

Symmetry in Intercultural Rhythm: A Geometric Perspective on Rhythm in Indian and Balinese Music

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The Kyoto Conference on Arts, Media & Culture 2025
Official Conference Proceedings

Abstract

The Carnatic music of South India and the folk music of the Balinese gamelan are very different genres with unique performance practices, ensembles, tuning systems and traditions. Both genres, however, appear to place precedence on temporal organisation of the music. This paper uses simple geometric tools to analyse a representative composition from each genre in order to acquire an understanding of the mathematics behind their construction. It is revealed that symmetry operates on multiple levels of scale and in complex ways. Through comparative analysis, differences as well as latent similarities in approach to symmetry in rhythm and metre are revealed. Through mathematical abstraction, musical relationships may be made between these and the cyclic rhythmic language of other intercultural genres (such as the music of sub-Saharan Africa). For performers and composers interested in intercultural collaboration, the semiotic translation of rhythmic features facilitates an improved understanding of the music. The results of this quantitative research may enable the contemporary musician to create new music with a hybridised intercultural style.

Keywords: music, symmetry, Carnatic, Balinese, rhythm

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Introduction

The term *symmetry* has been utilised in music and arts discourse with a range of various meanings. At times, the term is empirically employed, based on Euclidean mathematical models, yet it can also be used to represent qualitative and aesthetic principles that relate to a sense of proportion or natural balance.

Historic examples of symmetry in visual art are widespread and include the famous sculptures of Polykleitos (fifth century B.C.E.), and da Vinci's Vitruvian Man (1490). Both artists embraced mathematics and geometry in their art. Plato wrote about symmetry's essential role in nature and the physical world (Weyl, 1952), and broadly integrated philosophical thought with mathematics.

The antonym *asymmetry* seldom indicates a complete absence of symmetry, and the two terms can be rather considered a dualistic monism¹ – essential forces that together create a universal frame of reference (Weyl, 1952).

“Symmetry signifies rest and binding, asymmetry motion and loosening, the one order and law, the other arbitrariness and accident, the one formal rigidity and constraint, the other life, play and freedom” (Frey, 1949).

Unlike other artforms that are bound in time such as painting or sculpture, music is temporal in nature. Whilst musical time operates in one dimension, it is useful to visually represent its evolution in two-dimensional space. The benefits of this approach include that fact that two-dimensional objects elucidate cyclical patterns which are common in music, and secondly, such objects elucidate inter-relationships including those occurring synchronously.

This paper translates symmetrical principles from mathematics into the world of musical rhythm, supported by geometric diagrams. These visual representations allow the reader to gain insight into musical design regardless of whether they are a musician with music literacy skills or whether they are familiar with the genre or its performance practice.

Principles of Symmetry

Invariance

Invariance refers to the constancy of properties during a process of transformation.

“Symmetry means you have a distinction without a difference” (Wilczek, 2010). In music, the principles of repetition, contrast and development combine to create structure, and a sense of flow, direction, and journey for the listener. Contrast maintains interest. Repetition establishes hierarchy through reinforcement of material of primacy importance, whilst development (or variation) focuses upon the principle of likeness with difference that underpins narrativity in music (Lundy et al., 2010). Both repetition and development involve invariance, and provide a suitable environment for symmetrical processes.

¹ The yin-yang symbol of Chinese philosophy is an example.

Proximity of Perspective

As with any analysis, the proximity of perspective needs to be determined. Symmetries may operate on any level, from macroscopic global symmetries involving over-arching structure, through to microscopic local symmetries.

Axis of Reflection and Degrees of Symmetry

In mirror symmetry the *axis of reflection* is an imaginary line that bifurcates an object into two identical halves.² This axis appears as a pink dotted line in this paper's diagrams. Sometimes two or more axes exist, indicating there are multiple ways to create reflections. In rotational symmetry, multiple *degrees of symmetry* may exist, which means the object is invariant when rotated in portions of 360° .³

Symmetry in Euclidean Geometry

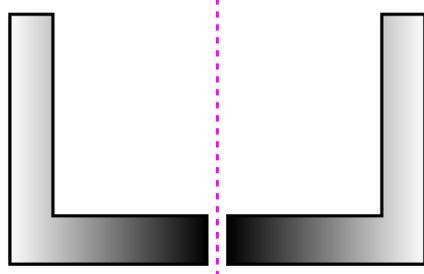
The following categories of symmetry from Euclidean two-dimensional plane geometry are useful for analysing the temporal features of music.

Bilateral Symmetry

Bilateral symmetry (alternatively *mirror* or *reflectional* symmetry) is commonly inferred when the term *symmetry* is used alone. Bilateral symmetry shows invariance about an axis, where one part is a reflection or mirror-image of another part. As music is typically visually represented as being executed along a horizontal plane of time, symmetries about the vertical (y) axis in music are temporal, whilst symmetries about the horizontal (x) axis involve pitch.

Figure 1

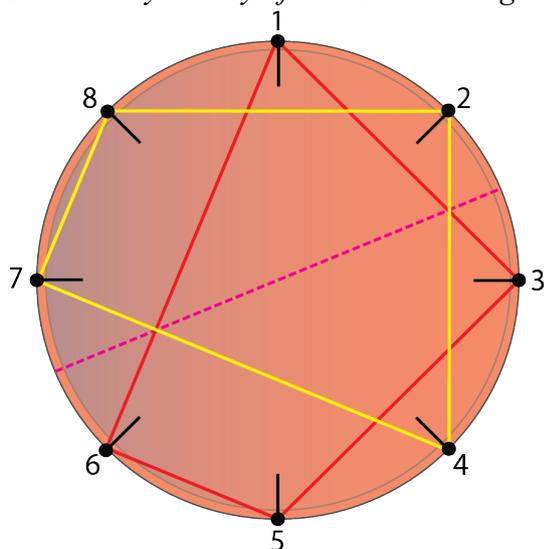
Bilateral Symmetry About the Vertical (y) Axis



The geometric diagrams in this paper elucidate symmetry in musical time. The circular clock-like diagrams represent a clockwise flow of time, normally orientated to start at 12 o'clock. Metrics around the circumference of these *timelines* indicate isochronous divisions of the timeline's period (like seconds on a clockface). Black dots on the circumference indicate the occurrence of a rhythmic event, or *onset*. Polygons connect onsets, and colour coding indicates meaningful relationships or patterns formed by groups of onsets, as in *motives* or *phrases*, or relationships between different musical voices. See Figure 2.

² The separating distance between reflected forms is the *interval of reflection*.

³ For example, a rectangle has 2 degrees of symmetry, an equilateral triangle has 3, and a circle has an infinite number.

Figure 2*Bilateral Symmetry of Two Interlocking Rhythms on a Timeline***Translational Symmetry**

The duplication of an object by a specific distance along a fixed straight line creates *translational symmetry*. Rhythm in time represents the most intuitive representation of the straight line, with its intrinsic homogeneity and constituent metrical units (Voloshinov 1996). In music, translation about a vertical (y) axis sounds as rhythmic repetition, whether it be of an onset, or a group of onsets that form a motive or phrase that repeat to create an *ostinato*.

Figure 3 represents translational symmetry arising from three repetitions of the initial (left-most) object, about a vertical axis. The green arrow indicates the direction of translation.

Figure 3*Translational Symmetry About the Vertical (y) Axis*

Figure 4 illustrates translational symmetry as a wallpaper diagram. The source material is the musical 4-part round *Frère Jacques*.⁴ Each row represents a different voice, and each coloured block represents a discrete 8-beat phrase, being the interval of translation.

⁴ Whilst pitch is not the focus of this paper, readers will find it easier to track the symmetry by singing the words and/or pitch of this melody to themselves. Readers unfamiliar with this melody may wish to listen to this example: https://youtu.be/Pa2_oWshsRM?si=iKfrf2J_02vJSmOu

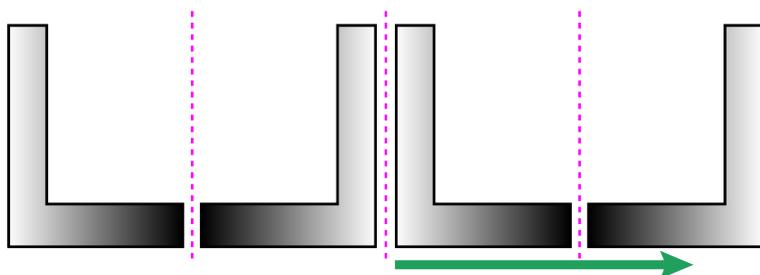
Figure 4
Translational Symmetry in “Frère Jacques” on a Wallpaper Diagram



Compound Symmetry

Compound symmetry combines multiple types of symmetry. For example, *glide reflection* takes a bilateral reflection and then applies translation.

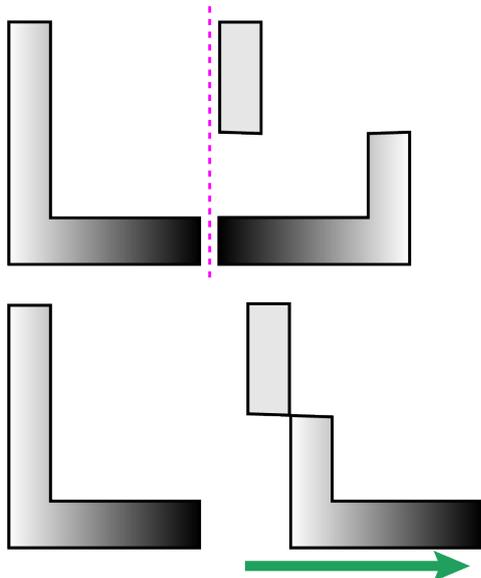
Figure 5
Compound Symmetry – Glide Reflection



Shear Symmetry

Shear symmetry exists when any of the aforementioned symmetries occur in an approximate manner, with transformations occurring non-uniformly.

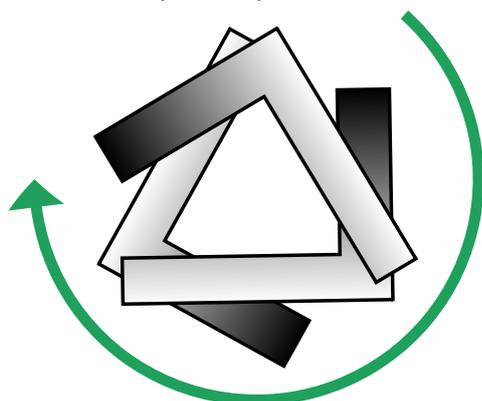
Figure 6
Shear Symmetry – Bilateral (Upper) and Translational (Lower)



Rotational Symmetry

Translational symmetry about an angled path instead of a straight line creates *rotational symmetry*. Whilst the circular diagrams in this paper might illude to the presence of rotational symmetry, they represent the one-dimensional parameter of rhythm, whose symmetries are inherently bilateral or translational.⁵ Figure 7 possesses three degrees of rotational symmetry.

Figure 7
Rotational Symmetry



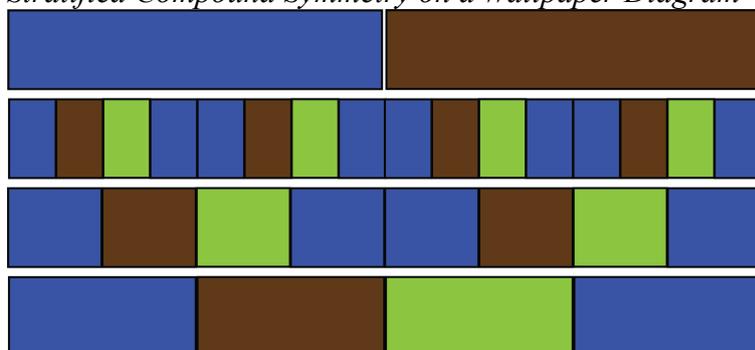
Symmetry Beyond Euclidean Geometry

Musical analysis precipitates further categories of symmetry beyond Euclidean two-dimensional plane geometry. I nominate the following to further comprehend the symmetries deeply inherent in the music analysed in this paper.

Stratified Compound Symmetry

Compound symmetry may apply to more than one musical entity simultaneously. Superposition of symmetries over the same period may create stratum of bilateral and translational symmetry as well as symmetries that overlap. See Figures 8 & 14.

Figure 8
Stratified Compound Symmetry on a Wallpaper Diagram



⁵ For a discussion on the musical application of rotational symmetries in musical composition, refer to Dimond (2018). We will see examples of bilateral, translational, shear and compound symmetries in the musical analyses.

Self-Similarity

Sometimes symmetrical patterns occur at different orders of magnitude. Stratum of bilateral and translational symmetry may occur locally and globally in a related manner. Scaling, recursion and geometric sequencing⁶ indicate the presence of *self-similarity*. Self-similarity shares a relationship to the principles of symmetry due to the presence of invariance under transformation.

Fractured Symmetry

Symmetry in music may occur in a nonlinear manner. Musical phrases or sections maybe highly correlated but the symmetry they embody is interrupted by periods of time. *Fractured symmetry* is present in the musical analyses, where periodic, nonlinear yet non-sporadic symmetry occurs.

Application of Symmetry to Temporal Musical Parameters

Musical time has different parameters which may be symmetrically organised.

Duration

A rhythmic phrase or motive may be represented numerically by the interval of time between successive onsets. These inter-onset intervals may be symmetrical, and may operate at the microscopic level of a motive, e.g. <3-2-3>.⁷ Larger examples of symmetry occur when a sequence of motives are strung together, such as in the *yati* patterns of South India.⁸ *Yati* categories bear names derived from their visual analogs. Refer to Figures 9 to 13.

Figure 9

Gopuccha Yati (“Cow’s Tail”) <5-4-3-2-1>

12345
 1234
 123
 12
 1

Figure 10

Srotogata Yati (“Stream Becoming a River”) <1-2-3-4-5>

1
 12
 123
 1234
 12345

⁶ Scaling involves invariance of proportion whilst the overall size changes. Recursion involves reiteration of a pattern in a self-referential manner. Geometric sequences differ from arithmetic ones in that they involve multiplication or division (rather than addition or subtraction).

⁷ Triangular brackets enclose a series of inter-onset intervals, with each integer representing the duration between onsets.

⁸ For more detail on *yati*, refer to Dimond (2018).

Figure 11*Sama Yati / Pipilika Yati* (“Ant Row”) <8-8-8-8-8>

12345678

12345678

12345678

12345678

12345678

Figure 12*Mridanga Yati* (Barrel-Shaped Like the Mridangam Drum) <1-2-3-4-5-4-3-2-1>

1

12

123

1234

12345

1234

123

12

1

Figure 13*Damaru Yati* (Hour-Glass Shaped Like the Damaru Drum) <5-4-3-2-1-2-3-4-5>

12345

1234

123

12

1

12

123

1234

12345

There is also the *vishama* (“irregular”) *yati*, which is asymmetrical.

In the analysis of rhythmic symmetries, it is worth noting that the measuring point is taken as the starting onset of any duration, rather than the mid-point of the duration.⁹ A discrete phrase or motive may also be separated by gaps or rests, called *karvai* in Carnatic music, which may be articulated by an initial onset. The value of such gaps is indicated in brackets in the analyses.

Number of Onsets

The number of onsets or attacks within a phrase or motive may be represented numerically and may show symmetrical properties. For example, the duration of the three phrases <1-1-1-1-1>, <2-2-1-1-1>, and <2-2-2-2-1> is 5, 7 and 9, respectively, yet they all have 5 onsets.

⁹ Rhythms are identified by where the attack begins, not by their duration. For example an inter-onset interval of 3 is measured from the first attack, not its mathematical midpoint (position 1.5 in the duration).

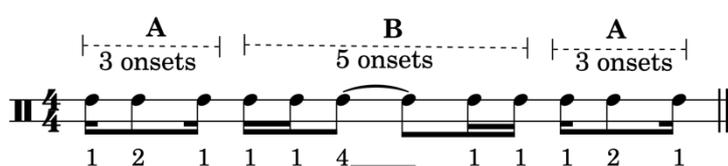
Form

Meta structures that involve repetition, contrast and/or development may show symmetrical properties. On a macroscopic temporal scale, bilateral and translational symmetry can operate upon musical structure, as represented by the formal analysis ABA or AAABBBCCC.

Symmetrical structures may arise from patterns that act upon different temporal features at once, and at different scales of resolution. Figure 14 is a rhythmic example of stratified compound symmetry, with bilateral symmetry contained in the series of inter-onset intervals per motive, number of onsets across the three motives, and the duration of the three motives across the entire phrase.

Figure 14

Stratified Compound Symmetry in a Rhythmic Phrase



Analysis 1: 75 *Akshara Korvai* (Guru Karaikudi R. Mani)

Background and Overall Structure

The mridangam maestro Guru Karaikudi Mani (1945–2023) composed this Carnatic piece for his 75th birthday.¹⁰ It is performed purely as a percussion ensemble in the *tani avartanam* format, based on a *korvai* (“strung together”) structure.¹¹

Rhythm and metre in Indian classical music have a strong mathematical basis. Ideas are naturally conceived, constructed and communicated using integers and arithmetic. The rhythmic language of *konnokkol*¹² (in the South) and *bols* (in the North) are powerful languages that are onomatopoeic in nature and not only serve mnemonic purposes, but carry semantic association to the integers and mathematics behind the music. Guru Mani exploits this association by symbolically integrating and featuring the integers 7, 5, and 75 into his composition.¹³

The overall meta structure is binary, which is typical of *korvai* pieces, with a *purvangam* (first part) and contrasting *uttarangam* (second part). Guru Mani designed the composition to fit a duration of 75 beats (or *aksharas*, per the title). It is set to a rhythmic cycle of 3 beats (*rupaka tala*). Both halves of the meta structure contain three subsections. Figure 15 ascribes labels to the main parts and subsections.

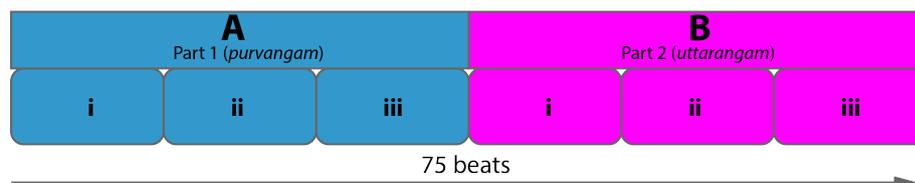
¹⁰ A performance of this composition appears on YouTube <https://youtu.be/WuCP2Ck3IYk?si=okFrjx6fOgNoPov>

¹¹ Adrian Sherriff later composed pitches to the rhythms of Guru Mani’s composition and this has been performed by the ensemble Tripataka https://youtu.be/EYh4Ag1WSxc?si=6L0dASilAwv-_0xp

¹² Also known as *solkattu*.

¹³ The Tamil term *kanakku* refers to the mathematical calculations necessary for artists such as Guru Mani to compose and improvise structured rhythmic sequences that comply with specific rhythmic cycles.

Figure 15
The Overall Structure of 75 Akshara Korvai



Guru Mani devised the series of sections to increase in density from the beginning to the end, through the incremental increase in subdivisions per beat, starting with 4 divisions per beat (*chatusra nadai*), then subdivisions of 5 (*khanda nadai*), 6 (*tisra nadai*), and lastly 7 (*misra nadai*). The whole structure is performed three times. This creates a trivial sort of bilateral symmetry from the series of 18 subsections, as well as translational symmetry from the tripartite repetition.

Part A – Purvangam

The three sections of the part A are represented by timelines in Figures 16 to 18. A duopoly of symbolic integers 7 (yellow) and 5 (red) exist, with an incremental development of the number of groups of each across the three sections. Each section displays bilateral symmetry. The invariance of the position of the axis of symmetry (pink), despite the change of timeline length from 48, to 60 and then 72 pulses in duration, indicates the presence of scaling and therefore self-similarity.

Figure 16
Part A, Section i

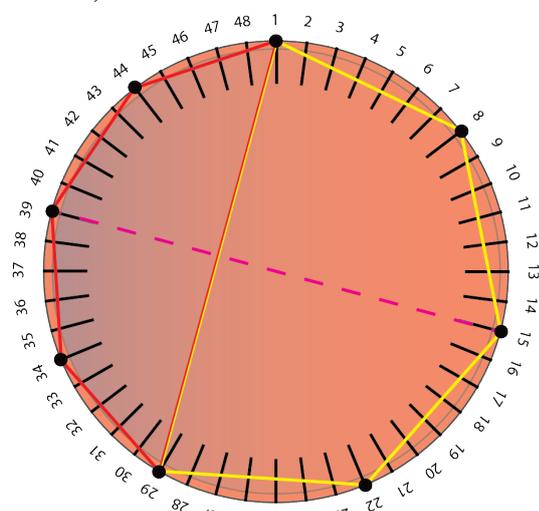


Figure 17
Part A, Section ii

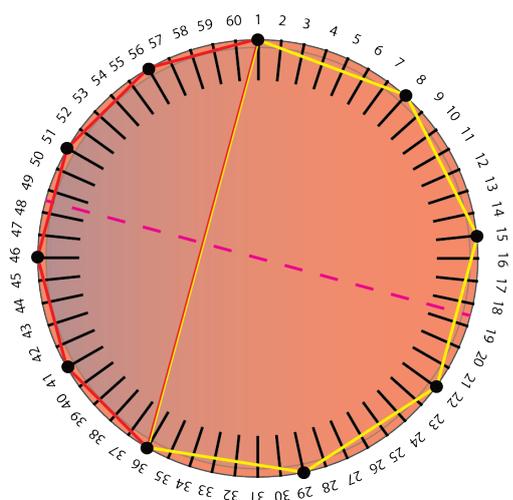
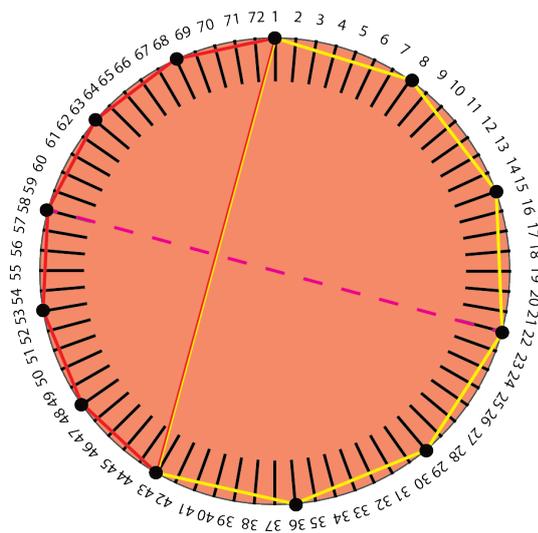


Figure 18
Part A, Section iii



The total number of pulses in sections i, ii, and iii creates an arithmetic sequence as illustrated in Figure 19.

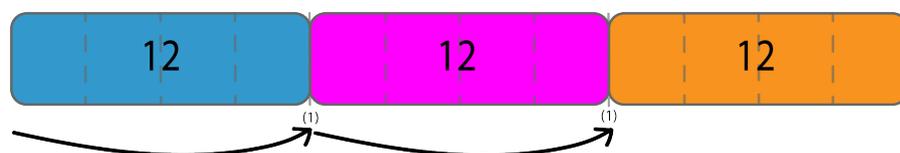
Figure 19
Part A, Total Pulse Count of Sections i, ii, & iii



The translational symmetry created by the duration of this sequence of sections is obfuscated by the presence of rhythmic scaling, where the beat subdivision progresses from 4:1, to 5:1 and lastly 6:1. The increase in total pulse count of each section (60:48 for sections i to ii and 72:60 for sections ii to iii) is balanced by a proportional decrease in the duration of each pulse,

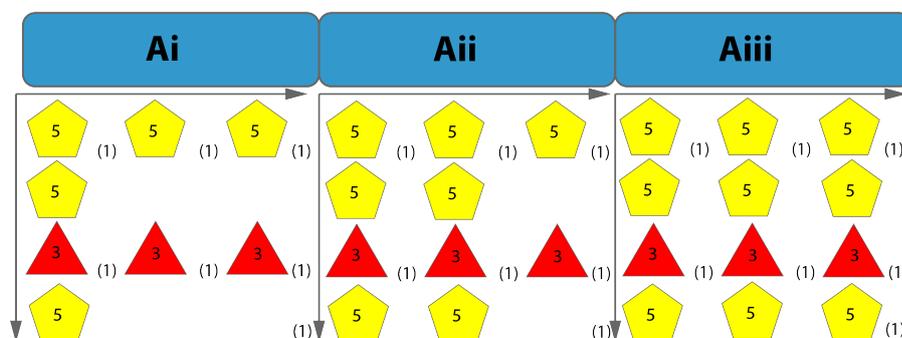
resulting in a scaled duration 12 beats uniformly for each section in part A. Figure 20 illustrates the scaled durations and resulting translational symmetry, expressed in beats.¹⁴

Figure 20
Part A, Scaled Durational Sequence of Sections i, ii, & iii



Guru Mani applies a consistent syntax in the enunciation of the groupings in Part A of the composition that features a 5-syllable word.¹⁵ These 5 onsets recur regardless of whether the duration of the motive is 5 or 7 pulses. Figure 21 tracks the onset structure for this half of the composition.

Figure 21
Part A, Onset Structure of Sections i, ii, & iii



Reading left-to-right and downwards for each section, it can be seen that the first and third rows demonstrate translational symmetry internally and are identical between sections, so possess fractured translational symmetry across the entirety of Part A. The second and fourth rows are identical in each section so demonstrate translational symmetry internally and combine to create a fractured *srotogata yati* pattern across the entirety of Part A (see Figure 10).¹⁶ Part A therefore combines Euclidean and nonlinear symmetries in the pattern of onsets.

Part B – *Uttaragam*

Part B is rendered consistently at the fastest rate of 7 divisions per beat (*misra nadai*). The three concentric circles in Figure 22 represent sections i, ii, and iii, commencing with the innermost circle at 12 o’clock and advancing outward after each 360° rotation with a kind of centripetal force.

¹⁴ Sections i, ii, and iii of part A have one beat of rest between them, demarcating the structure.
¹⁵ The five-syllable word *ta-di-ki-na-dom* is the one recited in the recorded performance.
¹⁶ This kind of non-linear symmetry that operates across meaningful subsections is something we will discover in the subsequent Balinese case study.

Figure 22
Part B, Sections i, ii, & iii

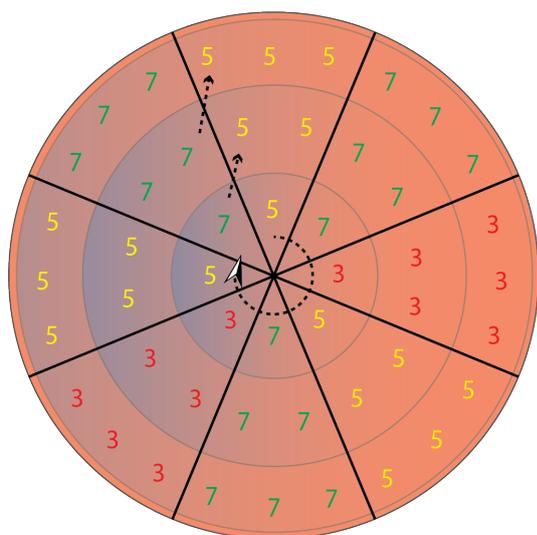
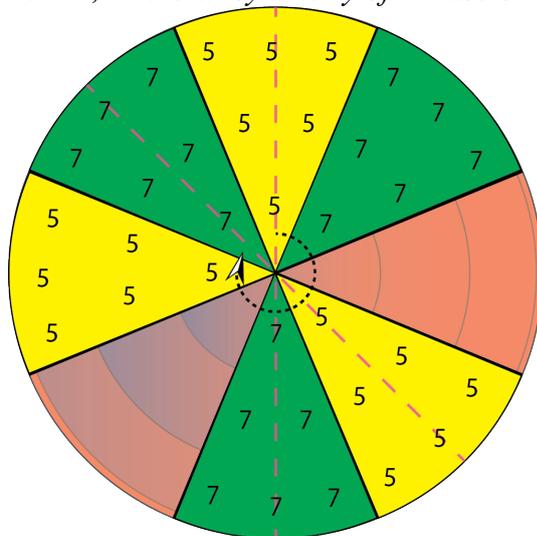


Figure 23 distinguishes the associated phrases of duration 5 and 7 from the rests of 3 (which are articulated gaps, or *karvai*). Yellow and green colour coding highlights the bilateral symmetry associated with the 5s and 7s, respectively.

Figure 23
Part B, Bilateral Symmetry of Phrase Structure in Sections i, ii, & iii



Whilst the phrases of part B possess fractured translational symmetry, they also combine to create an overarching *srotogata yati* with its associated growth and bilateral symmetry, similar to part A.

In part B the total duration of the sections increases geometrically, in contrast to part A (per Figures 19 and 20). Sections i, ii, and iii are 6, 12, and 18 beats long, respectively (or 1x, 2x, 3x). See Figure 24.

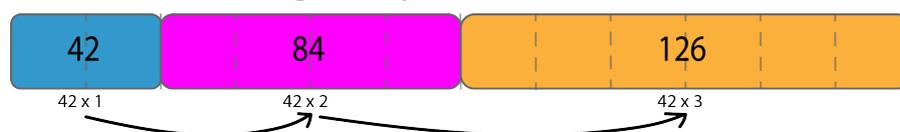
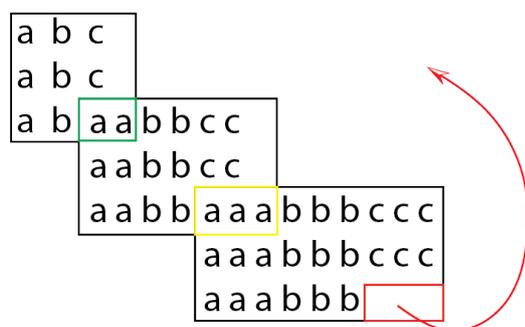
Figure 24*Part B, Durational Sequence of Sections i, ii, & iii*

Figure 25 reveals the tripartite structure so essential in the design of Indian classical music, as well as its circular nature that directs each sequence to its point of origin.¹⁷ The three phrase lengths (5, 7, 3) are represented a, b, c, respectively. The translational symmetry internal to each of the three sections gives the listener the expectation of the arrival of the third portion of the third repeat (logically phrase c). This expectation is foiled through the dovetailing of each successive section (illustrated by the overlapping rectangles).¹⁸ The resulting shear symmetry of each of the three individual sections is reconciled by the progressive macroscopic three-stage growth of this sequence and overarching *srotogata yati*. Figure 25 illustrates this effect as well as the self-similarity of the tripartite meta structure.

Figure 25*Part B, Phrase Structure of Sections i, ii, & iii*

Analysis 2: *Baris* (Traditional)

The ritual warrior dance *Baris* has been documented as occurring in East Java as early as 1550, and today ritual and secular forms of the dance are commonly included in contemporary performances and temple ceremonies (Dibia & Ballinger, 2004). This analysis is based upon the musical accompaniment contained in the first portion of the modern secular *Baris Tunggal*, as played by the Balinese *gong kebyar* orchestra.¹⁹ Given the lead role of the dancer in this music, the structure and evolution of the music of *Baris* is somewhat dependent on the dancer. I will focus on the stable, repeating elements which the dancer cues.²⁰

Baris is set to 8-beat *gilak* metre. The metric structure is underpinned by the two lowest, slowest-moving instruments, the large *gong ageng* (playing beats 1 and 5) and the medium-

¹⁷ Three-stage translational symmetries that resolve (or *cadence*) onto beat 1 (*sam*) of given rhythmic cycles are ubiquitous in both North and South Indian classical music, as found in *tihai* and *arudi*.

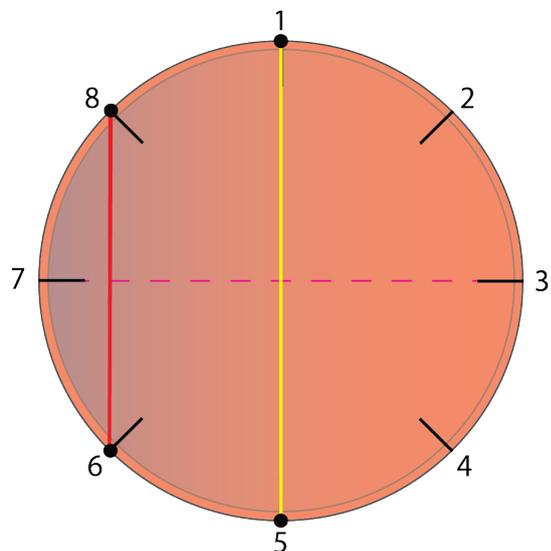
¹⁸ After Part B is concluded, it returns to the start of Part A – a greater tripartite translational symmetry and part of the piece's overall self-similarity.

¹⁹ Numerous recordings can be accessed via YouTube and published recordings. This analysis is based upon the version performed by the STSI Academy, Kodya, published in the CD that accompanies the book *Balinese Gamelan Music* by Michael Tenzer.

²⁰ Any mention of pitches in this analysis result from observation of the metallophone percussion instruments on the aforementioned recording. Rhythmic organisation of these pitches remains the primary focus of this analysis.

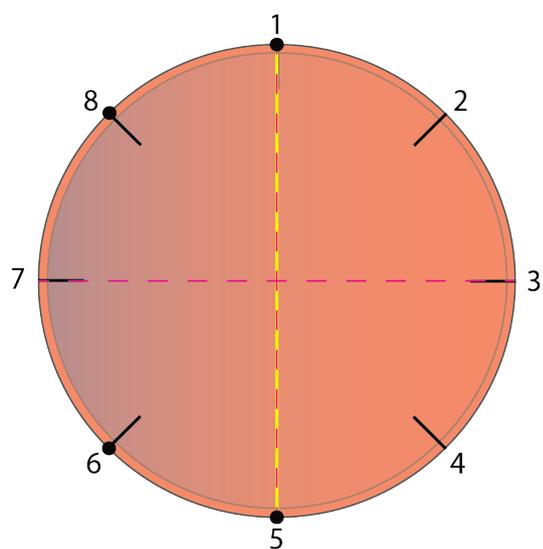
sized *kempur* gong (playing beats 6 and 8). These combine to create a bilaterally-symmetrical pattern.

Figure 26
Composite Gong Pattern for Gilak Metre



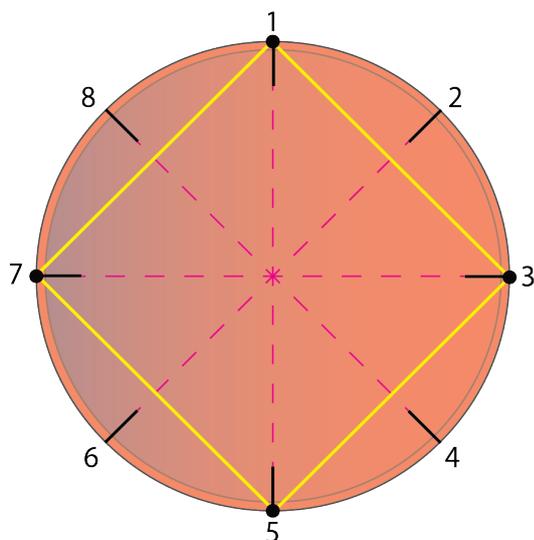
The large bronze keyed metallophone *jegogan* supports this metric structure.

Figure 27
Jegogan Rhythmic Pattern



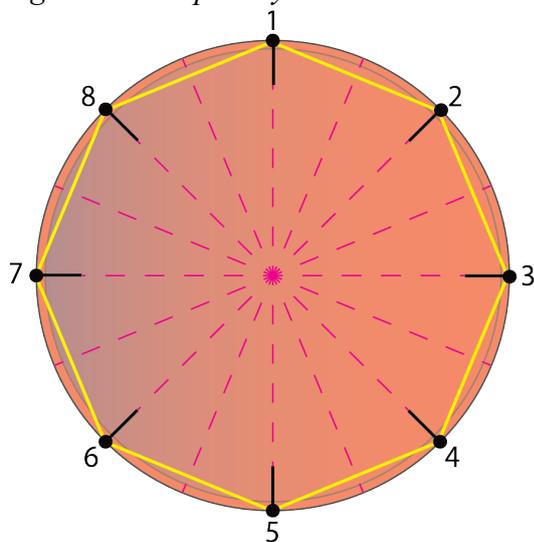
Above this metric structure sits the core melody played on the medium-sized bronze keyed metallophone *calung*.

Figure 28
Calung Rhythmic Pattern



The 8-beat metre is articulated by the small, dry gong *kempli* with an isochronous pattern which reinforces the prevailing tempo. This is also the rate of the core melody, played on the medium-sized bronze keyed metallophone *ugal*.

Figure 29
Ugal and Kempli Rhythmic Pattern



The pair of smaller bronze keyed metallophones *pemadé* and *kantilan* duplicate the melody played by *ugal* but with two equidistant attacks per note.

It is now necessary to consider some pitch elements of the Balinese *gong kebyar* orchestra in order to elucidate the rhythmic symmetries deeply woven into this music. The pitch collection for *Baris* is the five note scale *pélog*. Four pitches from this pentatonic scale are used to sound the simple isochronous melody on the *ugal* (per Figure 29).²¹ Figure 32 presents this melody in Western notation, with note names and Balinese solfege.

Figure 32
Pokok Melody in Western Notation With Balinese solfege



Figure 33 presents the *polos* (lower) and *sangsih* (upper) *kotekan* parts in Western notation. The *pokok* (melody) is also presented with arrows indicating how its four melody notes are embedded into the *kotekan empat* over the course of the 8-beat cycle.

Figure 33
Polos and Sangsih Parts in Western Notation, Showing Relationship to Pokok

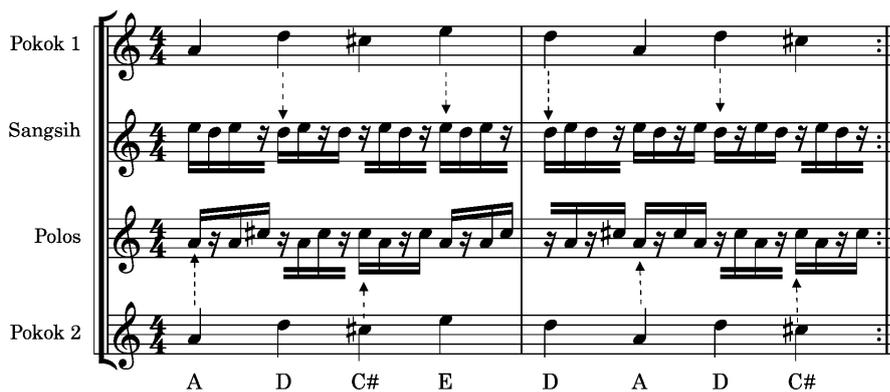
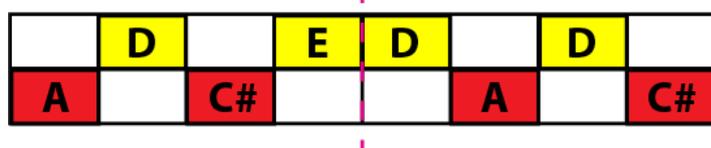


Figure 34 represents the eight notes of the *pokok* melody that coincide with the *polos* (lower – red) and *sangsih* (upper – yellow) *kotekan* parts in a box diagram. The bilateral symmetry of this pattern is evident from this diagram and Figure 35, which illustrates the same pattern on a timeline. The combination creates a *reflection rhythm*. Reflection rhythms are created when a mirror-symmetric image of a rhythm (about some axis of symmetry) becomes the rhythm’s complement (Toussaint, 2013).

Figure 34
Polos and Sangsih – Kotekan Alignment With Pokok



²¹ The 4 notes being the *selisir* mode of C# (ning), D (nong), E (neng), and A (nang).

Figure 37
Polos and Sangsih Kotekan Dyad Orchestration as a Box Diagram

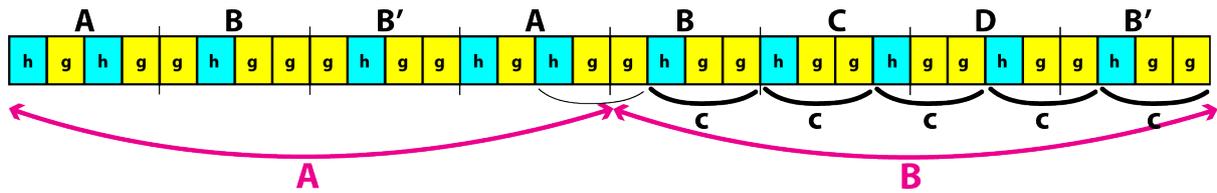
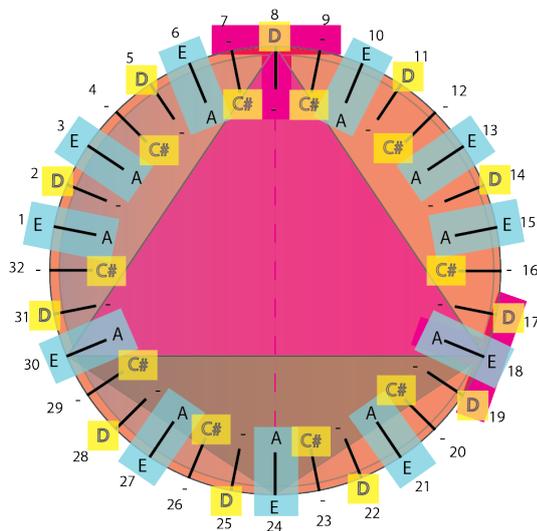


Figure 38 presents the *polos* (lower) and *sangsih* (upper) *kotekan* parts on a composite timeline, using the same colour coding. Whilst Figures 36 and 37 revealed symmetries by partitioning pitches or dyad cells into groups of 4 or 3 from pulse 1–32, this timeline reveals two offset structural symmetries overarching the 32 pulses. The timeline is rotated²² so that pulse 8 appears at 12 o’clock in order to more easily appreciate the symmetrical design.

The pattern of harmonic dyads (light blue) creates bilateral symmetry over the entire 32 pulses. This is easily viewed by this timeline’s rotation, whereas the skewed axis of the original series of inter-onset intervals obfuscates the symmetry.²³

The timeline also reveals fractured symmetry with two bilaterally-symmetrical portions. The first, indicated by the pink triangle and dotted line, reveals bilateral symmetry from pulses 30 through 18, orientated around a unique gap dyad that serves as a kind of fulcrum on pulse 8 (at 12 o’clock). For the second portion consisting of the remaining pulses 19 through 29,²⁴ a bilaterally symmetrical arrangement of harmonic dyads continue, however the gap dyads sound in opposite voices either side of the axis of symmetry – there is a voice inversion about pulse 24.

Figure 38
Polos and Sangsih – Kotekan Timeline Rotated by 7 Pulses



²² By 78.75° or 7 pulses counterclockwise.

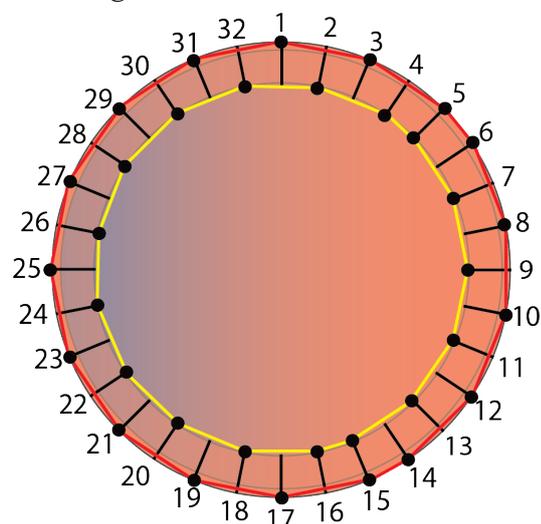
²³ The inter-onset interval series from pulse 1 per the prior box diagrams is <2-3-4-3-2-3-3-3-3-3>.

²⁴ This symmetry can also be seen by overlapping the primary symmetry, counting from pulses 18 through 30 inclusive, as illustrated by the brown triangle.

Lastly, the barrel-shaped *kendang* drums contribute their own texture and layer to the gongs and metallophones. A pair of *kendang*, *wadon* (the “female” lower part) and *lanang* (the “male” upper part) are orchestrated to create a two-part interlocking pattern like *kotekan*. Figure 39 shows the Western notation for the drums along with their onomatopoeic stroke names, and Figure 40 a 32-pulse composite timeline (with the *wadon* part in red and *lanang* part in yellow).

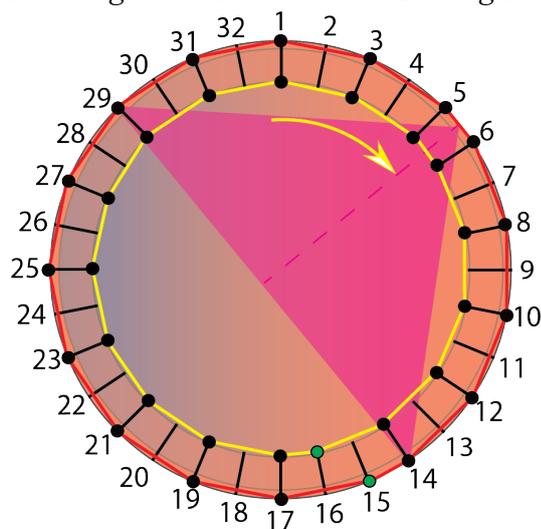
Figure 39
Kendang Parts in Western Notation

Figure 40
Kendang Parts Timeline



In the second half (pulses 17–32) the two parts are identical except that one is a displacement of the other by 1 pulse. This simple symmetrical translation creates another reflection rhythm and complies with the *kotekan* category *nyog cag*, which tessellates the pulse stream without coincident onsets between the parts.

The symmetry of the remaining portion is revealed when the upper *lanang* part (yellow) is rotated clockwise by one pulse, as illustrated in Figure 41.

Figure 41*Kendang Parts Timeline With Lanang Rotated by 1 Pulse*

There are two types of symmetry in the first portion. The rotated *lanang* part reveals translational symmetry between both drums, which play the same pattern from pulses 29–14 (originally displaced by 1 pulse).²⁵ Furthermore the pattern shared by both parts is internally bilaterally symmetrical, as indicated by the pink triangle.

The bilateral symmetry from pulses 29–14 is offset with respect to pulse 1, and applies to only half of the pattern, much like it was for the *kotekan* on the *reyong*. Two “disruptor” onsets (on pulse 15 and 16, indicated by the green dots) separate the *kotekan nyog cag* of the second portion (where the two parts are translations of each other, displaced by one pulse unit and with no coincident onsets), from the first.

Comparative Analysis

Rhythmic Cycle and Tempo

Both the Indian and Balinese traditions to which the analysed compositions belong have rhythmic cycles as the basis of their deep structure. The metric treatment differs between the 8-beat cycle of *Baris* and the 3-beat cycle of *75 Akshara Korvai*. In *Baris* the maximum subdivision of the beat is 4, and the longest phrases two cycles (e.g. the *kotekan*), so the longest repeating phrase period is 32 pulses. In *75 Akshara Korvai*, the beat is subdivided into as many as 7 parts, and furthermore, structural units (such as Part B) can span some 252 pulses. Indeed, the piece’s title specifies the vastly larger number of beats in one iteration of the composition.

Whilst tempo fluctuations (called *ombak*) are central to the narrative of the *Baris* dance performance, the Indian aesthetic is to hold the tempo stable (albeit with slight increases of speed acceptable as part of the build of excitement in the performance practice). The *kendang* drums lead tempo fluctuations in the *Baris* (based on the movements of the dancer),²⁶ whilst the most senior *mridangam* player (in this case, Guru Mani) sets the stable tempo in Carnatic percussion ensembles.

²⁵ This category of *kotekan* is called *kotekan norot*, which is similar to *kotekan nyog cag* except it permits coincident onsets.

²⁶ It is said the *kendang* are the equivalent of the Western orchestra’s conductor (Spiller 2008).

In *75 Akshara Korvai*, the piece gives the illusion of tempo increase through the systematic increase in subdivisions per beat (from 4 to 7 divisions), thus increasing density whilst maintaining tempo. The triple execution of the total structure may also give a slight feeling of tempo “waves,” as the composition reaches its climax in 7 divisions and then reverts to 4 divisions as it returns to the beginning. However, the approach to cycle and tempo are fundamentally different.

Orchestration and Texture

The Carnatic and Balinese musical traditions not only share a basis upon rhythmic cycles, but they also both musically articulate them. In the *gong kebyar* ensemble, the gong pattern underpins the meta structure of the 8-beat cycle, supported by the isochronous *kempli*, *jegogan* and *calung*. This approach to timeline foundation is known as *colotomy*. In the Carnatic tradition a system of hand claps, finger counts and waves articulates the beat and metre. In *75 Akshara Korvai* the reciter performs this role of keeping the *tala* (rhythmic cycle).

The vertical stratification of the rhythmic elements in *Baris* is designed in such a way that prioritises the resulting combination over the individuality of the parts. That is, the interlacing of the individual parts generates a tessellation of the temporal framework, coloured by the pitches and timbres of the various instruments in the ensemble that create resultant melodies and rhythms that are not achievable or contained by one instrument alone. Furthermore, the fast tempo of interlocking *kotekan* passages creates acoustic combing effects that may disorientate the unaccustomed listener. The result is a kind of perceptual rivalry multiplicity in perception not unlike the temporal features of the music of West Africa and the West African diaspora (Pressing 2002).

The organisation and hierarchy of the Balinese gamelan is compared metaphorically with the design of a tree,²⁷ and it is this vertical stratification of texture which contrasts strongly with the linear morphology of the Carnatic compositional approach. In *Baris*, various layers of orchestration are superimposed over the course of the performance, supporting the dancer, their movements and the narrative. In *75 Akshara Korvai*, all the instruments sound in unison at all times, forming a monophonic texture. Musical interest arises from the chronological evolution of the compositional ideas, established through the motivic syntax of the composition and the vocabulary and idiosyncratic developmental techniques of the tradition.

Axial Orientation, Compound & Fractured Symmetry, Self-Similarity

75 Akshara Korvai features symmetrical *yati* structures within the protocols of *korvai* composition. The “strung together” meaning of *korvai* manifests in the contiguous nature of many of the symmetrical designs, which evolve over contiguous sequences of time. However many of the deeper rhythmic patterns in this composition are nonlinear, in that the sequential relationships occur in a disjunct manner. These symmetries operate across multiple rhythmic cycles, and others are automorphisms that relate across different scales of magnitude.

The vertical stratification of the instruments in the Balinese gamelan lends itself to compound symmetries. Numerous stratified compound symmetries are found in *Baris* when considering vertical relationships between different instruments. Some of the symmetries are fractured or

²⁷ See Tenzer p.52.

nonlinear, and others skewed with respect to the cycle, contributing forward momentum to the music, contrasting the colotomic nature of the isochronous layers.

Conclusion

Whilst the Carnatic music of South India and the folk music of the Balinese gamelan differ in so many ways, with their unique performance practices, ensembles, tuning systems and traditions, the analyses of *Baris* and *75 Akshara Korvai* show that both possess manifold symmetrical properties in the temporal organisation of the music from the microscopic to macroscopic. Both genres are underpinned by periodic rhythmic cycles that create large-scale form with similar overall performance duration and exhibit symmetrical properties that are not merely translational in a single part. They both employ translational and bilateral symmetry in various ways, including symmetry that is orientated about decentralised axes, compound, and fractured symmetry operating upon multiple scales of magnitude. Analysis of other pieces from both traditions would establish the extent to which translational and bilateral symmetry occur in these genres, and whether fractured symmetry and self-similarity are idiosyncratic.

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