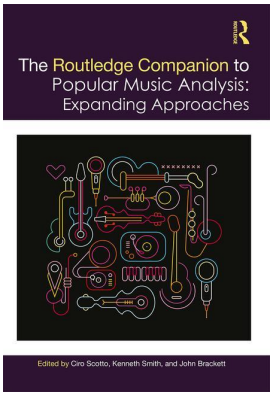

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PULSE AS DYNAMIC ATTENDING

Analysing Beat Bin Metre in Neo Soul Grooves

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Composing, arranging, and recording with Digital Audio Workstations all represent new opportunities for manipulating rhythm at a micro level. In the following, I will focus on the analysis of extended beats, or so-called "beat bin metre," in contemporary groove-based music. One way to produce extended beats is to introduce multiple pulse locations at the micro level of a groove. As I will demonstrate, multiple pulse locations change the shape of the beats and also affect the internal beat that the listener uses to make sense of the rhythmic events. Another way to extend the beat is to introduce sounds where the location of the beat is unclear or open to several placements. I will theorise both phenomena using the theory of "dynamic attending"[1] as my point of departure. I begin with a discussion of different notions of metre, and clarify how I use the term, and proceed to offer a brief presentation of the theory of entrainment and dynamic attending, before turning to my musical examples.

What Is Metre?

Most researchers agree that musical rhythm as an experiential phenomenon is a meeting of sound and listener; specifically, it comprises an interaction between the listener's structuring schemes, or what could be labelled "reference structures," and actual sounding rhythmic events.[2] Such reference structures are *virtual*, in the sense that they do not exist as sound *per se*. They are activated in the listener by the sound itself in the act of structuring the same sound. The specific structures that are actually produced in the listener derive from a combination of general perceptual processes, the listener's pre-understanding – that is, what the listener brings to the act of listening through training, culture, and so on – and the schemes that are implicitly present in the actual sounding rhythmic events.

Reference structures generate expectations in the listener regarding the events to come. An important aesthetic aspect of rhythm, and music in general, is its play with such expectations.[3] We might get what we expect, or we might not. In other words, sounding rhythm contains both its relevant structuring pattern *and* the potential for a significant or expressive variation of this pattern. This potential is addressed by, for example, Eric Clarke, who concludes that all acoustical rhythmic information in fact engages two different perceptual domains, expression and rhythm, the latter understood as rhythmic structure.[4]

While Clarke's rhythmic structure concerns patterns that are actualised by the particular *sounding* rhythm, metre is commonly regarded as the general measure against which sounding rhythms are mapped. Broadly, we might distinguish between three alternative understandings of metre. The first is "whatever we use to make sense of rhythmic events".[5] This would encompass, in principle, all structuring principles at work in our experience and analysis of rhythm, and it comes very close to what I call *reference structures* – it is, everything from general schemes of pulse, metre, and subdivision to the conventional figures of the style or genre. It may even entail the identity projected by any given groove, when such a groove establishes its own unique structural pattern as it proceeds in time. The second understanding of metre approximates the idea of "time signature" and traditionally also involves a matrix of accents. It is, in the words of Grosvenor Cooper and Leonard B. Meyer, "the measurement of the number of pulses between more or less regularly recurring accents".[6] In classic music theory (classic here referring to the status of both the theory and the repertoire from which it was derived) the matrix of strong and weak beats has been thought to be universal, in the sense that all music in 4/4 metre conforms to the same pattern. However, such matrices clearly come with different cultural inflections.[7] The third (though related) understanding of metre arises from its use to denote a grid of *different* levels of regularly spaced events in time, from the bar, to the basic beat (tactus or internal beat), to various levels of subdivision. This latter understanding evokes the way in which metre is represented in the Western notational system, and according to Christopher Hasty, "all our systematic theories of metre draw upon a conceptual framework grounded in the technology of metric notation".[8]

Each of these three overlapping understandings of metre is accompanied by an analytical and an experiential variant, so to speak. Metre denotes, in turn, the structuring schemes we apply in our *experience* of rhythm, and the standard with which we measure and map rhythmic events in *analytical and compositional* representations of music. Sometimes the dividing line between the experiential and analytical aspects of metre is rather blurred. Still, it is not a given that the metre used in analysis or composition is representative of the metre at work in the experience of those same rhythms. Regarding groove-based music, this disjuncture is relevant when we are confronted with the common practice of using the metric grid as the reference for mapping microtiming "deviations". Here, the metric grid serves as an analytical tool for representing actual onsets of rhythmic events (an event can be, for example, twenty milliseconds early or late in relation to the grid). Sometimes it is assumed that this analytical relationship between, for example, an early event and the grid is also valid in experience. Depending on the context, however, such an early attack might be heard not as a deviation from the grid/norm but as *part* of the norm – that is, as part of an extended beat. It is therefore crucial to distinguish between metre as an analytical tool for identifying and measuring the temporal aspects of actual rhythm, such as when we map microtiming and actual durations in relation to a grid of isochronous points in time, and metre as a "mode of experience".[9] Again, as I will demonstrate in the analyses to follow, there is no guarantee that a metric grid in a form that would measure rhythmic events – that is, an isochronometric grid of points in time – is actually at work when we listen to the music.

The experiential mode of metre, in the sense of a grid of regular pulsations at different levels, however, remains highly relevant to the experience of groove-based rhythm. The most important aspect of this mode is the basic pulse behind the music – the internal beat that represents the fundamental virtual reference for *both* the production and the perception of rhythm, to such an extent that if one fails to catch the correct or intended pulse, the

groove can change character completely or even fall apart. A listener who is not confident about a given musical style might structure the rhythm s/he hears according to a pulse that is different from the expected pulse, thereby cultivating an utterly different "understanding" of the music. The groove may also imply other, more or less isochronous levels of pulsations, such as a particular scheme for the grouping of beats with a matrix of accents (responding to the question, what is the beginning of the pattern and how should its beats be weighted?), as well as schemes for subdivision and syncopations. None of this is necessarily "given" when we listen to a groove, but if we are familiar with the musical culture in question, we often experience quite clear implications as to what the relevant internal beat(s), grouping(s), and subdivision(s) are.

However, this is not always the case, and when we are faced with music that plays on possible ambivalences at one or more of these metric levels, it becomes obvious that rhythm as an experiential phenomenon occurs at the meeting point of reference structures and sounding events. Whether we hear a certain rhythmic pattern in duple or triple metre, or binary or ternary subdivision, affects our experience.[10]

The experience of metre and our ability to synchronise with relatively regular pulsations at different levels in music has been linked to the perceptual process of listening, and in particular to the listener's tendency to allocate attention to salient events in the music (and other external rhythms). Mari Riess Jones and collaborators have theorized such processes in the temporal domain, developing the so-called theory of dynamic attending.[11] Justin London's seminal work on musical metre, *Hearing in Time*,[12] uses this theory as its point of departure for delimiting metre to a form of attentional behaviour that we use to make sense of rhythm, itself then understood as "patterns of duration that are phenomenally present in the music".[13] For London, then, rhythm involves the structure of the stimuli, while metre involves our perception and cognition of such stimuli.[14]

In this chapter, rhythm denotes the *interaction* between virtual structuring schemes and actual sounding rhythmic events. I delimit metre to the virtual schemes that correspond to the relatively regularly recurring pulsations at different frequencies (tempi) in the listener and use the theory of dynamic attending to suggest possible perceptual responses to the complexities presented by some selected examples of D'Angelo's neo soul grooves.

Metre as Dynamic Attending

The theory of dynamic attending, as developed by Jones and various collaborators over the past thirty years,[15] relies on key concepts from research into visual attention, including expectancy, attentional capture, and attentional focus, combined with theories of resonance in dynamic systems, to describe attentional processes accompanying events with a complex time structure, such as music. The dynamic aspect of the theory derives from an entrainment hypothesis that rests on two assumptions: first, that there exist internal oscillations in the perceiver, here termed "attending rhythms," and second, that the rhythm of the external event drives these attending rhythms, such that the attending rhythms *entrain* to the external rhythm.[16] The concept of attending rhythms is useful in order to explain how musical expectancies are generated, since the attending rhythms point to where in a repeated cycle a salient event is likely to occur. Such an attentional focus is the result of a process whereby attentional energy is allocated over time.[17] The musical event's temporal structure, on the other hand, is useful for the listener in an ecological sense, in that it affords cues for the synchronisation process that produce an advantageous attentional focus: when it works in

the right way, the temporal structure directs the listener's attention to the salient parts of the musical process – that is, the salient musical events simply capture one's attention.

The use of the word "rhythm" in the context of attending or internal rhythms conforms to its biological use as a single periodic process or so-called self-sustaining oscillation. This generates the periodic activity that is referred to as our expectations, which in a musical context resembles the notion of metre. Importantly, the expectation in a dynamic attending system is an active temporal anticipation; unlike, for example, a fixed clock, the attending rhythm can, when coupled to an external rhythm, adjust (entrain) and eventually synchronise with that rhythm. The relation is also robust with regard to perturbations, and the attending rhythm may adapt its period to more systematic rate changes in the external events.[18]

In this theory, the notion of self-sustaining oscillations is combined with the idea that attentional energy is allocated in time in accordance with expectations. Particularly interesting in terms of metre is the way in which the idea of a distribution of attentional energy over time transforms the metric expectation from a point-like event to an event that can extend in time: the attentional focus increases/the pulse narrows as synchronization improves and decreases/widens as synchronization degrades. I will now turn to a discussion of a groove where this dynamic notion of metre seems particularly relevant.

Extended Beats in D'Angelo's "1000 Deaths"

The song 1000 Deaths is the second track on neo soul artist D'Angelo's *Black Messiah* album (2014). *Black Messiah* followed the experimental and highly acclaimed *Voodoo* album (Virgin 2000) and introduces D'Angelo as socially engaged and politically concerned. Its release was accelerated by several months thanks to the events in Ferguson, Missouri, where a grand jury decided that the white police officer who shot the unarmed black teenager named Michael Brown would not be charged. *Black Messiah*'s social commitment and political nature is apparent from its heavily symbolic cover image, which zooms in on clenched fists in a black crowd.

The album also displays what has become a D'Angelo trademark, namely grooves marked by striking discrepancies between the pulse locations implied by different rhythmic layers at the micro level. Several tracks on D'Angelo's previous album *Voodoo* (co-produced by D'Angelo and Ahmir "Questlove" Thompson from the Soulquarian Collective) had a constant glitch of between fifty and hundred milliseconds between rhythmic layers,[19] which lie well above the empirical results of research into the just noticeable differences (JND) for music, whether in strict time or in rubato performance, indicating that they are clearly audible.[20] Whereas a gap of twenty or thirty milliseconds between, for example, the onset of a kick drum beat and a bass guitar playing on the same beat, is very common in groove-based music and tends to add vitality to a groove, such large gaps can be heard as glitchy. They are so great, in fact, that they approach the point at which the listener will not be able to integrate the two incidents into one.[21] Here D'Angelo and producer Questlove were clearly inspired by the glitch aesthetic of hip-hop producer-artist J Dilla, who became legendary for disturbing the natural periodicity of samples by shortening or lengthening one or more beats/slices of the sample. When this type of operation is looped, the resulting "halting" feel resembles the effect of multiple pulse locations described above.

Like *Voodoo*, *Black Messiah* is characterized by a mix of recorded live sound and micro-rhythmic manipulation post recording, and displays a similar inclination toward extreme

rhythmic feels. "1000 Deaths," for example, starts with a collage-like arrangement of samples from a non-credited sermon by an activist priest who calls Jesus a black revolutionary Messiah. This opening sound is underpinned by a groove texture marked by uneven pulsation at the faster levels of subdivision. At around 1'30" the sample is faded out and the main groove begins, overlaid by a relaxed and distorted lead vocal. A spectrogram of one bar of the groove from the first "verse" of the song (1'47"–1'50") reveals that the basic pattern of subdivision is completely evened out and corresponds precisely to a semiquaver grid. The extreme feel of the groove is produced by the numerous *extra* "off-grid" percussive events between the metric quavers. These "in-between" percussive events (see arrows in Figure 12.1) do not follow any specific pattern, and the discrepancies between these "noise bursts" and the regular semiquaver pattern vary as well.

In addition, each crotchet of the basic pulse consists of at least two events, for example, two different snare drum sounds or other percussive sounds, which articulate the same beat but with a micro-level temporal glitch (see Figure 12.2). Together with the halting feel of the "clashing" irregular subdivision within the isochronous sixteenth-note pattern, these cluster-beats produce the characteristic rhythmic feel of "1000 Deaths". The heavily lagging lead vocal further obscures the rhythmic pattern, transforming the groove into a lo-fi fabric of muddy rhythmic gestures. Consequently, the pulse is not particularly precise but rather forms extended beats, or "beat bins,"[22] of seventy to eighty milliseconds.[23] The "beat bin" is the perceived temporal "width" or extent of a beat according to the musical

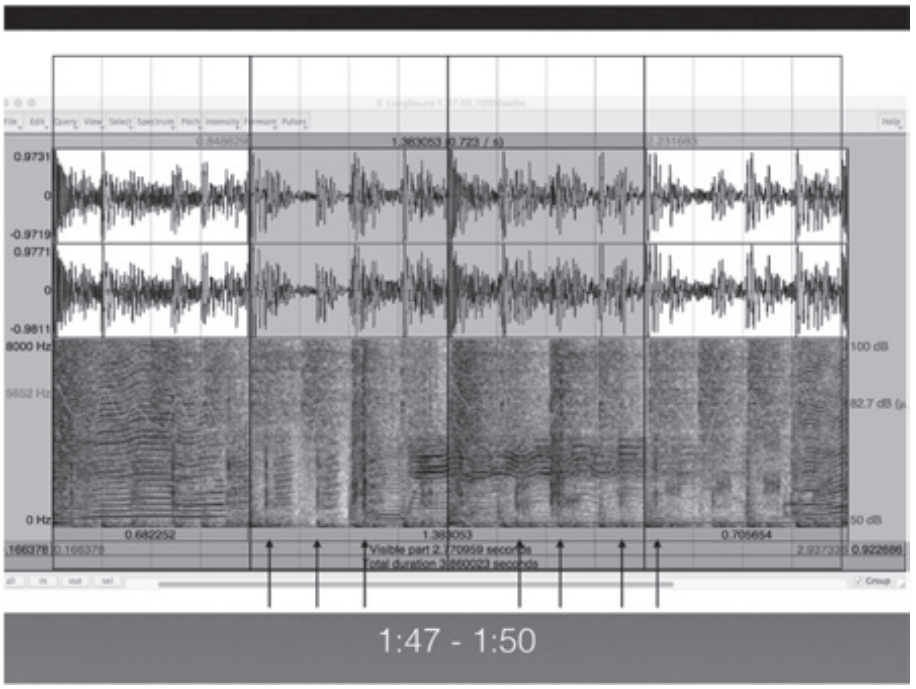

Figure 12.1 Waveform and spectrogram (0-8000 Hz) of one bar of the groove in "1000 Deaths" (*Praat* version 5.1.03, www.praat.org). Highlighted area comprises two beats. Quarter notes indicated by lines, sixteenth notes by stippled lines, and non-metric subdivisions by arrows.

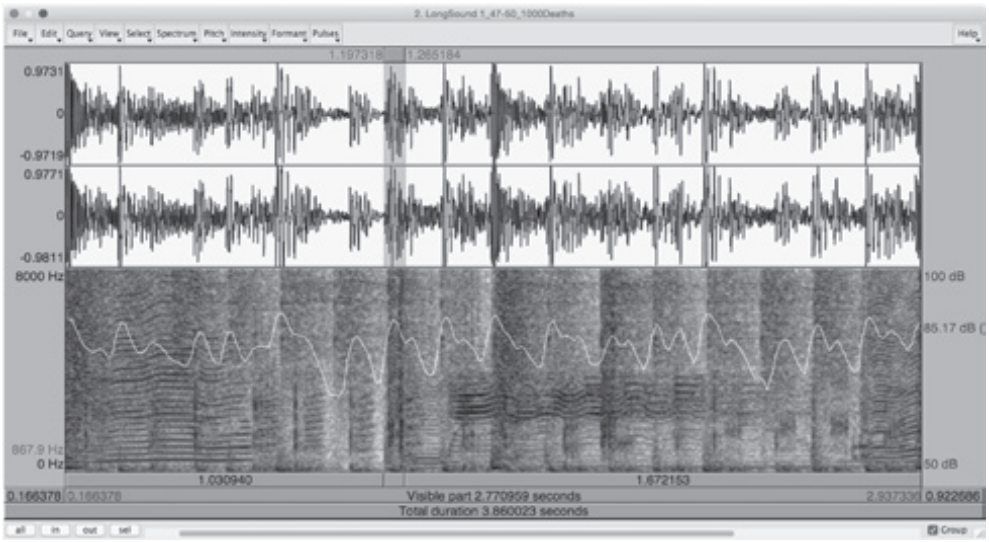

Figure 12.2 Waveform and spectrogram (0-8000 Hz) of one bar of the groove in "1000 Deaths" (*Praat* version 5.1.03, www.praat.org). Cluster pulse/beat bin of approx. 70 milliseconds between two different snare drum sounds articulating the same beat highlighted in light blue.

context. Multiple onsets of a particular beat falling within the boundaries of the perceived beat bin will be heard as a single beat, whereas onsets falling outside of these boundaries will be heard as belonging to another category – namely, that of "not part of the beat".[24] A wide beat bin, such as the one produced by the clustered rhythmic events marking the basic beat in "1000 Deaths," increases the listener's overall tolerance for "imprecise" location of rhythmic events, producing an openness as to where rhythmic events can and do take place at the micro level.

Referring to the theory of dynamic attending, we might hypothesise that the clustered pulse at the micro level of the groove causes a temporal widening of the metric expectation: each pulsation in the internal pulse of the perceiver becomes a wide beat bin that encompasses all micro locations of the pulse. This assumption relies on one of the central ideas of the theory of dynamic attending – namely, the possibility of a widening of the attentional focus. According to this idea, the attentional focus (that is, the virtual pulse) can be extended so as to encompass all of the competing pulse locations in the song.[25] This would mean that the attentional focus, instead of being a narrow peak, has a more saddle-like shape, as outlined in Figure 12.3. The process of perceptually tuning into the clustered beats in "1000 Deaths," that is, hearing the song as an instance of beat bin metre, can then be conceived of as a process of entrainment: the attentional focus gradually widens to encompass all the events that articulate the basic beats.

Even though the phase coupling between the external events and the internal attending rhythms reaches a stable condition also in the case of beat bins, this coupling might be looser than that accompanying a sharp attentional focus and a point-like metric pulse. Support for this assumption was found in a motion-capture experiment conducted on the song "Left and Right" from D'Angelo's previous album *Voodoo*. In the introduction of this song, the experiential metre is shaped by the groove's sharp percussive sounds,

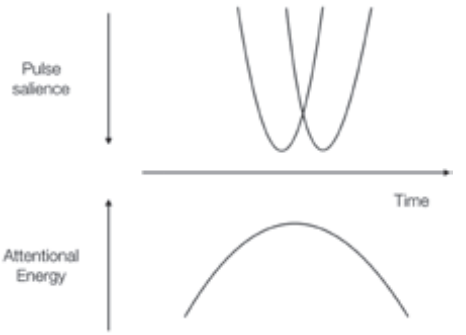

Figure 12.3 Widened metric expectation (beat bin metre) in "1000 Deaths".

which clearly indicate where the regular beats in the basic pulse of the song (at 92 bpm) are located at the micro level. Due to the distinct, percussive character of the instruments (rhythm guitar, shaker, and finger-snapping), the internal beats are accurate and point-like, and the different rhythmic layers appear congruent with this pulse. This facilitates a prompt and comfortable synchronisation of one's attentional rhythm with the external musical events. When the drum-kit layer (drums and bass) enters, a perturbation occurs, because these instruments locate the pulse significantly ahead of the existing guitar's pulse.[26] The repeated discrepancy between the pulse location of the drum-kit layer and the guitar layer can be accommodated by one's attentional rhythm as a phase perturbation. With reference to the theory of dynamic attending, then, we might assume that the metric expectation in the perceiver proceeds from a point-like isochronous metre in the introduction, through a phase of confusion and entrainment, to a shape where each beat in the basic pulse has been extended into a beat bin, which encompasses all of the different locations of the pulse at the micro level. Given the tight action-perception coupling in rhythm, our hypothesis in the motion capture experiment was that the motion would change accordingly resulting from the altered shape of the pulse in the groove. The results confirm our hypothesis, showing that when the perturbations are introduced to the groove, the pulse positions in the motion responses become less consistent, probably as a consequence of a widened attentional focus.[27]

Similarly, we could conceptualize the perceptual response to the "muddy" microrhythmic conditions in "1000 Deaths" as "beat bin metre": One attending rhythm with a considerably widened attentional focus is synchronised with the clustered pulse. The *period* coupling at the beat level is strong and regular, but the clustered metric events results in a looser *phase* coupling between the attending and driving rhythms. This looser phase coupling leads us to experience the multiple pulse locations at the micro level of the groove with a greater "rhythmic tolerance";[28] they all become part of one extended beat.

Metre and Temporality

The analysis of the grooves in D'Angelo's "1000 Deaths" and "Left & Right" shows that when we conceptualize metre as attending rhythms in the listener, the perceptual response to important stylistic microrhythmic features of the basic pulse, such as the above multiple pulse locations at the micro level, can be explained. In short, multiple pulse locations at the micro level of a groove generates an attending rhythm with a widened attentional focus,

that is, with a relatively generous tolerance for possible locations of the rhythmic events that constitute the basic pulse.

Conversely, approaches to the analysis of metre that conceptualises it as an isochronous series of points in time fail to capture such micro-rhythmic designs. This conception of metre, which I have earlier labelled the "metronome model"[29], has some obvious shortcomings in relation to the musical phenomena discussed in this chapter. First, it presumes that the listener's basic structuring scheme is a fixed period: it cannot adjust to time-varying events, or at least it becomes much more complicated to account for how we deal with such events. Likewise, the notion of the beat as a point-like event in time is problematic, for, as Edward W. Large and Jones state, it is evident that for "situations in which natural rhythmic fluctuations come into play,"[30] it is unreasonable to associate an expectation with a single point in time. Many theories of metre that rely on notated representations of the music have, moreover, tended to treat the relationship between metric structure and the actual sounding rhythm hierarchically: the metric grid represents the firm ground, and the music is generally measured in relation to this grid.[31] The structuring capacity in the human body has been thought of in the same way, as a non-dynamic relation between external music and a non-adapting isochronous timekeeper – that is, a "clock" – within the perceiver.[32] This approach fails to account for an experience where the actual sounds remain identical, but the perceptual response to them changes.

The theory of dynamic attending, and particularly its entrainment aspect, on the contrary, opens potential for a dialectical relation between "sound-listened-to" and perceptual structuring, presenting several means of accounting for the hypothesised perceptual responses to the grooves discussed. The first is linked to the possibility of adjustments in period and phase, which makes the location of the metric expectation an *emergent property* of the music rather than an external scheme governing the musical design. This latter aspect of the model makes a dynamic feature of the distance between each pulsation that can be subject to change. Such change can affect the overall tempo, which, according to the theory of dynamic attending, would be understood as a change of period, or it could affect the relative durations of the different beats within shorter musical units, which, again according to the theory of dynamic attending, would be conceptualised as variations in phase. In both "1000 Deaths" and "Left & Right," the tempo of the quarter-note level is perceived to be stable throughout, which means that the multiple pulse positions at the micro level of the crotchet pulse are probably perceived as variations in phase. In both cases, I would argue, these "challenges" to synchronising with the groove are matched by a widening of the attentional pulse into beat bins that encompass all rhythmic events that express the pulse. This allows for an understanding not only of the actual sounding beats but also of the virtual pulse – that is, the metre – as having both shape and extension in time. The theory of dynamic attending thus enables us to treat both the shape of metric pulsations and the distance between each pulsation as dynamic features, assuming only that the music is "regular enough".[33] Recent research by London and Rainer Polak shows that "regular enough" can, in fact, encompass a fairly wide variety of different metres.[34] More specifically, these scholars suggest ways in which non-isochronous pulsations may be integrated into a metrical framework based in dynamic attending theory. The empirical research into motion patterns in response to "Left & Right" referenced above supports these assumptions, showing that the crotchet level of the main groove of the tune, despite serious perturbations, is still regular enough to uphold synchronisation with a looser phase coupling.[35]

However, even though the theory of dynamic attending allows for considerable flexibility as to both the locus and the shape of the metric expectation, there must still be a limit: even a big bin has a rim. At some point, then, there is no longer enough regularity in the music for one's internal rhythm to be able to synchronise with it. When does metre (in the sense of a synchronisation between internal and external rhythms, as hypothesised by the theory of dynamic attending) ends and other structural concepts take over? This thought concerns the larger question regarding the ways in which the musical gestures themselves, over time, establish a set of figures unique to the song. Both metrical and non-metrical reference structures, which relate to both basic perceptual processes and cultural patterns, will be actualised in the listener by the music, and probably also changed as a consequence of the listening experience. This means that metre and other reference structures used in the act of listening may vary considerably. For some applying beat bin metre to a muddy groove goes automatic and without any concern, for others a groove with multiple pulse locations at the micro level might be heard as chaotic or even as a mistake. The pre-understanding of the perceiving subject varies. How we entrain to a groove – what metre we use to structure its events – will decide what groove we actually hear.

Notes

1 Mari Riess Jones, "Time, Our Lost Dimension: Toward a New Theory of Perception, Attention, and Memory," *Psychological Review* LXXXIV, no. 5 (1976): 323–355.
2 Anne Danielsen, *Presence and Pleasure: The Funk Grooves of James Brown and Parliament*. (Middletown, CT: Wesleyan University Press, 2006). Anne Danielsen, "Introduction," in *Musical Rhythm in the Age of Digital Reproduction*, edited by Anne Danielsen, (Farnham, Surrey: Ashgate, 2010) 1–19. Anne Danielsen. "Metrical Ambiguity or Microrhythmic Flexibility? Analysing Groove in 'Nasty Girl' by Destiny's Child," in *Song Interpretation in 21st-Century Pop Music*, eds. Ralf von Appen, Andre Doehring, and Allan F. Moore (Farnham, Surrey: Ashgate, 2015), 53–72.
3 See also David Huron, *Sweet Anticipation. Music and the Psychology of Expectation* (Cambridge, MA: MIT Press, 2007).
4 Eric F. Clarke, "The Perception of Expressive Timing in Music," *Psychological Research* LI, no. 1 (1989): 2–9.
5 Tellef Kvifte, "Flexible Meter—a Contradiction in Terms?" Paper given at the conference Musical Meter in Comparative Perspective, Cologne, April 2013.
6 Grosvenor Cooper and Leonard B. Meyer, *The Rhythmic Structure of Music* (Chicago, IL: University of Chicago Press, 1963), 4.
7 See, for example, chapter one of Chris Stover, *A Theory of Flexible Rhythmic Spaces for Diasporic African Music* (PhD diss., University of Washington, 2009).
8 Christopher F. Hasty, *Meter as Rhythm* (Oxford: Oxford University Press, 1997). The alternative understanding of metre proposed by Hasty in his book under the heading "meter as process" relies on a phenomenological framework and is aimed at the structural processes at work in rhythm as they happen.
9 Justin London, *Hearing in Time,* 2nd ed. (Oxford: Oxford University Press, 2012), 67.
10 For experimental research demonstrating this fact, see Eric F. Clarke, "Categorical Rhythm Perception: An Ecological Perspective," in *Action and Perception in Rhythm and Music*, edited by Alf Gabrielsson, 19–33, Publications issued by the Royal Swedish Academy of Music No 55 Stockholm: The Royal Swedish Academy of Music, 1987. Peter Desain and Henkjan Honing, "The Formation of Rhythmic Categories and Metric Priming," *Perception* XXXII, no. 3 (2003): 341–366.
11 Cf. Jones, "Time, Our Lost Dimension"; Edward W. Large and Mari Riess Jones, "The Dynamics of Attending: How People Track Time-Varying Events," *Psychological Review* CVI, no. 1 (1999): 119–159.

12 London, *Hearing in Time*.
13 Ibid., 4.
14 It may be noted here that this is, in principal, a different use of the word rhythm than the one I use in this chapter.
15 See, for example, Jones, "Time, Our Lost Dimension"; Mari Riess Jones and Marilyn Boltz, "Dynamic Attending and Responses to Time," *Psychological Review* XCVI, no. 3 (1989): 459–491; Large and Jones, "The Dynamics of Attending"; Mari Riess Jones, "Attention and Timing," in *Ecological Psychoacoustics*, edited by John G. Neuhoff (San Diego: Academic Press, 2004), 48–59.
16 Large and Jones, "The Dynamics of Attending," 123.
17 Jones, "Time, Our Lost Dimension".
18 Large and Jones, "The Dynamics of Attending," 124. Technically, an expectation about when something is going to happen – for example, a rhythmic event – is described as phase (fi) t, which is the position of the oscillation around the so-called limit cycle (the stable cycle of a self-sustaining oscillation) at time t. An expectation corresponds to phase 0, while the actual onset may vary from phase 0 (exactly on the expectation) to 0.5 (at the exact opposite of the expectation).
19 Kristoffer Yddal Bjerke. "Timbral Relationship and Microrhyhtmic Tension: Shaping the Groove Experience Through Sound," in *Musical Rhythm in the Age of Digital Reproduction*, edited by Anne Danielsen, 85–102. Farnham, Surrey: Ashgate, 2010. Anne Danielsen, "Here, There and Everywhere: Three Accounts of Pulse in D'Angelo's 'Left & Right'," in *Musical Rhythm in the Age of Digital Reproduction*, edited by Anne Danielsen (Farnham, Surrey: Ashgate, 2010), 19–36.
20 Eric F. Clarke, "The Perception of Expressive Timing in Music," *Psychological Research* LI, no. 1 (1989): 2–9; Anders Friberg and Johan Sundberg, "Time Discrimination in a Monotonic, Isochronous Sequence." *Journal of the Acoustical Society of America* XCVIII, no. 5 (1995): 2524–2531.
21 Richard M. Warren, "Perception of Acoustic Sequences: Global Integration Versus Temporal Resolution," in *Thinking in Sound*, edited by Stephen McAdams and Emmanuel Bigand (Oxford: Clarendon Press/Oxford University Press, 1993), 37–68.
22 Danielsen, "Here, There and Everywhere."
23 I want to thank Eric F. Clarke for suggesting this term.
24 Ibid., 29–32.
25 Other examples of the application of the theory of dynamic attending to extended beats in computer-based grooves are Kristoffer Carlsen and Maria A. G. Witek, "Simultaneous Rhythmic Events with Different Schematic Affiliations: Microtiming and Dynamic Attending in Two Contemporary R&B Grooves," in *Musical Rhythm in the Age of Digital Reproduction*, edited by Anne Danielsen (Farnham, Surrey: Ashgate, 2010), 51–68; Anne Danielsen, Mari Romarheim Haugen, and Alexander Refsum Jensenius, "Moving to the Beat: Studying Entrainment in Motion Patterns to Changes in Pulse Shape," *Timing and Time Perception* III, no. 1–2 (2015): 133–154.
26 For a more detailed analysis, see Danielsen, "Here, There and Everywhere."
27 Danielsen et al., "Moving to the Beat."
28 Mats Johansson, "The Concept of Rhythmic Tolerance: Examining Flexible Grooves in Scandinavian Folk-Fiddling," In *Musical Rhythm in the Age of Digital Reproduction*, edited by Anne Danielsen (Farnham, Surrey: Ashgate, 2010), 69–84.
29 Danielsen, "Here, There and Everywhere."
30 Large and Jones, "The Dynamics of Attending," 129.
31 See, for example, Cooper and Meyer, *The Rhythmic Structure of Music*; Lerdahl and Jackendoff, *A Generative Theory of Tonal Music.*
32 See, for example, Dirk-Jan Povel and Povel Essens, "Perception of Temporal Patterns," *Music Perception* II (1985): 411–440.
33 London, *Hearing in Time,* 2nd ed, 162.
34 Rainer Polak, "Rhythmic Feel as Meter: Non-Isochronous Beat Subdivision in Jembe Music From Mali." *Music Theory Online* XVI, no. 4 (2010); Rainer Polak and Justin London, "Timing and Meter in Mande Drumming from Mali." *Music Theory Online* XX, no. 1 (2014).
35 Danielsen et al., "Moving to the Beat."

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