm to a 2 Hz auditory signal; or to a 4 Hz signal; or to adjust this rhythm to match an auditory signal at 1.9 or 2.1 Hz. Jones argued that such internal rhythms control the deployment of attentional resources, and thus attentional energy is periodic and can be entrained to environmental stimuli; this is the idea underlying London's model of metrical perception, where internal rhythms entrain to features of the musical stimulus.[14] The rhythmic structure of music is rarely as simple as a 2 Hz pulse, of course. In practice, metrical patterns and their percepts are usually hierarchical in nature. What London's theory suggests is that hierarchical temporal patterns in the brain can entrain to hierarchical patterns of an auditory stimulus.

Most of what I have presented in this section currently has the status of a dominant view in music cognition and music theory. Individuals have internal rhythms which can be studied through movement, or at the level of brainwaves; they are hierarchical and cover a particular range of frequencies; and they can be tuned to regularities in the environment, including the sounds of a musical performance. This picture is convincing insofar as it goes. But it is not the whole story in determining the origin of musical rhythm: it is also important to consider what happens when two or more individuals interact, and their individual rhythms influence each other (entrain).

3. The rhythm of interaction: Entrainment, attention and emergence

As noted above, what appears to be unique to humans is the flexibility and precision with which one individual can adapt to the rhythmic structures of another's actions. There are numerous examples of inter-individual entrainment in other animal species: synchronous flashing in fireflies, synchronous courtship in fiddler crabs and so on.[15] For the most part, however, these seem to be automatic and invariable processes. Thus fireflies, to be capable of flashing in synchrony, require simply the ability

[11] McAuley et al (2006).
[12] Stynes (2007).
[13] Will et al (2015).
[14] Jones (2012).
[15] Buck and Buck (1968), Backwell et al (1998), Strogatz (2003).

to both generate a periodic flashing behaviour and to perceive the light signals of others. If the information about another individual's activity can influence its own, the laws of dynamical systems will see to it that a large group of animals synchronizes. In fireflies, frogs, crabs and crickets, interpersonal entrainment is not a flexible process which can be deployed consciously in order to meet a specific goal. In *homo sapiens* it certainly is, most obviously in making music and in some kinds of sporting activity (e.g. the synchrony of a rowing team), but there seem to be no parallels to this in the behaviour of other primates. Aniruddh Patel hypothesized that the ability to entrain to auditory signals is related to the development of a capacity for vocal learning, and is thus more likely to be demonstrated not in other primates but in birds (and some other animals).[16] Patel et al's famous study of a sulphur-crested cockatoo apparently entraining its movements (albeit intermittently) to recorded music is offered in support of such a theory,[17] as is Adena Schachner et al's paper in the same journal volume, which includes analysis of a large corpus of YouTube animal videos: as Schachner et al point out, however, "avian species do not entrain to auditory beats in their natural behavioral repertoire".[18] In this respect, then, we can continue to claim with some confidence that music is a uniquely human achievement, and that it depends crucially on the capacity for flexible interpersonal entrainment of endogenous rhythms. This capacity is worth considering in more detail, then, before considering its expression in music-making.

Interpersonal synchrony – notwithstanding the ubiquity of evidence in musical performance – was first analysed by William Condon in the 1960s.[19] Studying sound films of normal conversational interactions, annotating both phonetic production in speech and the movement of body parts frame by frame, he claimed to have identified both intrapersonal and interpersonal entrainment throughout his corpus. Where such synchrony was lacking, he suggested, was in cases of pathology – stroke, autism and so on.[20] Condon's method was difficult to replicate, and his results were treated with scepticism for some time, but more recent studies have demonstrated that interpersonal synchrony in conversational interaction is, if perhaps less pervasive than Condon claimed, nonetheless real. While the majority of studies of the structure of conversation focus on its sequential structure – the taking of turns, repair mechanisms and so forth – the mutual entrainment of endogenous rhythms seems to be a feature of conversation at least some of the time. It may still be a matter of disagreement whether such entrainment is a necessary condition for communication, as Alfred Schütz argued;[21] that it can and does happen is no longer seriously disputed. The conclusions of Adam Kendon – one of the most distinguished scholars to have followed Condon in this endeavour – are still pertinent today:

> interactional synchrony is best regarded as an achievement of the interactants that is attained when the participants come to govern their behavior in relation to one another in respect to a commonly shared frame or joint plan of action.[22]

Kendon's position foreshadows more recent developments in psychology and related fields that are relevant to the argument of this chapter, including the ideas of *joint action* and *distributed cognition*. These and related terms mark out a distinct research field. This field is concerned with processes of interaction through which two or more individuals come to share a commitment to carry out a task together – on which see also Margaret Gilbert's philosophical theory of 'joint commitment'– as a result of which thinking takes place between a group of individuals in the context of a particular environment and set of tools. [23] This chapter is not the place for a thorough review of these literatures. What is becoming increasingly clear, however, is that occasions of joint commitment and action lend

[16] Patel (2006).
[17] Patel et al (2009).
[18] Schachner et al (2009), p.835.
[19] Condon and Ogston (1967).
[20] Condon (1976).
[21] Schütz (1951).
[22] Kendon (1992), p.115.
[23] Gilbert (1996).

themselves to interpersonal entrainment (as Kendon suggested), and that they cannot be fully explained by describing the actions of individuals. These actions are not *summative*: they need to be studied in terms of the interactions themselves, and consideration needs to be given to *emergent* patterns of action.

Interpersonal entrainment between people in contexts of joint action – even so simple a joint action as a casual conversation – is often entirely spontaneous and unconscious. It is an emergent property of the interaction, bound by the general properties of dynamical systems, and its emergence is closely linked to mutual attention, especially visual attention: given similar verbal content, two people are more likely to mutually synchronise their movements if they look at each other. Exactly the same findings are replicated in studies of music-making: entrainment happens spontaneously and even when individuals are trying to avoid it, and it happens more readily given mutual visual attention.[24]

This, I argue here, is where we should look for the genesis and cultural evolution of musical rhythm, and for its relationship to rhythm in other human behaviours. Individuals spontaneously generate rhythmic (periodic) actions, and are able to entrain to periodicities in their environment, *and to periodicities in the actions of others*. This interpersonal entrainment happens spontaneously, but can also happen deliberately – that is, interactions that might at some point have occurred spontaneously are deliberately re-enacted, and in their recreation may be consciously moderated. Crucially, the patterns of interpersonal entrainment that emerge in music-making are far more complex, more flexible and far more amenable to conscious manipulation, than are the simple patterns of synchrony in fireflies or crabs. Amongst other animal species, humans have a remarkably flexible capacity for interpersonal entrainment; within human behaviours, music-making tends often to foreground the precision or flexibility with which we are able to coordinate our actions.

The patterns of coordination that emerge, and which can be reliably and stably produced by groups of people, are far more varied than many accounts of dynamical systems would seem to imply. The famous Haken-Kelso-Bunz (HKB) equation, for instance, models in simple mathematical form the interaction between two oscillators: the equation tells us that such a system has two stable modes, with the rhythms in phase or in an antiphase relationship, the former more stable than the latter.[25] Psychologists' finger-tapping experiments confirm that such simple behaviours conform with the predictions of HKB: people spontaneously and stably tap in phase or anti-phase with each other. Even a cursory consideration of musical performance, however – regardless of which musical culture is under consideration – tells us not only that most musical actions are far more complex than simple finger taps, but that they are coordinated in ways far more varied than HKB's two modes. Periodic rhythms of different speeds are coordinated, for instance, in various hierarchical and/or polyrhythmic configurations, while many more subtle phase relationships than 0° and 180° are widely exploited.

Musical rhythm, then, depends both on the existence of endogenous rhythms and their expression in periodic actions, but also on a uniquely flexible capacity humans share for the mutual entrainment of such actions in joint action contexts. In other words, rhythm is *both natural and social* in origin. If this argument is accepted, though, what are the implications for our understanding and interpretation of musical rhythm?

4. Reading social interaction in musical rhythm

If musical rhythm is irreducibly social in origin, it is equally true that it varies culturally. (This is true on whichever scale we conceive 'culture', whether we use the term to distinguish Europeans from Indians, or opera-goers from clubbers.) Existing accounts of that diversity leave a lot to be desired, as do theories of the relationship between social factors and cultural variability. Early comparative

[24] Clayton (2007a), Lucas et al (2011).
[25] Kelso (1995).

musicology developed seemingly logical, if completely unfounded, theories explaining the evolutionary progression from one or two-note melodies to heptatonic modes, and from unison to harmony. In talking about rhythm a greater confusion abounds, as is evident in the summit of this phase of musical scholarship, Curt Sachs' *Rhythm and Tempo*.[26] Sachs' discussion of topics such as the role of bodily movement and the relationship to language and poetry remains of interest, and he offers his own version of the 'social origin of rhythm' thesis when he states that an "impulse in man's evolution towards a stricter rhythm appears to have come from choral adaptation".[27] His account of the differences between primitive and advanced civilisations, however, becomes confused and self-contradictory. Rhythm in 'primitive' culture is distinguished by its imprecision, he argues, drifting from one metre to another to no metre at all. Nonetheless, the same author suggests that the sophistication of African and Indian drumming is striking, demonstrating that we should not confuse primitiveness with simplicity. Sachs' own apparent confusion on this point betrays the fact that the term 'primitive' was itself becoming anachronistic, as ethnomusicology abandoned the search for evolutionary narratives. In the case of rhythm, no coherent story was ever proposed in the first place.

Since that time, the challenge for some writers has been to describe the complexity and subtlety of various rhythmic systems: arguments have raged over appropriate modes of representation, whether or not a particular kind of music (especially African traditions) had metre in the Western sense or not, whether it should or should not be rendered in standard notation, and so forth.[28] If African music scholarship has tended to stress the importance of bodily movement from an early stage, in Indian and Indonesian music scholarship attempts to map rhythmical structures onto cosmological beliefs have achieved some currency. I have argued elsewhere that these homology theories – for example, that cyclic metrical structures in Indian music reflect a Hindu worldview based on very long recurring world-cycles (yuga) – are fundamentally flawed, and will not recapitulate that argument in detail here.[29] Rhythm was one of the parameters addressed by Alan Lomax's Cantometrics project.[30] Although this did not include metrical theory or analysis per se, Lomax was interested in the cultural variability of what he called 'rhythmic style'.[31] There has been relatively little engagement with general or universal theories of rhythm and metre, despite the richness of material in studies such as Simha Arom's monumental *African Polyphony and Polyrhythm*; or Clayton's model of north Indian tala, which attempts to locate this form of rhythmic organisation in the context of a generalizable theory of metre.[32] Recent signs of a reversal of academic fashions include Michael Tenzer's 'Cross-Cultural Topology of Musical Time', which frames a collection of analytical case studies in terms of a common set of descriptive terms.[33]

Western-focused theories of rhythm and metre since Lerdahl and Jackendoff have at least gestured towards the idea of universal theories. The adoption of a Chomskian 'generative grammar' approach suggests that their model should in principle be expandable to cover any form of metrical organisation, as Chomsky's is for different languages, although in practice little attempt has been made to implement this. Similarly with London's theory: since it is based on supposedly universal human capacities, it ought to be possible to expand it, with modifications, to cover any form of metre. Although London's monograph itself does not stray far from the Western tonal idiom, recent years have seen encouraging moves in this direction.[34]

[26] Sachs (1953).
[27] Sachs (1953), p.39.
[28] Agawu (2003).
[29] Clayton (2013).
[30] Lomax (1968).
[31] Lomax (1982).
[32] Arom (1991), Clayton (2000).
[33] Tenzer (2011).
[34] Neuhoff and Polak (in prep).

It seems clear that just as evolutionary theory offered little and homology theory led us up a cul-de-sac, ongoing conversations between music theorists, music psychologists and ethnomusicologist-analysts is leading to a florescence of cross-cultural theorisation of rhythm and metre. For all the positive aspects of these developments, however, the death of homology as a model and Cantometrics as a method leave us with a vacuum where we might be looking for connections between cultural specificity of rhythmic structures and ethnographic accounts of the meanings and functions of particular musical styles.

There is no reason to believe that such an endeavour will be easy – that ways of organising rhythm musically can be easily and transparently related to some aspect of social relations, or to ideologies expressed in other cultural spheres. One reason for this is that musical styles and repertories are historically constructed and sedimented, so that as social relations and institutions change, modes of musical performance are not created anew but adapted and recreated from what was previously practised. If the rhythmic organisation of a particular musical style reflects anything, it is not the current form of the social institutions to which its performers belong, but a long and incremental historical process of emergence, transformation and adjustment in the face of social conditions that change either subtly or dramatically.

Nonetheless, the work of unpicking some of these processes is potentially very valuable when it comes to understanding the ways in which music reflects and constructs social realities, and is implicated in layers of shared and differentiated behaviours and intentions across humanity. Making no claim to finality, then, the last part of this paper offers some thoughts on the rhythmic organisation of Hindustani classical music in the light of the proposals above.

5. Hindustani classical music and its rhythm

Before looking at some examples from actual performances, a brief summary of Hindustani rhythmical concepts and terms may be useful (readers already familiar with the topic may safely skip the next two paragraphs). The various genres and styles of Hindustani (north Indian) classical music are classified into metred and unmetred sections. Performances usually begin with unmetred sections (alap, ranging in duration from a few seconds to an hour or more), which in their extended form gradually develop from very slow and loosely structured to faster music more clearly structured around a simple pulse or beat. The metred forms that follow are organised according to one of a small number of tala patterns. Talas are conceived as metrical units or cycles comprising a fixed number of equal time intervals (matras); these matras are organised into two or more vibhags (sections/divisions). Thus a tala is a repeating hierarchical pattern comprising a sequence of nominally equal time units.

Melodic and rhythmic compositions and extemporization are performed within the tala framework. The simplest way of demonstrating the relationship to the tala is to conclude improvised episodes by returning to the mukhra, a part of a composition used as a refrain, or with a cadential figure ending on the first beat (sam). A common form of cadential figure is the tihai, which comprises a motif (which can be simple or complex) repeated three times. The approach to the sam, especially at the end of an improvised section, is termed aamad (arrival), and achieving this process in an aesthetically pleasing manner is an important aim of the performers. The normal mode for a performance (other than a drum solo) is for the singer or instrumentalist to be designated as ‘main artist’ and make all decisions about repertoire, tempo and so on, with a drummer designated as ‘accompanist’; in many performances, nonetheless, drummers take opportunities to display their own ability to take the musical lead.

If the most obvious question to ask about rhythm in Hindustani classical music is How does tala work?, the less obvious question on which I want to focus here is What does tala do? – or more broadly, What does the rhythmic organisation of Hindustani classical music achieve for those performing and listening to it?

First, it is clear that the general structuring principle outlined above – the transition from unmetred to metred – helps to organise the attention of everyone who engages with it in specific ways. In particular, a solo instrument or voice performing slow, unmetred music (alap) affords his listeners a specific kind of attention, which Jones and colleagues refer to as 'analytic attending'.[35] Since there is no regular beat structure the music does not easily afford a motoric response or a forward-looking, predictive (protensive) mode of listening. Although the performer may be planning ahead, the listener is forced to pay attention to the sound in the present. In terms of social relations, such a musical performance is likely to develop in a context in which contemplation, introversion and perhaps meditation are valued, and within which an ethos can be created that encourages such a mode of attention. In other words, it is likely to develop in quite particular social settings, in which highly skilled specialist musicians are afforded the patronage required to develop their art. Historically, alap in the modern sense is not described in the earliest historical sources on Indian music such as the Natyashastra– where music is described as an adjunct to dramatic presentation – but first appears in a treatise called Brihaddesi (9th century CE).[36] It appears to have developed long after various metrical song forms had been established.

The transition from unmetred to metred music is a significant one, which many musicians conceive in terms of a shift from an inward- to outward-facing attitude. Nayan Ghosh, uniquely placed as a highly-regarded performer on both sitar and tabla, explained the difference as follows:

> Alap is a journey inward and the gat [metred] portion is a journey outward, that's where there's a dialogue. The two people are musically conversing with each other … A step further would be where the audience also becomes so much a part of that whole conversation that you forget that there are three entities: the main artist, the accompanist and the audience.
> Nayan Ghosh, Mumbai, 23rd May 2005

As Ghosh makes clear, the transition from alap to tala-bound sections marks a move from an individual engagement with the musical materials to a social, dialogic engagement.[37] The livelier, more rhythmic music is played together with an accompanist, and makes most sense when listeners actively engage with the tala structure (which they may show by means of specific hand gestures). In performance, rhythm emerges from melody, and social engagement from contemplation – which, intriguingly, is likely to reverse the direction in which these forms emerged historically.

Metred music affords what Jones calls 'future-oriented attending',[38] in which the listener is attuned to a regular temporal structure and unpacks the music in real time with reference to a protention of the temporal structure. The listener knows roughly what the soloist is trying to achieve in aamad (the return to sam, the 'one'), and roughly when it must occur, and hears the music in relation to possibilities she herself can imagine. This is possible due to a combination of two things: the regular beat which affords entrainment, as well as a knowledge of the particular tala pattern, which provides a conscious knowledge of the number of beats in a tala cycle. In other words, an enculturated, expert listener is not only entrained to the musical beat – in a way open even to a complete novice listener – but also actively deploys culturally-specific shared knowledge.

In the metred sections, these learned metrical structures organise interactions which in turn indicate social formations and relationships. As demonstrated by Clayton,[39] tala structures the interactions between soloist and accompanists, and also between musicians and listeners, with the latter often

[35] Drake et al (2000).
[36] Widdess (2010).
[37] Alap can involve dialogue, for instance when two singers or instrumentalists alternate in its performance, or when a singer is accompanied by a melodic instrument. The paradigm case is, however, that of strictly solo performance.
[38] Drake et al (2000).
[39] Clayton (2007b).

being drawn into visibly demonstrating the fact that they share the flow of the tala and therefore appreciate the musicians' achievement in creating transitions that are both consonant with this framework and aesthetically pleasing (which may include 'unexpected'). This process can be understood as something like Schütz's 'mutual tuning-in relationship', in which participants share the temporal flux of inner time:[40] clearly in this case, it is shared culturally-specific knowledge that affords this mutual tuning-in.

This sharing of temporal flow is usually experienced as felicitous. Psychological studies of much simpler experiences in which individuals share temporal structure in analogous ways demonstrate empirically the link between interpersonal entrainment and social effects such as increased prosocial behaviour, affinity and feelings of belonging to a group (entativity).[41] How much stronger might such effects be in real-life situations, which may also be highly affective and meaningful in terms of real social identities and relationships? No wonder that ethnomusicologists such as John Blacking have argued for many years that musical performance leads to heightened 'fellow-feeling' and hence social bonding.[42]

The story is not so simple, however, since this sharing of inner time – to use Schütz's language – takes place within a hierarchical setting. It is socially shared, but the individuals doing the sharing are placed in hierarchical relationships: main artist to accompanist, expert to lay listener. Such hierarchies are both expressed and understood, but may also be contested. What happens when an accompanist doesn't wish to be led? In practice such situations are familiar to musicians in this tradition, and many moments of conflict can occur, moments which are usually concealed from audiences. Singer Ranjani Ramachandran spoke about her experience as a young soloist having to manage more senior accompanists:

> [It] happened in one [concert that a] senior tabla player was very mad at me. I was not getting the laya [tempo] I wanted. I gave one laya, and he actually didn't give the right laya; then I changed it. So he got very mad! He just stopped and looked at me: I didn't know how to react! I didn't do anything – he then started. He was just trying to say: "You cannot do this to me, you cannot tell me what laya I should play."
> Ranjani Ramachandran, singer – Interview, Pune, 19 Feb 2010

The shared knowledge of tala structures, then, affords a high degree of coordination and common ground, a felicitous sense of cooperative interaction and mutual tuning-in. It also organises specific relationships that are potentially or actually antagonistic.[43] Tala organises a musical interaction in such a way that an individual invites others present to share a temporal structure that he has chosen. Everyone present knows that the process of sharing this temporal flow may be a rewarding one. They also know that it may require them to adopt a submissive attitude towards a leader. Is embodying such a position also felicitous? If not – if, for example, it seems to imply subservience to a younger musician – then can this leadership be contested without compromising the positive outcomes hoped for?

In many years involvement in this musical culture as listener, I have observed some – but in truth very few – occasions on which such tensions have resulted in a breakdown of communication between musicians, and consequent failure to achieve even the most basic of performance aims. Rather more often, performance operates in a less clearly defined mode in which individuals may or may not be engaged in contest of some form. Is the tabla player deliberately playing slightly slower than the main artist wants? Or is he struggling to understand what is required? Or is he doing what was requested, but nonetheless being implicitly scolded by a main artist who simply wants to make a statement of his

[40] Schütz (1951).
[41] Marsh et al (2009).
[42] See Blacking (1977); Emile Durkheim's influence was strong on both Halbwachs and Blacking.
[43] Clayton and Leante (2015).

own leadership? Are the musicians really competing to see who can play fastest and most brilliantly? Or are they complicit in presenting a staged performance of faked antagonism that does not in fact reflect their real investment in the event? Such issues are often unclear, because musicians tend to be complicit with each other at least in as much as any true antagonism should be concealed from the audience. In any event – teamwork, antagonism or some indeterminate or ambiguous state in between – these interactions are framed by the shared knowledge structure that is tala.

If the view outlined is to be productive, it requires more detailed ethnographic and interpretive work on a range of musical genres. In the case of Hindustani classical music, if the basic social function of tala is as described above, we might ask if specific talas – and specific tempi – have particular, nuanced social functions, or simply supply variety and the option to fit given texts or melodic patterns in different rhythmic configurations. Given that the organisation of performing ensembles varies, including in the extent to which they are strictly hierarchical or tending to egalitarianism, how does this variety – and arguably a historical trajectory towards the latter – interact with the social affordances of the tala system? Can both hierarchical and egalitarian groups be organised by the same system, or does change in the former correlate in some way with change in the latter? Does the rhythmical structure of music exert an influence on social institutions, or vice versa? Possible questions are legion, and the more abstract they become, the more likely they are to apply to other societies and other musical forms.

6. Conclusions

Musical rhythm is irreducibly social in nature. The social origins and functions of rhythm have been proposed many times in the past – Halbwachs and Sachs are not the only scholars to have made such a proposition – but recent work in music psychology and ethnomusicology allows us to reframe the argument in a new way. In this view, musical rhythm originates in both endogenous physiological rhythms *and* the dynamics of interaction between individual human beings. These dynamics lead to often complex forms of emergent structure, and thus musical rhythms are not simply the sum of rhythms produced by individuals. If this point is conceded then the social origins of rhythm are uncontestable, and we may turn our attention to the ways in which cultural variety relates to interaction dynamics that are common to all humans. Nonetheless, in this view the social and the cultural are not set against the 'natural', since the endogenous rhythms of which musical rhythm is built are biological processes, and the dynamics of their interactions follow the same rules as interactions between mechanical systems such as pendulum clocks. The 'social', to put it another way, emerges from the 'natural'.

Human musical rhythm is remarkably flexible, complex and diverse. This diversity suggests that local factors have an important role to play in shaping rhythmic systems: it is less clear how systematically these local factors can be linked to aspects of social organisation. Is it simply the case that given the nature of physiological rhythmic systems and the dynamics of interactions between dyads and larger groups, a huge number of possibilities are inevitably generated and are more or less randomly distributed around the globe? Or is there some identifiable process by which the emergence, selection and refinement of different approaches is driven by (or drives) the development of social institutions and cultural norms? The paucity of plausible theory in this area demonstrates that there are no easy answers.

Aside from the difficult issue of how different rhythmic structures and systems develop, a renewed focus on the social also points us to reconsider the social functions and efficacy of musical rhythm: regardless of where rhythm comes from, let alone what it may be taken to symbolise, what does it *do*? In what ways do different kinds of metre, or non-metrical organisation, afford particular kinds of interaction and attentional focus between individuals? Why might these kinds of interaction be found interesting, rewarding or emotionally satisfying? What can we do, with musical rhythm to guide our interactions, that we cannot do without? The argument presented in these pages is intended, above all, to call for more attention to be given to such questions.

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