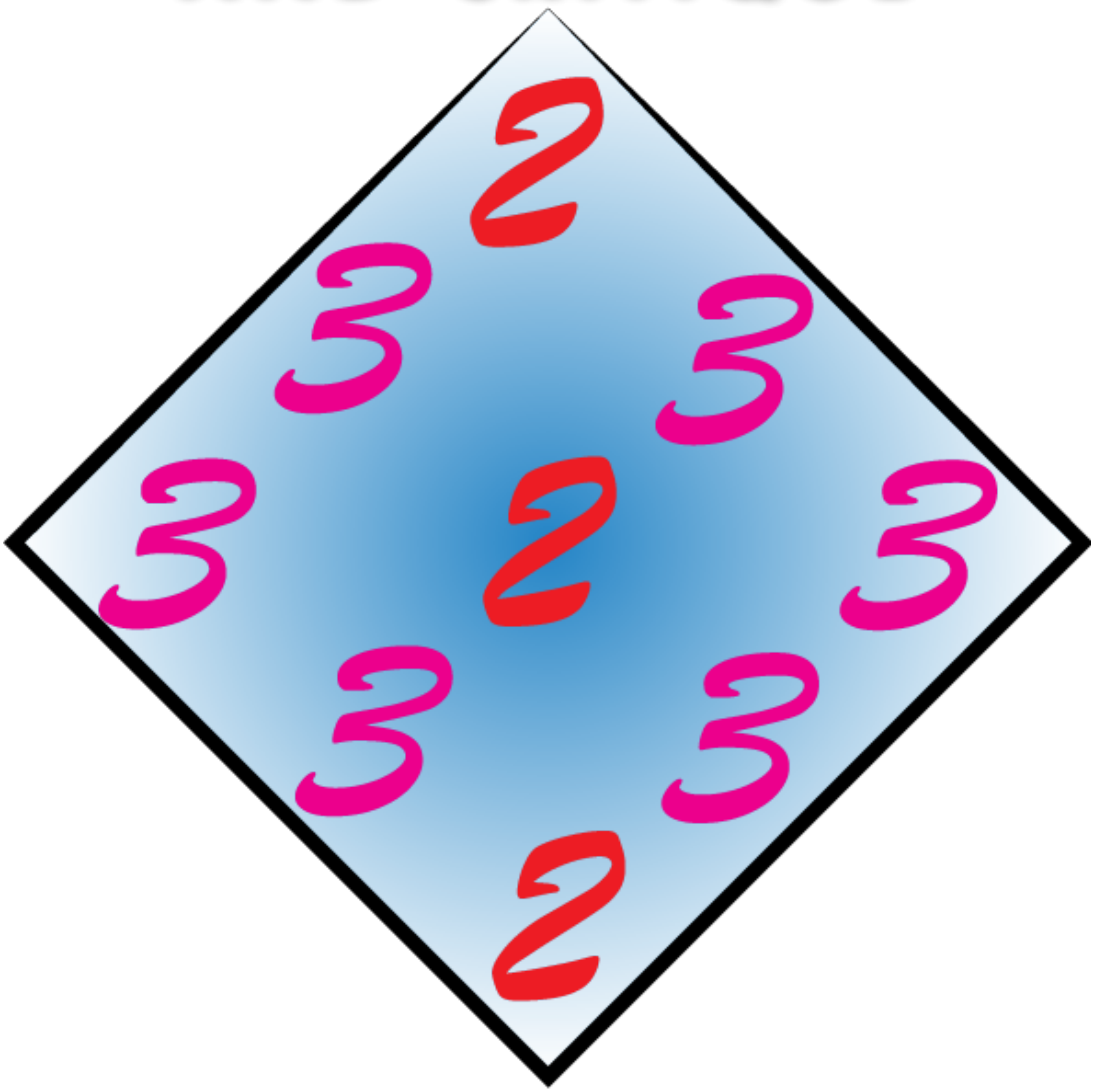
RHYTHM DIAMONDS: AN INTRODUCTION AND CRITIQUE



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INTRODUCTION

WHAT ARE RHYTHM DIAMONDS?

Rhythm Diamonds are arrangements of numeric sequences represented visually in a symbolic manner. Their interpretation is meant to be flexible, and potentially exhaustive of all possible combinatorial pathways through such a sequence.

Given the significant range of possibilities for musical application, the current study restrains the topic to focus on rhythm diamonds in their pure form, as applied to musical rhythm. Some suggestions on application of pitch will also be offered. For a broader look at various interpretations of the principles, including shapes other than diamonds, refer to Sheehan (2021).

GREG SHEEHAN

Greg Sheehan is an Australian percussionist who, through a diverse range of collaborations and creative research, has developed a system which guides his teaching and professional practice, known as *Greg Sheehan's Rhythm Diamonds*. This paper looks at his system as presented in his book *The Rhythm Diaries* (2021), and is best read in combination with that text. Visit Greg's web site at:
https://gregsheehan.com.au/

FOCUS OF CRITIQUE

This paper's objective is to elucidate the Rhythm Diamonds concepts for practising musicians, in order for the reader of *The Rhythm Diaries* to have a clearer understanding and potentially more satisfying application of the knowledge contained within. The book serves not only musicians, however, but also contains a wealth of visual art, historic photographs and so on that provides an aesthetically pleasing function as a "coffee table" book also. This paper does not critique these aspects whatsoever.

FUNDAMENTAL PRINCIPLES

Any discussion between musicians about the principles of time in music involves a negotiation of concepts and terminology not universally understood or agreed upon. Different musical experiences, teachings and traditions will provide context for the terms and principles employed, which may not translate precisely from one tradition – or indeed practitioner – to the next. The definitions offered here have prevailed during my musical experience, but may diverge from your own. They are offered to avoid confusion as the principles of rhythm diamonds are investigated.

BEAT & SUBDIVISION

Beat gains its intrinsic identity from the periodicity of its occurrence. It is therefore essentially mathematically trivial, as its identity, once formed with respect to subdivision, replicates itself *ad infinitum*. Polyrhythm and polymetre exploit the beat-like effect of regular grouping of subdivision to create different illusions, patterns and effects.[1]

One cannot normally speak the true definition of a beat without counting the value of a beat's length with respect to a subordinate measurement of time called the *subdivision* or *pulse*.[2] The subdivision is the atomic unit of time, whose combination forms not only beats (if regularly grouped) but also rhythm as a whole (with all its manifest variety).

METRE

We know that beats are subdivision-dependent from working with simple and compound *metres*.[3] 2/4 and 6/8 metres differ not in the number of beats, but rather in the presence of three pulses per beat in 6/8, as opposed to two pulses per beat (or multiples of two) in 2/4.[4]

Sheehan conflates the terms *beat* and *pulse* throughout his book, and never defines *metre* with respect to these terms even though metres are frequently specified. In chapter 2 Sheehan refers to both the *alap* of Indian classical music and free jazz as examples where there is a "liberation from tempo" and pulse (11). The *alap* of Hindusthani instrumental music will contain three subsections, namely *alap*, *jor*, and *jhala*. These last two sections are very much pulsed, even know there may be no consistent metre. Underpinning the role of metre and

[1] For an investigation of polyrhythm refer to Dimond, chapter 3.

[2] I consider these two terms as synonyms, and will tend to use the former term over the latter as *subdivision* more clearly indicates the presence of a microstructure.

[3] Though the term *metre* is used for consistency throughout this paper, the term *time signature* is equally applicable and is used by Sheehan.

[4] These metres are thus defined as being simple duple and compound duple, respectively.

pulse are the concepts of *nibaddh* (bound) and *anibaddh* (unbound), which refer to musical sections that are formed in *tala* (metre) or not. *Jor*, the second aforementioned section, means "momentum" and does have regular pulse whilst metre is absent (Ruckert p.284). Furthermore, there is plenty of free jazz that is extremely pulsed, even through polyphonically so and again without a consistent metre. I believe it is problematic to make such generalisations in a couple of short paragraphs.

Sheehan proceeds to cite metres from countries such as the Balkans where beat length may vary, citing the "short, short, short, long" sequence found in a version of 9/8 metre. This is true, but it is not the pulse that gives rise to this sound on its own, but rather the grouping of pulse that forms beats of these relative values (short/long). I.e. the pulses are grouped 2+2+2+3 to create the four beats in this example.

Many similar examples of the use of the term *pulse* include page 193, where 15/8 metre is defined as potentially consisting of a "pulse of 5 threes". I would suggest that Sheehan is defining the beat of a value of 3 (subdivisions), and five groups of 3 make the 15/8 metre. The syntactical ordering of the group count and value is contradicted in Sheehan's book. For example the "phrasing sequences" from 3 to 32 (p.16-17) are counter-intuitively ordered in the reverse fashion, such that the aforementioned "pulse of 5 threes", being 33333, is here represented as 3x5.[5]

Sheehan sets up potential confusion for the reader in situations where the total value of a rhythmic sequence is being adapted to different metres. In applying the 7777666554 triangle to "4/4 time" Sheehan suggests manipulating the sequence's total value by adding "4 beats" to increase the total value of the sequence from 60 to 64 – which is divisible by 16. Sheehan's goal here is to make for easy application of the sequence to 4/4 metre subdivided into sixteenth-notes, but this is not made clear by the lack of definition and contradictory use of the term *beat,* as well as the term *phrase* (see below).

Sheehan also conflates the terms *rhythm* and *pulse* in his chapter on pulse, making an analogy with the human heartbeat (which is actually a rhythm) and a correspondence with both these terms (10). Furthermore, Sheehan conflates the terms *metre* (time signature) and *pulse* in his chapter on triangles (81).

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[5] Perhaps detecting this confusion, Sheehan uses red colour-coding and a legend on these pages. The ambiguity remains. Sometimes in my music notation I use circled numbers to indicate the value of the grouping, and in written form speak of the number count of groups in alphabetical format, whilst the size of the grouping in numeric format, e.g. five 3s.

PULSE TRAIN

The distillation of beat and rhythm into its formative subdivisions, and then replicated results in a stream of equidistant events called the *pulse train*.[6] Whether articulated with an attack or onset or not, the pulse train continues as the underlying mechanism that unifies and measures all temporal events. (Imagine a train track with its equidistant sleepers extending out to the horizon whilst you traverse the tracks at a steady pace.) This view of the pulse train caters to the additive rhythmic system and the music of many cultures (including Indian Classical and Western contemporary music) that relies upon steadiness and uniformity from bar to bar and cycle to cycle. The practice of partitioning the pulse train into groups and building sequences is precisely the process required to perform rhythm diamonds.

Experience shows that the acknowledgement of the pulse train is especially critical during moments of silence. That is, it is the unsounded or unarticulated portions of time that need to be carefully accounted for by applying ones internal sense of clock-like time, informed by the pulse train.

In Sheehan's chapter on The Pulse (pp.10-13) he acknowledges the relationship of pulse to tempo but also likens it to "our mother's heartbeat" (which is a rhythm not a pulse nor beat), to the cosmic ratios of planetary orbits (which he correctly acknowledges as "cycles"), and points to the inherent principles of "regularity", integration through its role as a "through-line" in music, its ability to "align" us, and its "steady" nature. All these latter principles support my definition of *pulse train*.

TEMPO & SURFACE SPEED

Tempo is measured in beats per minute (B.P.M.) and refers to the quantity of beats that would be executed in that timeframe. Note that subdivisions of the beat will therefore pass more quickly. The reader is encouraged to use a metronome and to consider its ability to provide a steady beat as a valuable training tool, with the goal to inherit similar qualities in ones sense of internal clock. The metronome should be used creatively and flexibly, not as a crutch but as a reference tool which gives the practicing musician feedback on their success or failure at temporal tasks.

The measure of speed in terms of this underlying pulse train is referred to as the *surface speed*, and is calculated as follows:

Surface Speed = Tempo x Subdivision (quantity per beat)

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[6] The term *subdivision train* might be equally applicable but feels a bit too cumbersome.

Surface speed gives an absolute measure of how fast something may be. For example, it verifies that 32nd-notes (demi-semiquavers) at 60 b.p.m. are actually slower than septuplets at 70 b.p.m., even though the former may look denser when notated.[7]

[7] The surface speeds are 480 and 490 respectively. Other musical situations exist where the music's surface speed can be significantly denser in slow tempi and small subdivisions than fast tempi and larger durations of rhythm.

PHRASE & GROUPING

Sheehan employs the term *phrase* where I prefer the term *grouping*. This is because a phrase can often be an entity much longer than a single numeric entry ("digit") on a rhythm diamond. A phrase is popularly considered even larger than a *motif*,[8] and thus may combine a structural unit derived from a sequence of 2, 3, 4, or even 5 numeric entries on a rhythm diamond. Adopting this definition facilitates the construction of a motif that may characterise and unify a phrase.

For example in the *konakol* of South India (which appears as some inspiration to Sheehan), a motif of the 5 syllables *ta di ki na dom* can be embedded in the tripartite phrase:

ta di ki na dom = 5

ta - di - ki na dom = 7

ta - di - ki - na - dom = 9

This *pancha nadai* structure is typical of a South Indian phraseology that makes a logical pathway through successive groupings via use of motif.

It is therefore desirable to master the syntactical units of grouping and subsequently their sequential composition in "sentences" or phrases.

Unfortunately for the reader, Sheehan also applies the term *phrase* when he should refer to the *total value* of a rhythmic sequence, referring for example to the aforementioned 7777666554 triangle as having a "wonderful 60 beat phrase" (79).

Sheehan also confusingly uses the term "meter" where a grouping of subdivision is intended (p.205).

The primacy of the role of subdivision or pulse in rhythm diamonds is not unlike South Indian classical music, whose phrases are based on discrete values of subdivisions beneath the larger constructs of beat and metre.[9] Sheehan's rhythm diamonds are thus phrase-centric, and his text would benefit from the presentation of the concept of *additive rhythm*, introduced next.

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[8] Schoenberg defines phrase as that which can be sung in a single breath (3). Refer to Chapters 2 and 3 of Schoenberg (1970).

[9] Refer to Sankaran for an introduction to the Carnatic genre with a temporal focus.

ADDITIVE RHYTHM & UNIQUE PRIME FACTORIZATION

This principle, like many listed in this paper, are inferred by Sheehan but not explicitly stated. For a more complete overview of this principle as applied to rhythm, refer to Dimond (2019).

Additive rhythm considers the atomic unit of pulse as the genesis of time rather than the whole bar.[10] Additive rhythm's power and flexibility is derived from its congruency with the *unique-prime-factorization theorem*, which states that every integer greater than 1 either is prime itself or is the product of prime numbers.[11] For example:

4 = 2x2

6 = 2x3

8 = 2x2x2

32 = 2x2x2x2x2

Composite numbers can also be expressed as a summation of prime factors and a different prime, e.g.:

8 = (2x3) + 2

This enables us to exhaustively identify all the ways to reduce a composite number to its building-blocks of 2 and 3. Thus the only four options of for realising a sequence of length 8 with groups of 2 and 3 are:

2+2+2+2

3+3+2

3+2+3

2+3+3

The first is the perfectly even beat (e.g. 4/4 subdivided in quavers), and the latter three should be recognised as circular permutations of the same ubiquitous sequence, creating the rhythmic basis of Elvis' *Hound Dog*, the Afro-Cuban *tresillo*, and the *habanera* of Tango.

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[10] Contrastingly, *divisive rhythm* is conventionally taught and employed in Western European art music, and is the basis of its system of notation. It considers a bar as a generative rhythmic unit and progressively divides this into smaller parts—typically powers of 2—to create a 'rhythm tree'.

[11] The first seven primes are 2, 3, 5, 7, 11, 13, and 17.

The process becomes more involved for larger numbers, as there are necessarily more possible combinations.[12] Take for example the ninth prime 23. Being prime, no perfectly even beat division is possible. Its nearest lower composite is 22, whose prime factorization is 2 x 11. The factor 11 can either be grouped 3+3+3+2 or as 3+2+2+2+2. That is, the adjacent interval vectors that utilise 2 and 3 to make 11 are <<0,1,3>>[13] and <<0,4,1>>[14]. Therefore for 22 we could double either of these vectors, but reduce the number of 2s by one so that the deficit 1 (required to total 23) could be added to make an extra 3 to compensate. This logic is outlined as follows:

23 = 22 + 1

23 = (2 x 11) + 1

11 = <<0,1,3>> or <<0,4,1>>

Selecting the first vector option:

23 = 2 x ((1 x 2) + (3 x 3)) + 1

23 = (2 x 2) + (6 x 3) + 1

23 = (1 x 2) + (7 x 3) = <<0,1,7>>

Selecting the second vector option instead:

23 = 2 x ((4 x 2) + (1 x 3)) + 1

23 = (8 x 2) + (2 x 3) + 1

23 = (7 x 2) + (3 x 3) = <<0,7,3>>

It is empowering to calculate that the only two ways to use additive rhythmic units of 2 and 3 to create such a large time cycle as one with 23 pulses is limited to these four and their combinatorial reorderings:

(1 x 2) + (7 x 3)

(4 x 2) + (5 x 3)

(7 x 2) + (3 x 3)

(10 x 2) + (1 x 3)

The primacy of 2 and 3 as atomic rhythmic units corresponds to the *metrical feet* of prosody. For example, groups of 3 often correspond in practice to the disyllabic *trochee* – ˘ (stressed-

[12] This example extends the principle for the reader interested in exploring more difficult problems, and this paragraph can be skipped for those not concerned with such large primes. For a definition of *interval vectors* and associated principles please refer to Dimond 2019. The associated mathematics lies outside the scope of this particular paper.

[13] One 2 and three 3s.

[14] Four 2s and one 3.

unstressed), with the stressed syllable taking double the length (and weight) of the unstressed syllable, thus totalling 3 units. Additive rhythm provides for the development of a more flexible syntax in metres whether they be composite with a regular beat length (as in 12/8), or prime with no option for perfectly even beats (as in 7/8). The atomic rhythmic units of 2 and 3 may group to form repeating patterns of beats of the short and long variety as in prosody, creating identifiable grooves such as the asymmetric metres common in the non-Western traditions that Sheehan mentions in his introduction (p.11).

Sheehan catalogs the "phrasing sequences" from 3 to 32 (pp.16-17). As a matter of personal preference based on experience, I would have orientated these groupings in the reverse manner, that is, by listing the quantity of repetitions followed by the value of the grouping. For example Sheehan's version of 19:
2 2 2 2 2 2 2 2 2 1

is summarised:
2 x 9 +1

whereas in oral and written communication I prefer the initial factorization:
9 x 2

expressed as "nine two's".[15]

Less superficially, a large list like this could easily overwhelm the reader. My recommendation is that the larger numbers be considered as composites of the primes and that these are drilled as the syntactical units. Then mere arithmetic can bring the performer to practical realisation of the "phrases". For example, phrase of value 11 as eight variations (p.16). With mastery of the constituent primes, however, these could be represented merely by the six binomials:
10+1

9+2

8+3

7+4

6+5

Knowing the prime factorization of the larger numerals, and applying circular permutation also, empowers the performer to execute all of Sheehans' eight examples plus others where

[15] This orientation is what I use in my own factors in this paper. The same product may be thought of as "nine lots of 2".

the “1” is concatenated with an adjacent grouping. E.g.
3 2 2 2 2

This example can be deduced from 3+8, 5+6, 7+4, or 9+2, all of which are listed as separate entries in Sheehan’s list of phrases.

DURATION & TOTAL VALUE

Any grouping – be it one or a group of onsets, or an entire cycle such as a rhythm diamond – has a *total value*. Duration is measured in subdivisions or pulses with respect to the pulse train that underlies it. Rhythmic durations are executed in the knowledge that it is the interval of time that is measured from one attack point to the next – not the duration of the related sounding pitch – which essentially defines rhythm. Musical interpretation allows for a myriad of choices as to the real length of musical attacks, and how they may be realised with further subordinate attacks.

When Sheehan writes of the “total beats” of a particular diamond, he is really referring to the total value of the diamond in terms of the number of pulses/subdivisions. (Refer for example to Sheehan p.22 and the value of the 332 diamond being “24 beats”.) Other times Sheehan refers to the “sum total” (e.g. p.25).

The interdependence of total value upon metre, beat and subdivision is often overlooked by Sheehan. E.g. the sequence with a total value of 64 on p.41 is acknowledged has being “a good series of numbers over 4/4”, however it is presumed that one is subdividing by 2s or factors of 2s (such as semiquavers). The reader must adopt the practice of looking at total value and deducing its factors (e.g. 64 has factors of 32, 2, 16, 4, and 8), before then considering what subdivision in what metre will match.

There are times Sheehan hacks total value in order to adopt a rhythm diamond into a desired metre and subdivision (typically 4/4 and semiquavers). Such procrustean modifications to total value include the appending of 4 pulses to the 7777666554 triangle to total 64 instead of 60, making it “a great phrase over 4/4” (p.79).[16]

The total value of a standard 9-digit rhythm diamond is easily found by $3a + 6b$, or $3(a+2b)$. Refer to Figure 1.

Though the total value (or “sum total”) figure is typically presented as the defining numeral of Sheehan’s rhythm diamonds (e.g. p.25, 34, 36, 41, 72, etc), he sometimes instead replaces it with a numeral that refers to the duration of the metre in pulses that recurs

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[16] Rather, I would translate this to meaning it would “completely fill 4 bars of 4/4 metre subdivided into semiquavers”.

throughout the structure, such as the diamond of 45 pulses entitled “15!” (p.192) and the square of 95 pulses entitled “19!” (p.199).

PERMUTATION & COMBINATION

The very genesis of Sheehan’s rhythm diamonds system is attributed to “variations” of number sequences introduced to him by a friend and student of Indian Classical music (Sheehan 2). The systematic consideration of possible reorderings of number sequences lies at the heart of Sheehan’s system and his book.

In my tabla studies I was introduced to the term *addhā* (अद्धा) which is Hindi for “half”.[17] In practical applications, the term refers to the regrouping of phrases within a rhythmic cycle (*tala*). Such a process is a variation technique that retains overall phrase/cycle length. It can be heard in the contrast between two 16-beat talas *tintal* (4+4) and *sitar khani* (3+3+2), as well as during fast improvised *laggī* (लग्गी) of light classical tabla accompaniment in *dadra* (6 beats) and *keharwa* (8 beats) talas.

By definition, *permutations* are cyclical reorderings[18] whilst *combinations* exhaust all possible orderings. Combinations can be deduced by the factorial equation denoted *!* where

$c! = a \times b \times c$

E.g. the total combinations of 3 items = $1 \times 2 \times 3 = 6$.

To provide limitations on the mathematical possibilities in order to make the resulting sequences realistically executable by the average musician, Sheehan’s rhythm diamonds are based upon the three combinations of two single-digit numerals in strings of three – one of one digit and two of another (e.g. *bba*). This reduces the possible combinations of a string of three numerals to 3, because there are only 2*!* places where the placement of the singular digit (*a*) can go that make any difference.

$$\frac{3!}{2!} = 6 \div 2 = 3$$

Because this kind of sequence has only two single-digit numerals in strings of three, circular permutations yield the same result as combinations. Refer to Figure 1 and the three strings ascending from left to right (*bba*, *bab*, and *abb*).

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[17] Bharat Jangam, private lessons in Pune, July 3 1996.

[18] Much like the three standard positions a triad can take - root, first and second inversion.

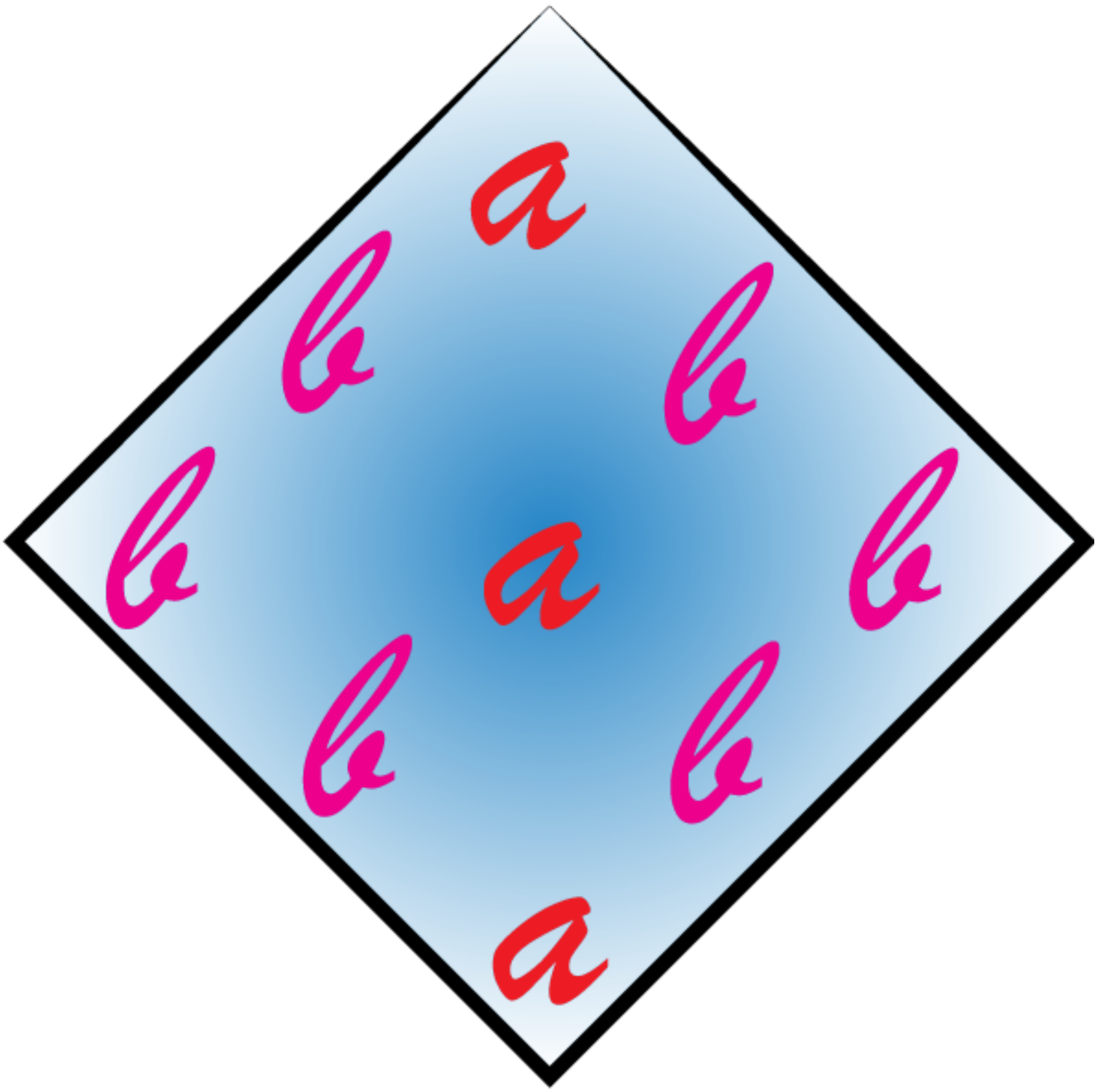

Figure 1. The schema of a standard 9-digit diamond.

PATHWAYS THROUGH DIAMONDS

For any standard 9-digit diamond consisting of three strings of a three-digit sequence in its three permutations, there are 84 different possible pathways one could render a sequence of 9 digits.[19]

Figures 2 to 5 illustrate some rhythm diamonds. Sheehan encourages practising constituent lines first before assembling them into full sequences (of 9 digits). Start by perceiving the diamond as three ascending diagonals (such as the 332, 323 and 233 diagonals of Figure 2). Then, plot out alternative pathways (such as playing the vertical sequence first and then the two "wings" of identical numbers, e.g. 222333333).[20] A full sequence is referred to as "playing through the diamond" (p.23).

It is not compulsory for multiple performers to follow an identical pathway. Given that the total value remains constant no matter what pathway one takes, as prowess with the principles increases, superimposition of different pathways can be rewarding. The use of pitch can assist the sense of cadence as multiple performers converge to the start of shared diamond. A simple approach to building this sense of independence can start with the overlaying of a diamond upon an appropriate beat.[21]

TRANSLATIONAL & ROTATIONAL SYMMETRY

The bilateral symmetry of the rhythm diamonds is apparent in their design as illustrated in Figure 1, with a central row of 3 of digit *a* flanked by two "wings" of 3 of digit *b*. 9 is a square number, yet Sheehan writes of his early preference to orientating the square on a vertex because diamond orientation "represented a much more open and flexible way of viewing a group of numbers" (p.22). Toussaint talks of categories of axial orientation in symmetries, and the change (and challenge) to visual perception for symmetries that feature positive or negative diagonal axial slopes (p.229). I suggest that Sheehan intuitively noticed and enjoyed the variety of viewpoints that diamond orientation encouraged with its diagonals and pathways, as well as the consistency of the inherent square root (3) sub-sequences that could be assembled in those diagonal formations.

Translational symmetry is an automorphism that leaves the structure of an object unchanged whilst simply relocating it some distance along a straight line. Rotational symmetry resembles translation, only the vector of relocation is not straight but rather

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[19] Refer to Sheehan p.90-91 for the factorial mathematics that proves this.

[20] Refer to Sheehan p.38-39 for pathway ideas.

[21] For example the 556 diamond of Figure 3 could be played whilst the drummer plays 12 beats of 3, or 9 beats of 4. Clapping and reciting in this way also train the performer for the contrapuntal effect.

angled or curved.[22] The geometric and mathematical application of these symmetrical approaches are apparent as underpinning principles not only to the construction of rhythm diamonds, but some of the approaches to their pathways in performance also.[23]

The 332 diamond of Figure 2, for example, can be viewed as translations of this 332 motif around its border in various directions related by 45° angles (and multiples thereof). The central digit (2) could be acquired through a rotational symmetry commencing at either side vertices of the diamond (east or west) and "wrapping around" the diamond to the other side.

Symmetry grants us an alternative perspective to permutation and combination as a means for conceiving and realising rhythm diamonds.

[22] Refer to Weyl for an in-depth look at symmetry, as well as Dimond 2019 for an application to music.

[23] The fundamental principle of repetition applies here, which, along with contrast and variation, form the trinity of formal principles in music.

RHYTHM DIAMOND EXAMPLES

Some of the 9-digit diamonds using groupings less that 8 are illustrated in the following diagrams. Again, each have 84 potential pathways through them. There are 72 9-digit diamonds that use groupings from 1 through 9.[24]

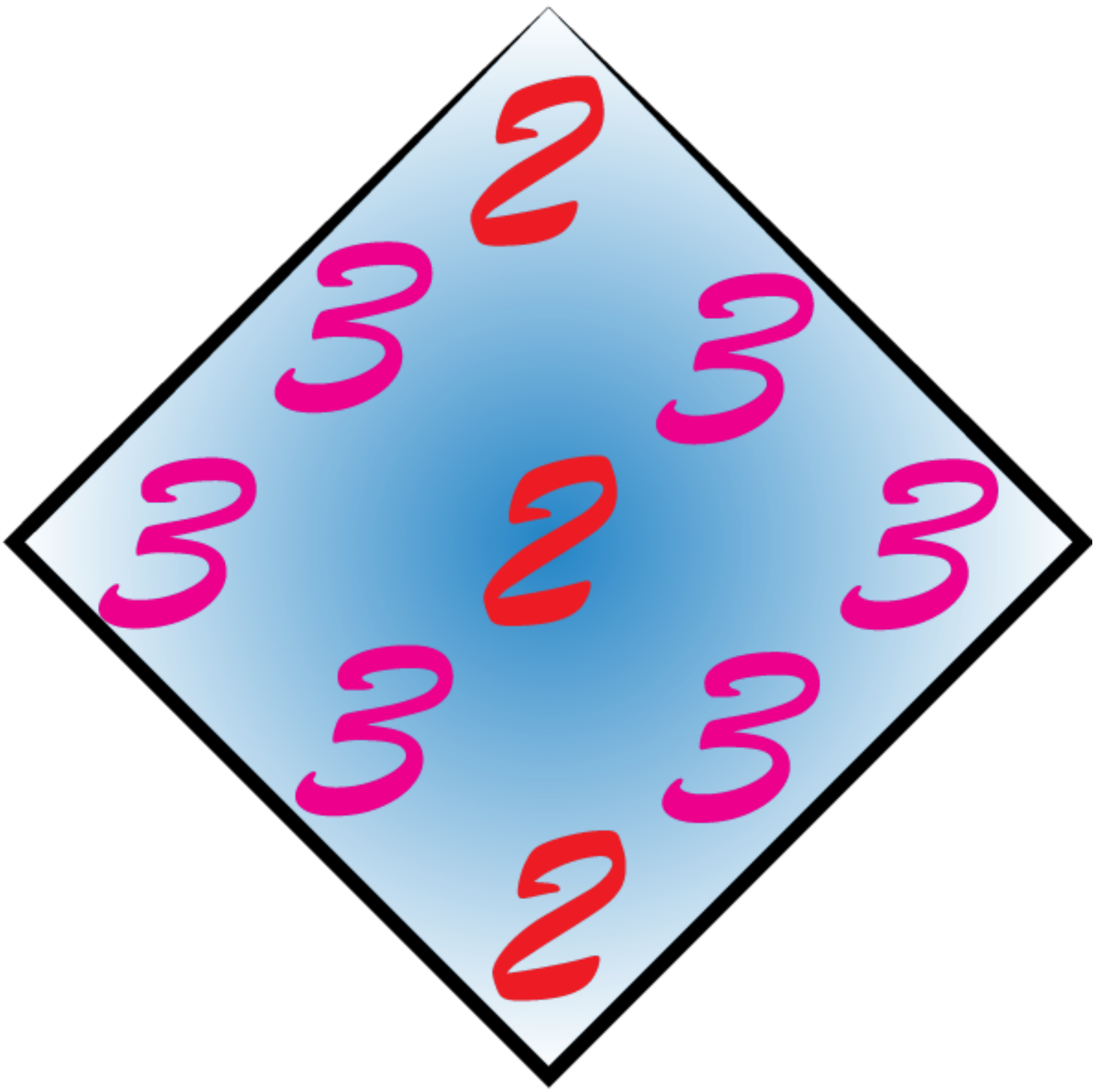

Figure 2. 332 diamond. Total value = 24.

[24] Refer to Sheehan 25 for a complete chart of diamonds.

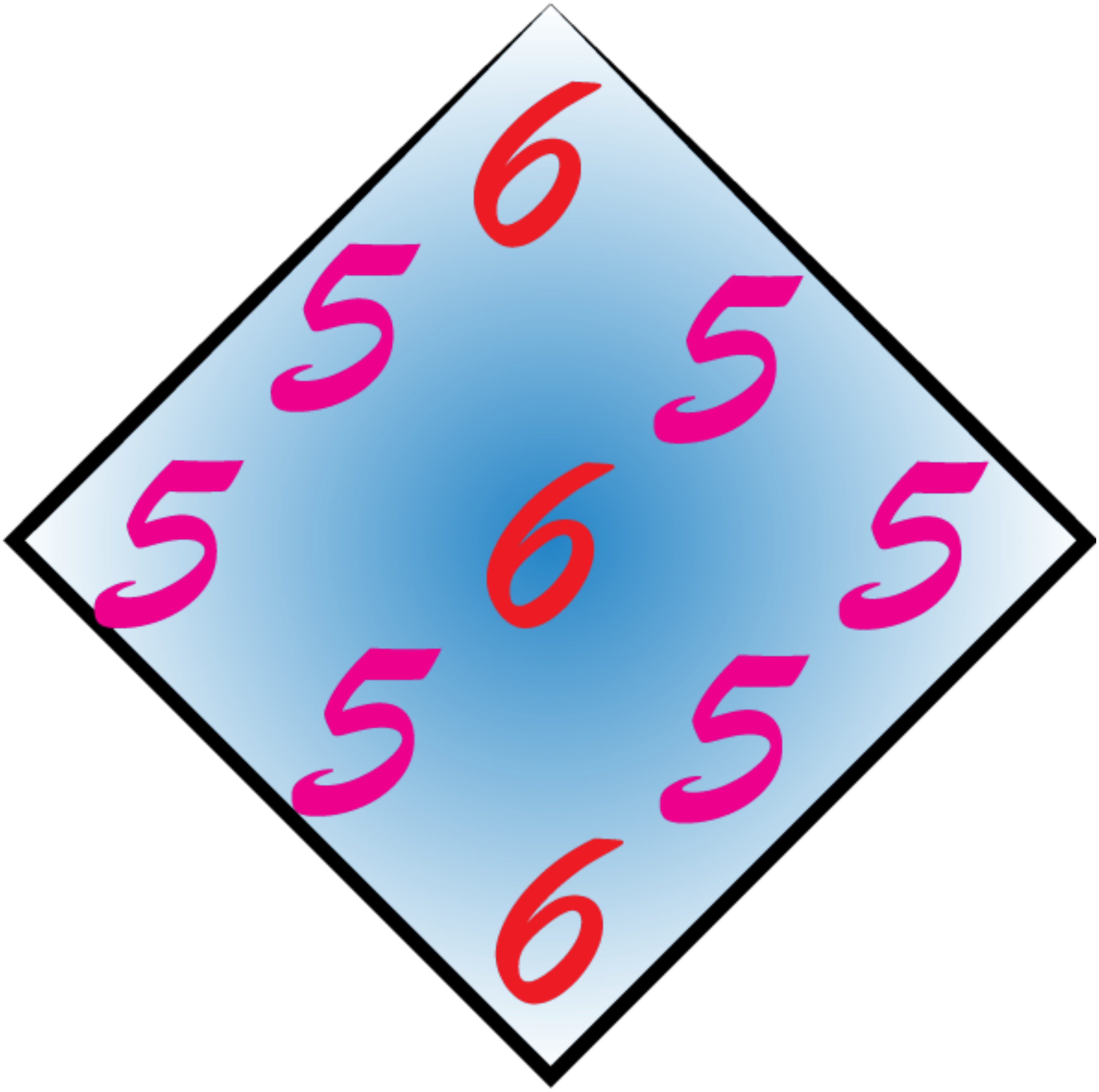

Figure 3. 556 diamond. Total value = 48.

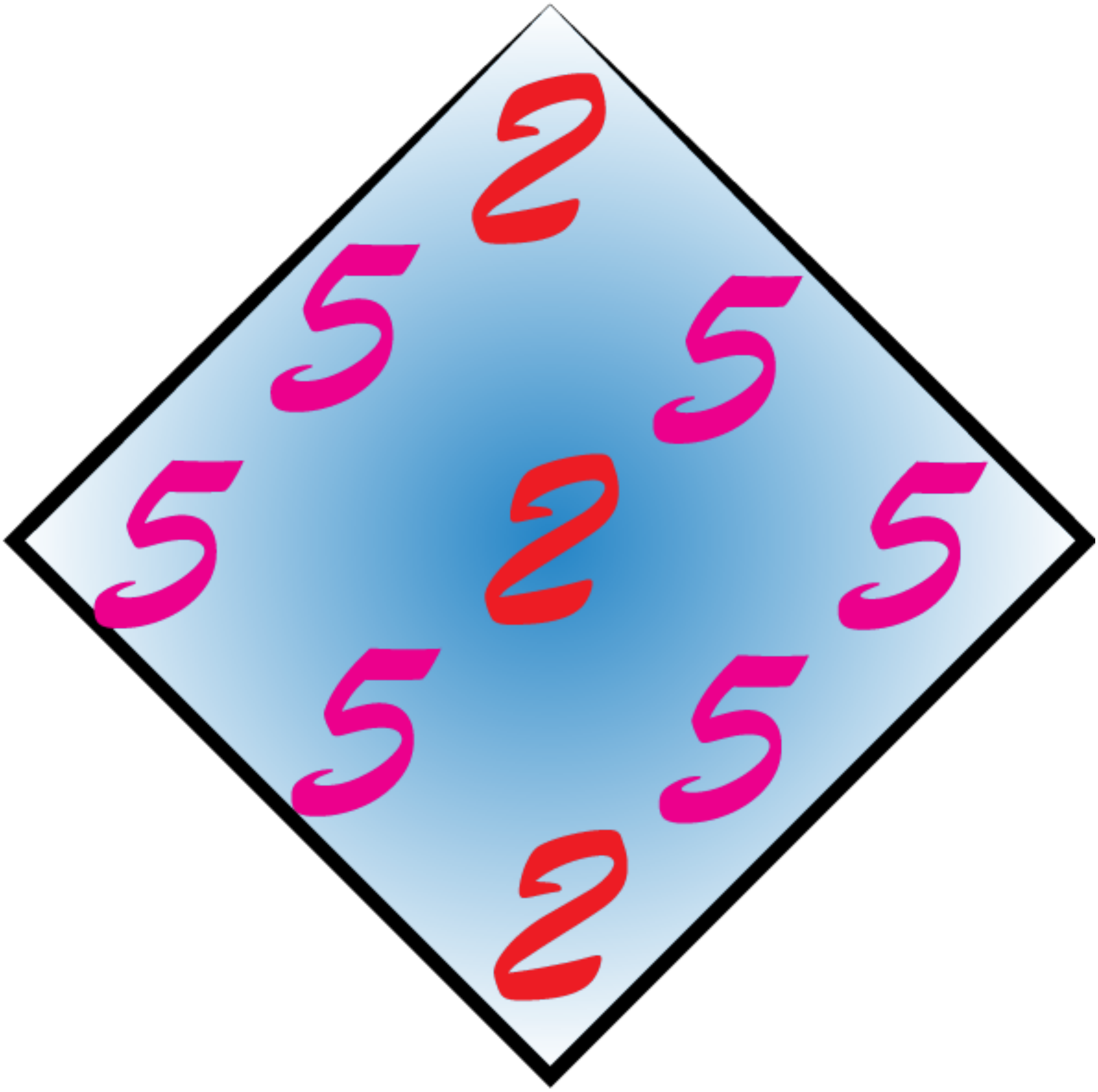

Figure 4. 552 diamond. Total value = 36.

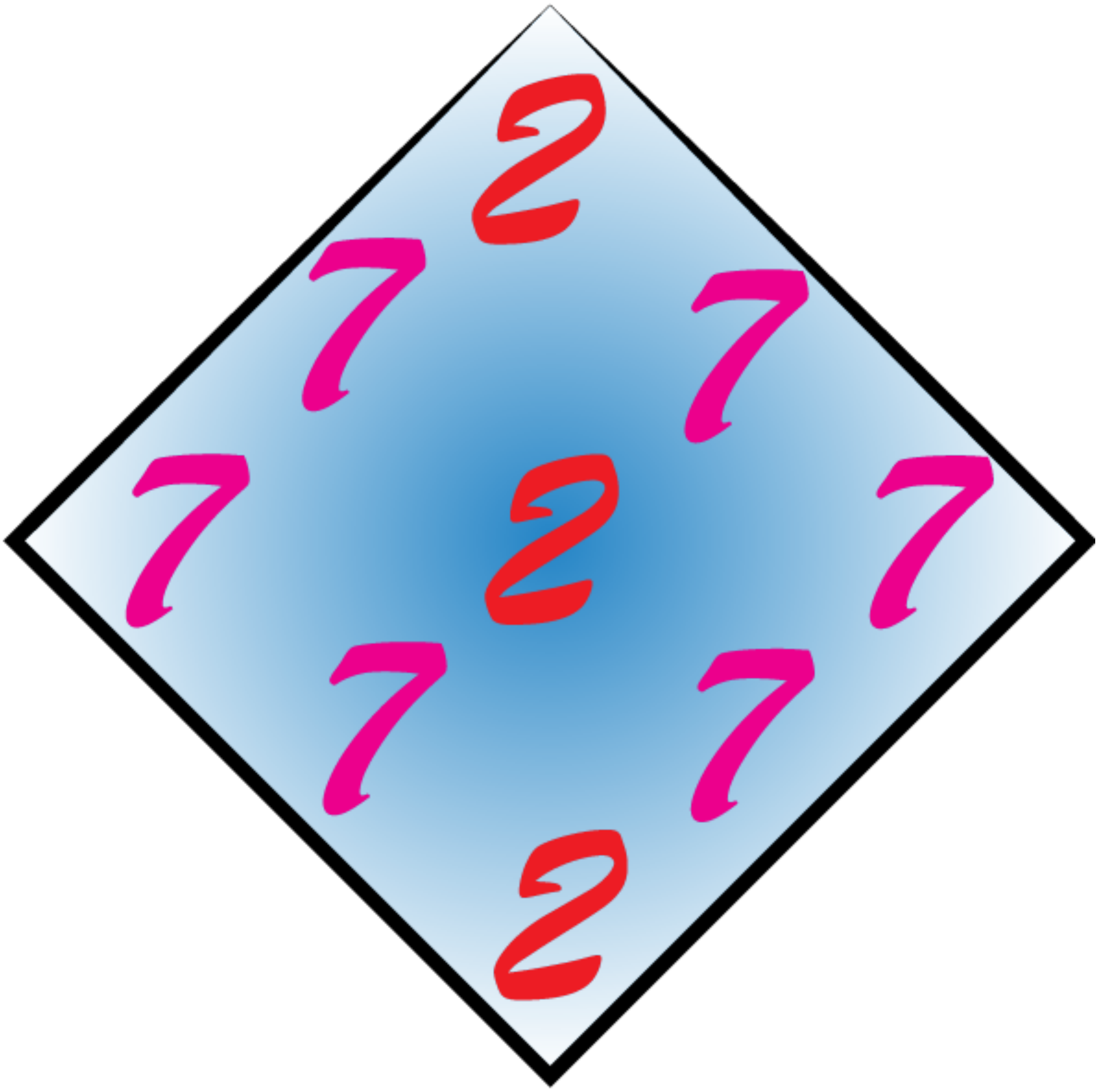

Figure 5. 772 diamond. Total value = 48.

RHYTHM SYNTAX

Rendering rhythm diamonds is wholly reliant upon the sequencing of structural units much like words to form sentences. Adopting the *konnakol*[25] of South Indian music is not only fit for the purpose but also acknowledges much of the source of inspiration for Sheehan's rhythm diamonds.

Here are some suggested "words" for some basic groupings. Note the primacy of 2 and 3 when it comes to building larger groupings. The hyphen represents 1 unit subdivision of rest.

1 TA

2 TA KA

3 TA KI TA

4 TA KA DI MI

5 TA DI KI NA DOM or TA KA TA KI TA or TA KI TA TA KA

6 TA DI - KI NA DOM or TA KI TA TA KI TA

7 TA - DI - KI NA DOM or TA KA TA DI KI NA DOM or TA KI TA TA KA DI MI

8 TA DI - KI - NA DOM or TA KI TA TA DI KI NA DOM

9 TA KA TA KI TA TA KA DI MI or TA - DI - TA DI KI NA DOM

WHAT MAKES A GROUPING SOUND LIKE A GROUPING?

For a grouping to sound like a syntactical unit it requires contrast to surrounding structural units. Failing to make a word sound discrete can run the risk on unintelligibility through concatenation with neighbouring words. The following are approaches to encourage intelligibility of grouping, and should be practiced separately and in combination.

Accent.
A dynamic increase on the onset (1) of each grouping is one of the best ways to indicated that it is the start of a syntactical unit. Practising accents in additive rhythm is furthermore one of the best ways to generally improve a consistent pulse train. The idiomatic demands of

[25] Also termed *solkattu*. Refer to Sankaran p.45-46 for other suggestions.

each instrument also expose technical challenges in accent patterns that are worthy of practice. Other types of articulation (e.g. staccato, legato) can also combine to make a characteristic motif and therefore grouping.

Rest.
Placing silence between groups or between onsets of groups will make risk of concatenation with neighbouring groups almost impossible. Structural gaps or rests are known as *karvai* in South Indian music.[26]

Timbre.
Orchestration of grouping is important to avoid the "machine-gun" monotony of pulse trains. Drummers, composers, vocalists and instrumentalists must all consider the role timbre plays in grouping rhythms. Logical changes of timbre can help enunciate grouping, even with a single pitch. For example, 552 525 255 could all be played on the pitch B, but with the groups of 2 being played as a harmonic. In ensemble situations, there exist limitless possibilities of how to orchestrate and share groupings amongst the musicians.

Pitch.
Assignment of pitch is a powerful way to reveal rhythmic procedures. For example in the reducing sequence 7654321, if the first onset of each group was a C, and the intervening attacks in each group were the remaining pitches of an ascending C major scale, the effect of acceleration would be emphasised.

THE CHALLENGE WITH GROUPINGS OF 1

Obviously a group of 1 is immediately followed by another 1 of the successive group, and the use of rests or gaps is not possible to make the group intelligible, so other aforementioned approaches become more important.

It is natural for groups of 1 to also be subsumed into neighbouring groups, such that 1 followed by 2 will be perceived as 3. Of the 72 nine-digit diamonds listed by Sheehan (25), 16 diamonds have at least three groups of 1 – and many have six groups of 1. For these 16 diamonds special attention needs to be placed on how these 1s are enunciated for the aforementioned reasons. It is also reasonable to re-group these 1s with their neighbours, so that for example the 112 diamond sees two successive 1s as a group of 2, and a 1 followed by 2 or a 2 followed by one as a group of 3.

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[26] Refer to Dimond p.55.

APPLYING PITCH

Some of Sheehan's collaborators share their experience with applying rhythm diamonds to pitch in his book (pp.269-297). This paper need not repeat these examples which inspire some good approaches to single-line and chordal-instrument performance.

My advice is to reduce the pitch material used whilst the rhythmic concepts are fresh and challenging. This could involve droning on single pitches and using accent to enunciate grouping. I also advise not even adding pitch to your instrument until you can recite groups readily, by speaking the associated *konnakol*.

Once ready, using pitch to making grouping clear, as aforementioned, should be the primary goal. Whilst a modal or consistent-key approach is satisfactory and rewarding, chord progressions and cycles of keys can be next superimposed to grant the diamond a longer sense of journey. In-so-doing, a series of diamonds may be rhythmically identical but developed in the area of pitch and harmony.

APPENDIX: ERRATA

The following errors were discovered in the first edition of Sheehan's text.

Page x. Ben Harrison listed twice (line 4 and 5).

Page 31. The notation of the first 3 examples is incorrect. The 12/8 bars contain only 6 quavers on the top line but 12 on the bottom (beat). Given the suggested grouping for 5s, and the prevalence of semiquaver subdivisions on this page, the metre perhaps should be 12/16 with dotted quaver beat.

Page 90. The placement of all the divisors is misprinted in the factorial equations.

Page 140. The concentric circle diagram is captioned to represent all the combinations possible from the throw of three dice but does not match the combinations listed on page 138. The only way to achieve a sum total of 3 (111) is missing from the 6 o'clock position of the diagram, and furthermore the diagram seems to involve dice with 9 faces.[27] It however skips the sum total 27 (achievable by 999), also possibly intended for the 6 o'clock position of the diagram. A colour version of this diagram forms the basis of the cover page of the book.

Page 273. The notation contains incorrect and missing rests and ligatures leading to bars and voices that do not match the time signature and the value of the bar/s.

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[27] Such a *enneahedron* (or *nonahedron*) is impossible to create with regular, equal faces, so any game of dice with such an object would skew probability towards those faces of a larger surface area!

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