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Modelling the Groove: Conceptual Structure and Popular Music

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LET me start with a somewhat problematic assumption, which is that listeners know a good groove when they hear it. What is problematic about this assumption is not that it in any way misrepresents what can often be observed: a groove starts up and people stop whatever they are doing and begin to pay attention to the music; they either put their bodies in motion or adapt ongoing motion to follow the pull of the groove. No, what is problematic is the status of the knowledge behind these actions: what is it that listeners know when they know a good groove?

Perhaps the problem is that most listeners are not long on detailed declarative knowledge when it comes to music, and so it is difficult to gain access to what they know. But musicians are not much better where the groove is concerned. When asked what makes for a good groove musicians as often as not become vague, refer to things like 'feel', and summarize with the koan-like 'You know it when you hear it.'[1] But again, what is it that musicians know when they know a good groove?

Part of the difficulty with asking this question lies with the fact that a groove is most typically created by a small group of musicians working together, each contributing parts to the composite whole. On the production end of things, then, a groove involves knowledge shared between musicians. This aspect of the groove was given a compelling analysis by Ingrid Monson in her 1996 *Saying Something*. There, Monson described in detail the contributions of members of a typical jazz rhythm section to a musical groove and discussed the complex

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[1] For instance, Charlie Persip explains a groove as follows: 'When you get into that groove, you ride right on down that groove with no strain and no pain – you can't lay back or go forward. That's why they call it a groove' (quoted in Paul F. Berliner, *Thinking in Jazz: The Infinite Art of Improvisation*, Chicago Studies in Ethnomusicology, Chicago, 1994, 349). My point is not that musicians or listeners are inarticulate about grooves, but that characterizing the knowledge behind their descriptions is not easy.

social interactions that mark small-group improvisation.[2] It is these social interactions that present both a barrier and an opportunity to those interested in exploring the knowledge behind grooves. The barrier is a consequence of the failure to develop a theory of music adequate to the highly dynamic domain of improvised music. As Monson noted,

> this essential interactive component of improvisation, with its emergent musical shapes and historical as well as socially constructive dimensions, has not been an object of theoretical inquiry. Structural relationships [which are typically the focus of music-theoretical inquiry] must, of course, be included within the discussion of how music communicates, but they do not operate independently of – and in fact are simultaneous with – the contextualizing and interactive aspects of sound.[3]

But there is an opportunity here as well: interactive modes of musical production suggest a thorough re-examination of what counts as knowledge about music. Rather than limiting ourselves to conventional music-theoretical constructs (and their representations), we need to think of musical knowledge as involving a network of information that includes assessments about bodily states or the possibilities for bodily motion, knowledge about the basis of musical interaction, and abstract concepts.

In what follows I want to explore a way to model the knowledge basic to producing and understanding musical grooves that can accommodate this more general perspective on cognitive organization. My approach takes as its point of departure work in cognitive anthropology which proposes that culture consists of knowledge. As Naomi Quinn and Dorothy Holland put it, culture is 'not a people's customs and artifacts and oral traditions, but what they must know in order to act as they do, make the things they make, and interpret their experience in the distinctive way they do'.[4] Quinn and Holland proposed that cultural knowledge is organized through ideational complexes that are widely shared by members of a society and that play a central role in their understanding of the world and their behaviour in it. In my own work, which focuses on the cognitive processes basic to understanding music, I call such complexes conceptual models. Conceptual models are relatively basic cognitive structures that act as guides for reasoning and inference; each model consists of concepts in specified

[2] See Ingrid Monson, *Saying Something: Jazz Improvisation and Interaction*, Chicago Studies in Ethnomusicology (Chicago, 1996), chapters 2 and 5. A typical jazz rhythm section consists of drums, bass and piano or similar 'comping' instrument; the term 'comping' derives either from 'accompaniment' or 'complement' (see *ibid.*, 43).

[3] *Ibid.*, 190.

[4] Naomi Quinn and Dorothy Holland, 'Culture and Cognition', *Cultural Models in Language and Thought*, ed. Holland and Quinn (Cambridge, 1987), 3–40 (p. 4).

relationships and pertains to a specific domain of knowledge.[5] I view such models as basic to more extended knowledge structures that allow members of a group or society to perform complex actions as well as to communicate with one another.[6]

To give a better sense of what a conceptual model involves, in the first section that follows I shall present a rudimentary conceptual model for musical rhythm. This will provide a framework for my discussion of grooves, as well as an introduction to the broader view of musical knowledge that I want to develop. Essential to this view – and to the conceptual model I shall sketch – is the idea that knowledge structures are part of an active process of understanding and creating music. Knowledge structures are used by listeners to guide their understanding of a musical work as it unfolds; knowledge structures – but not necessarily the same ones – are also used by musicians to guide the performance of a musical work.[7]

Once I have this general perspective on musical and rhythmic knowledge in place I shall turn to the more specific case of modelling the groove. In developing this model I shall adopt a strategy somewhat different from previous studies of the groove.[8] In those studies, 'groove' has been either related to or considered

[5] For my treatment of conceptual models, as well as a discussion of their antecedents, see Lawrence M. Zbikowski, *Conceptualizing Music: Cognitive Structure, Theory, and Analysis* (New York, 2002), chapter 3. The conceptual model, as I construe it, is related to knowledge structures proposed by a number of other researchers in cognitive science and is thus similar to the idealized cognitive model (George Lakoff, *Women, Fire, and Dangerous Things: What Categories Reveal About the Mind*, Chicago, 1987), cognitive domain (Ronald W. Langacker, *Foundations of Cognitive Grammar*, i: *Theoretical Prerequisites*, Stanford, 1987; ii: *Descriptive Application*, Stanford, 1992), frame (Marvin Minsky, 'A Framework for Representing Knowledge', *The Psychology of Computer Vision*, ed. Patrick Henry Winston, New York, 1975, 211–77; *idem*, *The Society of Mind*, New York, 1985) and mental model (Philip Nicholas Johnson-Laird, *Mental Models: Towards a Cognitive Science of Language, Inference, and Consciousness*, Cambridge, MA, 1983). (Structures such as these also informed Quinn and Holland's approach to what they came to call cultural models.) From the larger perspective that I develop, musical concepts are a result of processes of categorization, and relationships between musical concepts are derivative of the process of cross-domain mapping. Conceptual models are consequently the first level of organization for concepts.

[6] For a rewarding study of more extended knowledge structures see Edwin Hutchins, *Cognition in the Wild* (Cambridge, MA, 1995). There Hutchins describes in detail the coordinated knowledge that allows the navigation team of a large naval vessel to control the vessel's movements.

[7] For the sake of concision I shall speak as though listener and performer were two different individuals. It is clear that this is typically not the case: most performers are engaged in active listening to music, and in many cultural settings the dividing line between listeners (that is, members of the audience) and performers is either unclear or non-existent. I should also note that my use of the notion of a 'musical work' is not very heavily freighted, and is intended to apply to the broadest possible range of musical expression.

[8] See, in particular, Charles Keil, 'Motion and Feeling through Music', *Journal of Aesthetics and Art Criticism*, 24 (1966), 337–49; Berliner, *Thinking in Jazz*, chapter 13; Josef A. Prögler, 'Searching for Swing: Participatory Discrepancies in the Jazz Rhythm Section', *Ethnomusicology*, 39 (1995–6), 21–54; as well as Monson, *Saying Something*.

equivalent to 'swing', with both viewed as species of musical 'feel' that are produced by complex and continuously changing interactions among musicians. I focus on a construct derived from such interactions but considerably more stable: this is 'the groove' as it appears in soul, rhythm and blues, jazz fusion and various other popular genres. A groove of this sort is typically a large-scale, multi-layered pattern that involves both pitch and rhythmic materials, and whose repetitions form the basis for either a portion or all of a particular tune. Because such patterns change only gradually over the course of a performance (if they change at all), developing a model for them is a relatively tractable challenge, yet one that has implications for the study of the performance and reception of popular music as a whole.

Teasing apart the elements of a composite whole like a groove is often challenging. There are, however, instances when a performance begins not with the whole groove but with only a portion of it (and, in some cases, a subsidiary portion at that). In the second section that follows I explore one such example from a recording by Eric Clapton, and propose how this groove is modelled both by performers and by listeners. There will emerge from this analysis a somewhat changed view of rhythm in popular music and the part embodied knowledge plays in its construal, as well as a fuller sense of what is encompassed by the notion of modelling a groove. I then discuss briefly the opening moments of two further recordings – one by Miles Davis, the other by James Brown – as a way of refining my characterization of how grooves are modelled. What will emerge from these analyses (which focus both on specific musical grooves and on ways we can understand the groove) is a perspective on the socially constructive dimensions of music which offers ways to think about how both individuals and groups contribute to the creation of music.

Conceptual models and musical rhythm

A basic conceptual model for musical rhythm

As noted above, conceptual models are relatively basic cognitive structures that act as guides for reasoning and inference. The approach to cognition that they embody assumes that knowledge is, at least in part, organized into fairly small, coherent structures. If, once one of these structures is active, we are given a little bit of appropriate situational context we have available many likely inferences on what might happen next in a given situation.[9] To get a better sense of what knowledge structures involve, let us consider a very basic model that might help to guide our reasoning about musical rhythm. We can think of the model as

[9] Although I characterize conceptual models as 'relatively basic' and 'fairly small', this is only within the context of higher cognitive processes (which is where I prefer to focus). Were we to consider the whole of cognition it would be apparent that conceptual models are hardly basic, and are of a compass that is far from small. For further discussion see Zbikowski, *Conceptualizing Music*, chapters 3 and 5.

organized around four informal propositions.[10] These propositions make up an integrated, mutually reinforcing whole – that is, a conceptual model for musical rhythm:

P1 Rhythm concerns regularly occurring musical events.
P2 There is differentiation between rhythmic events.
P3 Rhythmic events are cyclic.
P4 There is a strong sense of embodiment associated with musical rhythm.

Before discussing how the model is used I should note three things. First, this model is not intended to represent a sophisticated account of musical rhythm – it is formulated with an eye to practicality rather than to music-theoretical rigour – and is shaped in certain respects by practices typical of Western music. Second, while the model is intended to be broadly applicable to a fairly wide range of music, there will nonetheless be certain types of music – unmeasured harpsichord preludes of the seventeenth century, for instance, or some of the incredibly dense and complex music written by Conlon Nancarrow – that will fall outside its purview. Third, even if we accepted this model as a viable cognitive construct it is doubtful whether those who rely on the model to guide their musical judgments could articulate any portion of it. That is, the model represents implicit rather than explicit knowledge.[11]

With these things in mind, let us consider how this model might be used as a guide for musical understanding. Confronted with a sample of putatively musical sound we would look for manifestations of regularity (P1) which were in some way differentiated (P2). Were the sound only minimally differentiated – a series of taps on a table top, for instance, or the steady drip of water from a tap – we might suspect it was not music, and look for other things to clarify the situation. Among these would be some measure of cyclicity (P3) – that is, a higher-order pattern of differentiation which would group subsidiary patterns of more locally differentiated events. Finally, something that is really rhythmic, according to this model, is something we can, at the very least, tap our toes to (P4).

The model, as presented above, offers one way to characterize the knowledge behind a listener's judgments about whether the sounds they hear are musically rhythmic. The model, principally through its final proposition, also raises a question: just how does embodied experience contribute to our cognitive lives? For many researchers, 'cognition' means 'what the brain does when it thinks'.

[10] As will become clear in what follows, I am not concerned here with formal propositions of the sort that are either true or false. My focus is instead on informal propositions that embody beliefs or knowledge. My assumption is that such informal propositions could be rendered as formal propositions (and would then be true or false for some situation), but such an exercise is beyond what I want to accomplish here.

[11] By 'implicit knowledge' I mean knowledge that is not articulated; 'explicit knowledge' is, consequently, knowledge that is articulated. As I construe them, both implicit and explicit knowledge are accessible to consciousness; implicit knowledge is thus not equivalent to unconscious knowledge.

Although brains are, quite obviously, situated in bodies, it is assumed that information accumulated by and within the body – that is, the results of the processes of perception and proprioception – is simply of a different order from the information that forms the basis of our thoughts.[12] While it is also assumed that there is some connection between perceptual information and thought, the nature of this connection is often unspecified. The idea that there is 'a strong sense of embodiment associated with musical rhythm' is consequently treated as a habit of thought rather than a statement about knowledge grounded in embodied experience. In contrast to this view, other researchers have worked from the position that perception and proprioception contribute significantly and directly to the substance of our thought.[13] One of the most fully elaborated theoretical proposals based on this position has been made by the cognitive psychologist Lawrence Barsalou, and in the following I shall outline his proposal as a way of providing a fuller account of the sort of knowledge listeners use to make sense of musical rhythm.

Conceptual models and embodied experience

Key to Barsalou's approach is the assumption that neural states associated with perceptions are recorded in the brain.[14] Brain maps of such neural activations can operate even in the absence of bottom-up sensory stimulation (as when we remember a particular perception). Barsalou calls the neural records of perceptions and their associated brain maps 'perceptual symbols', and shows how cognitive operations that make use of perceptual symbols can represent types and tokens, produce categorical inferences, combine the symbols to produce hierarchical propositions, and yield abstract concepts. It is through operations such as these that perceptual symbols, which are for the most part not accessible to our consciousness, provide the basis for the conscious images and concepts that occupy our thoughts.

The schematic nature of the neural records basic to perceptual symbols makes it possible for perceptual symbols to participate in cognitive structures of which they were not initially a part, but with which they share focal features. For instance, our conceptions of rhythm in general, and of musical rhythm in particular, are strongly informed by the manifold regularities basic to human experience – the regular cycles of our breathing, the alternation of our limbs in

[12] See, for instance, Daniel C. Dennett, 'The Nature of Images and the Introspective Trap', *Content and Consciousness* (London, 1969), 132–46; Jerry A. Fodor, *The Language of Thought* (Cambridge, MA, 1975); Allen Newell and Herbert A. Simon, *Human Problem Solving* (Englewood Cliffs, 1972); Zenon W. Pylyshyn, *Computation and Cognition: Toward a Foundation for Cognitive Science* (Cambridge, MA, 1984).

[13] See, for instance, Mark Johnson, *The Body in the Mind: The Bodily Basis of Meaning, Imagination, and Reason* (Chicago, 1987); Gerald M. Edelman, *Bright Air, Brilliant Fire: On the Matter of Mind* (New York, 1992); Antonio R. Damasio, *The Feeling of What Happens: Body and Emotion in the Making of Consciousness* (New York, 1999).

[14] The theory is presented in Lawrence W. Barsalou, 'Perceptual Symbol Systems' and 'Perceptions of Perceptual Symbols', *Behavioral and Brain Sciences*, 22 (1999), 577–609 and 637–60.

walking or the repeated actions that accompany our physical work. These regularities are, of course, specific to the modality of proprioception rather than audition. For such regularities to inform our understanding of musical rhythm the properties and relations common to physical experience and musical rhythm must be exploited, and used for more abstract concepts that inform our understanding of both.[15] Three such concepts are regularity, differentiation and cyclicity. Regularity is the periodic recurrence of some event; Colwyn Trevarthen has recently argued that our knowledge of such regularity comes first from proprioception during the first months of life, and is only subsequently applied to musical experience.[16] Differentiation involves simultaneous non-identical regularities, such as what occurs when different limbs are engaged in regular but independent motions. Cyclicity involves composite regularities made up of coordinated differentiated regularities; most forms of human locomotion (including infants' creeping and crawling) involve cyclicity. Although I have characterized each concept in terms of information that could be gleaned from proprioception, regularity, differentiation and cyclicity can also be heard in rhythmic music. Indeed, from the perspective of Barsalou's theory, perceptual symbols associated with both proprioception and audition contribute to these concepts.

The concepts of regularity, differentiation and cyclicity, framed in terms of perceptual symbol systems, thus offer a sort of meeting ground for embodied

[15] Connections between perceptual symbols and abstract concepts are discussed in Barsalou, 'Perceptual Symbol Systems'; *idem*, 'Abstraction as Dynamic Interpretation in Perceptual Symbol Systems', *Building Object Categories in Developmental Time*, ed. Lisa Gershkoff-Stowe and David H. Rakison (forthcoming); and *idem*, 'Abstraction in Perceptual Symbol Systems', *Philosophical Transactions of the Royal Society of London: Biological Sciences*, 358 (2003), 1177–87. Support for the idea that the musical conception of rhythm is abstracted from proprioceptive information comes from recent neuro-imaging data which shows that musicians do not directly access information about sensorimotor function in their cognition of rhythm. See Lawrence M. Parsons, 'Exploring the Functional Neuroanatomy of Music Performance, Perception, and Comprehension', *The Biological Foundations of Music*, ed. Robert J. Zatorre and Isabelle Peretz, Annals of the New York Academy of Sciences, 0077–8923/930 (New York, 2001), 211–31. A rather different approach that provides a sensorimotor account of rhythm while avoiding the issue of concepts entirely (thus offering an alternative to the view I present) can be found in Neil P. McAngus Todd, Donald J. O'Boyle and Christopher S. Lee, 'A Sensory-Motor Theory of Rhythm, Time Perception and Beat Induction', *Journal of New Music Research*, 28 (1999), 5–28.

[16] Trevarthen proposes that within the first weeks of life infants begin to develop a body-moving rhythmic and emotionally modulated system called the Intrinsic Motive Formation (IMF) system. The IMF coordinates and regulates movements and their prospective sensory control, and in the process creates an integrated hierarchy of motor rhythms with varying qualities of expression called the Intrinsic Motive Pulse (IMP). Trevarthen writes: 'Musicality, the active part of it at least, is the aurally appreciated expression of the activity of the IMF, with the IMP as its agent' (Colwyn Trevarthen, 'Musicality and the Intrinsic Motivic Pulse: Evidence from Human Psychobiology and Infant Communication', *Musicae scientae*, Special Issue, 1999–2000, 115–215 (p. 160)). See also Colwyn Trevarthen and Kenneth J. Aitken, 'Infant Intersubjectivity: Research, Theory, and Clinical Applications', *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 42 (2001), 3–48.

knowledge and knowledge about music. Regularity, for example, is instantiated both by periodic motions of the body and by a succession of evenly spaced musical sounds. These concepts can also be specified for music and coordinated through an inferential structure for making judgments about music, such as the conceptual model for musical rhythm discussed above. The concept of regularity is specified through P1 of the model, differentiation through P2 and cyclicity through P3. Although this specification foregrounds musical knowledge, embodied knowledge is still part of the picture. This is suggested by P4: rhythmic music is something to which we can move. When musical events summon the concepts of regularity, differentiation and cyclicity (either singularly or jointly), knowledge about both music and bodily motion is activated. Such events will, in consequence, function as ready targets onto which bodily motions can be mapped.

There are, nonetheless, limitations on how mappings between bodily motion and musical events can be accomplished. It is a simple psychological and physical fact that we cannot tap our toes to just anything: if recurrent musical events occur at too great a temporal interval (if the beat is too slow) the rhythmic frame diminishes in salience; if the temporal interval is too small (if the beat is too fast) we will typically find some other way of organizing the events in order to create a meaningful rhythmic frame.[17] More specifically, research on temporal acuity and judgment has demonstrated a significance for periodicities in the 600–700 millisecond range. Using the crotchet as the unit of the beat this yields a range of ♩ = 85–100, and whenever possible we prefer to locate the beat in this range.

The approach to embodied knowledge I have sketched here, and the relationship of that knowledge to musical knowledge, offers one way of explaining the strong connection between bodily motion and rhythmic music noted by many writers. The concepts key to our understanding of rhythm – regularity, differentiation and cyclicity – draw on focal features of both our embodied and musical experience. It is thus natural to imagine music that correlates with some of our favourite bodily motions, and to imagine bodily motions that correlate with some of our favourite music.

Conceptual models, listening and performing

From the perspective of research in cognitive psychology, the notion of rhythm – although not necessarily musical rhythm – is basic to human experience. This is the first sense in which I invoked 'listeners' at the beginning of this article: except in rare cases of neuro-anatomical dysfunction, human beings are rhythmic beings. It should not be assumed, however, that everyone responds to a given work of music in the same way – cultural knowledge, including knowledge about how to map bodily motion onto physical sound, is also involved.

[17] For a review of the relevant literature and empirical data see Justin London, 'Cognitive Constraints on Metric Systems: Some Observations and Hypotheses', *Music Perception*, 19 (2002), 534–9.

This is the second sense of 'listeners' that it is well to keep in mind: being a member of a musical culture means knowing how to interact with the musics specific to that culture. When listeners respond to a groove, they are demonstrating a particular kind of cultural knowledge, characterized in part by the conceptual model I have outlined.

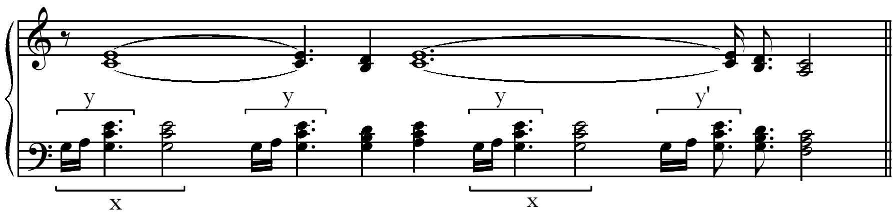
Real or imagined bodily motion is, of course, how most listeners respond to a groove. It is also a prerequisite for the musicians producing the groove. This is not to say that we should equate, in a simple way, the physical activities associated with producing music and responding to it: clearly there are differences, and these distinguish people who can make music from those who cannot. There is a similar and related difference between the knowledge used to guide these activities: the conceptual models used to produce a work of music are not the same as those used to guide listening to that same work. But they are in most cases related. This issue will be explored in more detail below, but its outlines can be glimpsed by considering how the provisional model for musical rhythm sketched above could be applied to the creation of a satisfying musical performance. The musician who undertakes this task must get orientated to the set of regularly occurring musical events that make up the piece in question (P1), clearly differentiate its constituent elements by various stratagems of performance (P2), be sure to project the larger framework for rhythmic organization (P3; this is something that is particularly important for various kinds of dance music), and keep the music rhythmically alive (P4). Of course, a skilled musician relies on more than these general directions to produce a compelling performance. Nonetheless, this outline suggests that the basic touchstones we use to organize our understanding of and interactions with musical rhythm also serve as guides for musical performance.

Summary

According to the perspective I have developed here, our knowledge about music is organized through conceptual models. These models are cognitive structures, but cognition is here understood to include, by way of perceptual symbol systems, information drawn from perception and proprioception. Concepts like regularity, differentiation and cyclicity, all central to our understanding of musical rhythm, are a common ground where embodied and musical knowledge meet. Because such concepts rely on experiences shared by all humans, they will be in evidence (in one form or another) in all human cultures. This is not to say, however, that all cultures will apply them to music in the same way; indeed, being a member of a musical culture means knowing how to apply these concepts to the musics specific to that culture. And these applications will not be uniform even for members of the same musical culture, in that the concepts will be specified in one way for listening, and in another way for performing.

With these thoughts in mind, let us now explore the conceptual model behind a specific musical groove, starting from the perspective of the musicians generating the groove.

Example 1. First statement of the groove for Eric Clapton's 'It All Depends' (incomplete).



Modelling the groove

Eric Clapton, 'It All Depends'

'It All Depends' appeared on Eric Clapton's 1985 release *Behind the Sun*.[18] The tune, written by Clapton, is a moderate-tempo pop tune with something of a rhythm-and-blues flavour. The words for the song are occupied with an evaluation of a romantic relationship: is there something special between the singer and his beloved? 'It all depends on how you feel' – advice addressed predominantly to the beloved – is the answer provided by the chorus.

The recording begins with unaccompanied keyboards (synthesizers set up to sound a bit like inexpensive electronic organs, played by Chris Stainton and Peter Robinson) performing the music shown in Example 1. One thing notable about this music is the irregularity of the durations it presents. Were we to reckon these durations in terms of semiquavers, for instance, we would get the following pattern:

1 1 6 8 1 1 6 4 4 1 1 6 8 1 1 3 3 8

A common assumption among rhythmic theorists is that performers and listeners infer a regular beat (and thus a metre) when presented with such a pattern.[19] Indeed, given the importance of regularity to our conception of rhythm such an assumption seems fully warranted. And yet it need not be viewed as necessary in this particular case, in that more comprehensive regularities are evident within this passage. For instance, there are two statements of a large pattern (indicated with an 'x' on Example 1), which is four crotchets in duration and which comprises exactly the same pitch material both times. There are also four statements of a smaller pattern (three complete – 'y' – and one partial – 'y′'), all of which are two crotchets in duration (except for y′, which

[18] 'It All Depends' is not particularly noteworthy within Clapton's career; indeed, perhaps the most memorable song on *Behind the Sun* (Warner Bros. 9 25166-2) is 'Forever Man', which was the only tune on that release to get significant airplay.

[19] Fred Lerdahl and Ray Jackendoff, *A Generative Theory of Tonal Music* (Cambridge, MA, 1983), 18.

is truncated by a dotted quaver) and which have the same pitch material. And, as is evident from Example 1, the x and y patterns also overlap: each x begins with a y. These regularities suggest patterns typical of rhythmic music as characterized by the basic conceptual model outlined above. In line with P3 of that model (and to some extent supporting P1), the passage lays out two large cycles. Each begins with an x pattern, has a total duration of eight crotchets and, in its second half, has pitch material that contrasts with x. There are also four small cycles, resulting in the sort of differentiation of musical materials implied by P2. Each such cycle begins with a y pattern, has a duration of four crotchets and, in its latter half, involves pitch material which is sometimes almost exactly the same as y (something that happens when y co-occurs with x) and which is at other times different from y.

These various patterns suggest that, while a performer or listener might certainly infer a beat when hearing the music of Example 1, he or she would not have to do so in order to understand the passage as rhythmic, for the passage clearly sets out a multi-levelled rhythmic frame. The passage also provides an unambiguous tonal centre, which is projected both by the sustained pitches notated in the upper staff and by the statement of a C chord after each pair of semiquavers. Indeed, what we have here is a groove: a large-scale multi-layered pattern that involves both rhythmic and pitch materials. Although the notion of a groove that is not framed by a regular beat may seem counterintuitive, I would like to pursue it for a moment, both because of the lack of an explicit beat in Example 1 and because such a notion has interesting consequences for our understanding of grooves.

Were we to reflect, through musical notation, aspects of the rhythmic frame set out by this groove we might arrive at something like that given in the first portion of Example 2. There, the semiquaver figure is rendered as an upbeat, leading in each case to a tonic chord on the strong beat of the bar. This interpretation is supported by the entrances of the shaker (Phil Collins), guitar (Clapton) and bass (Donald 'Duck' Dunn), which are shown in the latter portion of the example. While the shaker, in semiquavers, lays out the ground for the various durations of the solo keyboard part (all of which can be understood as some multiple of a semiquaver), the guitar and especially the bass reinforce the sense that the tonic chords subsequent to the semiquavers should be heard as accented.

Although the time signature of Example 2 suggests the presence of a regular crotchet beat, the excerpt is remarkable for its studious avoidance of such a beat. Indeed, excepting the regular iterations of the shaker, the musicians articulate only beat 1 of the metre. The effect of the whole is remarkably like that of syncopation – note the agogic accents on the third quaver of the bar in bars 5, 7 and 8 and on the sixth quaver in bar 6, an emphasis Duck Dunn heightens by preceding each of these moments with silence – except that the regular metric cycle against which these emphases play is present only in its absence. What this suggests is an implicit quadruple metre, which is understood but never sounded by the musicians. There are thus two interacting rhythmic layers in the music of Example 2, each with a different function: an explicit layer, which projects

Example 2. First and second statements of the groove for Eric Clapton's 'It All Depends'.

the essential materials of the groove (and which involves both pitch and rhythm); and an implicit layer, which serves as a frame of reference for the explicit layer and as something that is left unstated.[20]

[20] After hearing this example Joti Rockwell suggested that the recording was almost certainly done with a 'click track': that is, the musicians coordinated their performance by listening to a series of equally spaced clicks that were prerecorded on one track of the master recording. Once the musicians laid down their various parts the click track was switched off or erased. After listening to the recording with this in mind, I agree: I think it highly likely that the technique was used, for there is a rock-solid consistency to the rhythmic frame of 'It All Depends' that does not typically come about by chance. I do not, however, believe that making what is implicit explicit for the purposes of recording argues against the notion of an implicit frame for the groove, for two reasons. First, the click track is used simply to ensure the consistency of the final product – it is not an intrinsic part of the conception of the groove, and would not be used for live performance. Second, the click track is typically undifferentiated, whereas the implicit rhythm is differentiated. This latter point is taken up in more detail below.

Let me take these observations and incorporate them into a conceptual model that captures not only the interaction between these rhythmic layers, but also the larger organizational structure of the groove for ‘It All Depends’. Again, the model is presented as a set of correlated propositions, but this time the perspective is that of the performing musicians.

G_1P1 The rhythmic framework for the groove is a danceable quadruple metre, which is never stated as such.
G_1P2 The main elements of the groove always line up on the downbeat, and are syncopated everywhere else.
G_1P3 The bass anchors the basic syncopations of the groove, and all the other instruments align themselves with these.
G_1P4 The materials of the groove are organized in two- and four-bar units; the groove starts again at the conclusion of the fourth bar.
G_1P5 Textural elements (like the shaker) add dimension to the rhythmic layers of the groove, but do not directly participate in the groove’s syncopations.

As was the case with the rudimentary conceptual model for rhythm, there is no expectation that the musicians who enact this groove would be able (or need) to render these propositions as explicit statements or formalize them in the way I have, nor do these propositions embody all of the knowledge necessary to play the groove. The model is instead intended to capture what is essential for performing this groove. For instance, consider what would happen were another musician to add a significant accent on the sixth quaver of bars 5, 7 and 8. Such an accent would not be in opposition to most of the propositions of the model, but it would conflict with G_1P3. The result would not be wrong (in a simple way) but it would create a groove that was different from that heard on the recording. Note that the latter half of each bar of the groove (with the exception of bar 6) is relatively sparse; this provides an opening into which one of the musicians might insert a bit of fill. Clapton in fact does just this in bar 8, when his upward scoop signals the end of the groove pattern. Were the situation entertained above to transpire – another musician adding accents on the sixth quaver of bars 5, 7 and 8 – the opening in the last half of each bar would almost completely disappear, and the distinctiveness of Clapton’s scoop would be lost.[21]

In a third iteration of the groove (the last before the vocals enter) a conga part (played by Ray Cooper) is added; the music is given in Example 3. Broadly speaking, this part conforms to G_1P5 of the model: it is a textural element that does not directly participate in the syncopations basic to the groove (and is thus

[21] According to the conceptual model, the first pass through the groove with solo keyboards is also somewhat exceptional (in that there is no bass to anchor the basic syncopations). This would be in keeping with hearing this pass as introductory.

Example 3. Third statement of the groove for Eric Clapton's 'It All Depends'.

similar to the shaker part). The conga part does, however, hint at the quadruple metre that is behind the groove by introducing agogic accents on beats 2 and 4. What is significant is that this is quadruple metre as it is usually performed in rock and roll: a four count with one kind of accent on beats 1 and 3 (the typical strong beats of quadruple metre) and another kind of accent – the 'backbeat' – on beats 2 and 4.

Conventional metric theory does not really have an adequate description for the differentiation of accents common in rock and roll: beats are either strong or weak.[22] An alternative, inspired in part by the distinction between explicit and implicit rhythmic layers drawn above, would be to construe a typical rock-and-roll quadruple metre as consisting of two levels of rhythmic activity: a primary level (with accents on beats 1 and 3) and a secondary level (with accents on beats 2 and 4). On the one hand, the secondary level is defined in relation to the primary level; whence the term 'backbeat', which designates a secondary kind of beat in relation to the main beats that are in 'front' of them.[23] On the other hand, the secondary level has a measure of independence, suggesting as it does a distinctive way to move the body (most often as some sort of reaction to the accents of the primary level). Extending this perspective to the groove of 'It All Depends', we could characterize the explicit layer of the groove as occupying a tertiary level: its rhythmic pattern is defined in relation to both the primary and the secondary levels of the implicit layer (remembering that the implicit layer is made partially explicit with the entrance of the conga part). Following the ideas about connections between embodied and musical knowledge developed above, each of these levels could function as a target onto which bodily motion could be mapped.[24]

Let me pause at this point and review features of the perspective on musical rhythm and metre developed in connection with my model for the groove of 'It All Depends'. First, the explicit rhythmic pattern of a groove may be framed in relation to an implicit pattern. This implicit pattern is knowledge shared by the musicians performing the groove, and its status is as something so familiar that it need never be stated. Second, the rhythmic structure of dance music may include distinct, and correlated, rhythmic levels. Such levels will be distinguished not solely by their place within a metric frame, but by association with distinctive timbres, registers, pitch collections, agogic accents or combinations of these things. Each level offers a target onto which we can map bodily motion.

[22] Recent metric theory enriches this picture by recognizing relative degrees of strength and weakness among beats: beat 3 of a quadruple metre is reckoned to be stronger than beats 2 and 4, but weaker than beat 1. However, this phenomenon is thought of as a consequence of interacting, hierarchically distinct cycles of strong and weak beats. (The classic study in this connection is Maury Yeston, *The Stratification of Musical Rhythm*, New Haven, 1976; see also Lerdahl and Jackendoff, *A Generative Theory of Tonal Music*, 18–21, and Harald Krebs, *Fantasy Pieces: Metrical Dissonance in the Music of Robert Schumann*, New York, 1999.) The differentiation between beats with which I am concerned – a differentiation common in dance music, including dances such as the sarabande, mazurka, hambo and Swedish polska – is not addressed by this approach to metre.

[23] This spatial metaphor is not, in my experience, worked out in discourse about rock-and-roll rhythm. That is, no one talks about 'frontbeats', or further spatializes their characterization of rhythmic relationships in ways distinct from those in which rhythm is generally characterized; for instance, musicians from a wide variety of backgrounds characterize musical events as 'on' or 'off' the beat, which I take to be a fundamentally spatial conception of beat location.

[24] Virgil Thomson, observing the prevalence of syncopation in early twentieth-century dance music, noted 'A silent accent is the strongest of all accents. It forces the body to replace it with a motion.' 'Jazz', *A Virgil Thomson Reader* (Boston, MA, 1981), 15–18 (p. 16). My thanks to Alex Ross for leading me to this quotation.

This motion may be real or imagined, and may involve only one portion of our body or one distinctive gesture (with another gesture or portion of the body assigned to another rhythmic level).

Having developed a conceptual model which could serve as the basis for producing a musical groove, let us now consider how this model might relate to one used for understanding that groove.

One groove, two models

As I have already suggested, we should not expect an audience's model of a groove to be the same as that of the musicians producing that groove; we should, however, expect there to be correlations between the two if we imagine them to be part of the same overall body of cultural knowledge. As a general rule, the audience's model will be more comprehensive and less specific – in other words, it will be quite a bit like the rudimentary conceptual model for rhythm we have already outlined. Figure 1 explores this through a diagram that places the two models in correspondence with one another. P1 from the basic model (which focuses on regularly occurring events) correlates with G_1P2 and G_1P3 of the model for 'It All Depends' (which pertain to the explicit layer of the groove). P2 (differentiation between events) correlates with interactions between the explicit and implicit layers (that is, G_1P1, G_1P2 and G_1P3). P3 (cyclicity) correlates most directly with G_1P4, although the propositions related to the explicit and implicit layers of the groove also have relevance for the cycles of rhythmic events assumed by P3. P4 (embodiment) correlates weakly with G_1P1: on the one hand, both models have a place for embodied knowledge (in the case of the musicians' model this knowledge is represented by the notion that the quadruple metre basic to the groove should be danceable), but where this knowledge is front and centre in the basic model, it remains somewhat behind the scenes in the musicians' model.

As is evident from Figure 1, while there are connections between the two models it is not the case that the musicians' model is a straightforward expansion of the basic model; it is instead a specialization of the knowledge embodied in the basic model. The knowledge basic to P1, for instance, is manifested in two different propositions (G_1P2 and G_1P3), each of which is concerned with a different aspect of the explicit layer of the groove. These propositions, taken together with G_1P1, also serve to represent the knowledge associated with P2. This seems to suggest that P1 and P2 from the basic model could be combined, yielding a proposition something like 'Rhythm concerns regularly occurring, differentiated musical events.' Nonetheless, while such a proposition certainly seems fundamental to the musicians' model, the concepts of regularity and differentiation (each associated with different proprioceptive information) are perhaps best kept distinct in the basic model for musical rhythm.

The connections between the two models seem clear. There remains, however, the question of how knowledge implicit in the musicians' model can be accommodated by the listener's model. Does it really make sense to say that a listener's expectation that musical rhythm is embodied will be satisfied by a

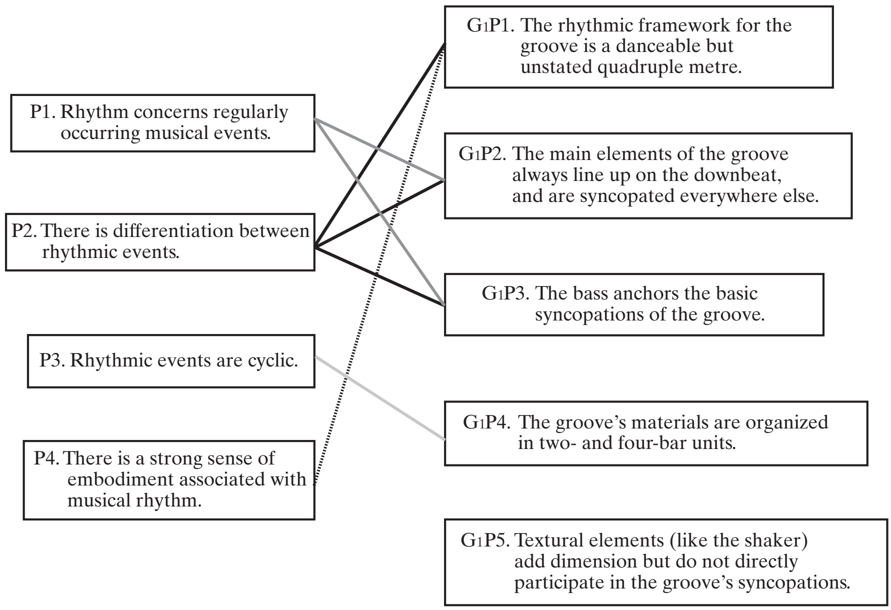


Figure 1. Correlation of the rudimentary model for musical rhythm and the model for the groove of 'It All Depends'.

rhythmic layer that is never stated? The answer lies in the limitations on human temporal perception that have been demonstrated by empirical research on temporal acuity and judgment.[25] Returning to the music of Example 2, we can note that there are only two evenly spaced series of musical events to be found there (and thus two possibilities for evenly spaced beats): the semiquavers of the shaker, and the combined attacks on the first beat of each bar. At the tempo taken in the recording, the semiquavers are spaced 170 milliseconds apart; at this speed the events occur simply too quickly to be processed individually, and will be heard not as beats but as subdivisions of the beat. At the other extreme, the first beats of each bar are spaced 2.73 seconds apart; these events occur too slowly to be understood as successive beats. The unstated crotchets of the implicit rhythmic layer, however, occur at intervals of 681 milliseconds, which is in perfect conformity with our preferred temporal interval for the beat. We are psychologically predisposed, then, to hear the constituent beats of the implicit layer of the groove for 'It All Depends'.

A psychological predisposition to hearing beats spaced at 681 millisecond intervals is not, however, quite the same thing as hearing a multi-levelled

[25] Justin London, 'Cognitive Constraints on Metric Systems: Some Observations and Hypotheses', *Music Perception*, 19 (2002), 529–50.

rhythmic pattern – remember that the full context for the groove assumes that beats 1 and 3 of the implicit layer are distinct from beats 2 and 4. Thus our predisposition must be combined with knowledge about what sort of metrical patterns are typical of popular music. We can reflect this stylistic knowledge by adding a proposition to the basic model for musical rhythm:

P5 Popular music and rock and roll involve a two-levelled quadruple metre.

This proposition then works together with the other four, yielding a model for musical rhythm in popular music (as distinct from the basic four-proposition model for musical rhythm).

Both the musicians' model and the listener's model for the groove thus combine embodied knowledge and conventional (or stylistic) knowledge, and this knowledge can be either explicit or implicit. Modelling the groove is not a simple matter of propositional knowledge, any more than it is an unthinking response to sonic stimuli. It is instead the result of a process where, as individual humans, we interact with what we hear as well as with the social and cultural context within which that hearing takes place.

Interactions with the groove

Even working within the limits I have set myself, the world of the groove is a rich and varied one. I consider only two further examples, with the expectation that the approach I have outlined could be applied to many more. The first, from a performance led by Miles Davis, demonstrates what happens when the features of the musician's model of the groove do not match those of the audience. The second example, from a performance led by James Brown, shows how a groove can engender a more highly specified dynamic frame, which in turn suggests a richer set of possibilities for mapping physical motion onto patterned sound.

Miles Davis, 'If I Were a Bell'

Miles Davis began his 1956 recording of Frank Loesser's 'If I Were a Bell' with eight finger snaps spaced about 625 milliseconds apart: a perfectly clear counting beat that sets up an indisputable metric frame.[26] But when Red Garland, playing piano, enters, he does so between the snaps, as shown in Example 4. Davis's snaps set out not the counting beat, but divisions of the counting beat. The result is what jazz musicians call a 'double-time feel', which involves playing twice the speed of the main metric frame but without speeding up the basic

[26] The personnel on the recording include Davis on trumpet, Red Garland on piano, Paul Chambers on bass, Philly Joe Jones on drums and John Coltrane on tenor saxophone. The recording session took place on 26 October 1956 in Hackensack, NJ, and appeared on *Relaxin' with Miles*. It has been re-released under the same name on CD as Prestige OJCCD-190-2. My thanks to Paul Steinbeck for bringing this performance to my attention.

Example 4. Introduction to Miles Davis's version of 'If I Were a Bell'.

harmonic rhythm of the tune. The harmonic rhythm, as Garland's piano part suggests, is one main harmony per bar, and these are then grouped into two- and four-bar units (as Paul Chambers's bass part suggests, and the repetition of Garland's evocation of the Westminster chimes confirms).[27]

The model for the groove set up by Davis and his rhythm section is a straightforward one, and can be characterized with just three propositions:

G_2P1 The music has a double-time feel.
G_2P2 The groove is organized into two- and four-bar units.
G_2P3 There is one basic harmony per bar.[28]

While Davis's finger snaps, by themselves, almost certainly do not signify a double-time feel to most listeners, Garland's and Chambers's confident

[27] The Westminster chimes are more properly called the Westminster Quarters. For a discussion of the pitch successions basic to such chimes, see Daniel Harrison, 'Tolling Time', *Music Theory Online*, 6/4 (October 2000; <www.societymusictheory.org/mto/issues/mto.00.6.4/toc.6.4.html>).

[28] The notion that there is one basic harmony per bar fits not only with Garland's introduction, but also with the predominant harmonic pattern set out by Loesser in the original version of the tune. It should be noted, however, that in performance there is a harmonic change – sometimes subtle, sometimes more pronounced – in the second half of almost every bar, which is typical of the way such harmonic patterns are interpreted by the rhythm section.

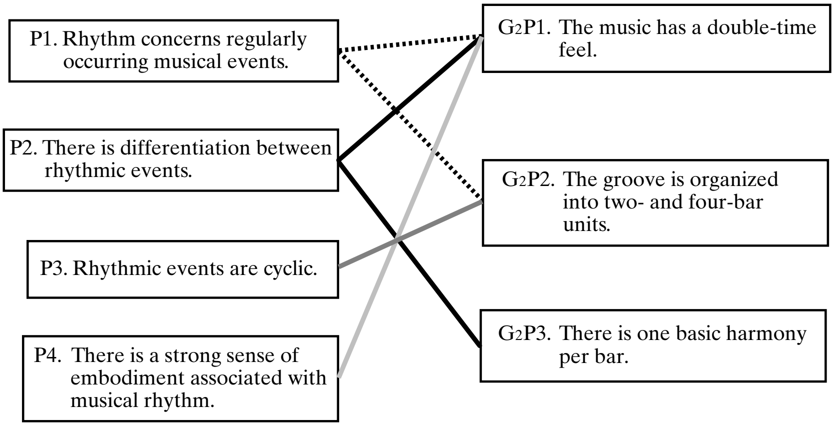


Figure 2. Correlation of the rudimentary model for musical rhythm and the model for Miles Davis's version of 'If I Were a Bell'.

entrances, together with the musical pun of the introduction, suggest that the group had worked out the arrangement in advance and that Davis's finger snaps were understood as cues for the divisions of the beat.[29]

Setting aside, for the moment, the disruption caused by Garland's entrance we find that, once again, the musicians' model has a number of close relationships with the basic model for rhythm. Connections between the models are diagrammed in Figure 2. P1 from the basic model (regularly occurring events) correlates with G_2P1 and G_2P2 of the model for 'If I Were a Bell'; given the tempo, it is easier to hear the two- and four-bar units as contributing to an explicit sense of rhythm than it was in Clapton's 'It All Depends'. Similarly, P2 (differentiation between events) correlates with G_2P3 because, given the tempo, the harmonic changes occur at what would be a comparable minim level in many other tunes, and their contribution to the differentiation of materials is easily heard. P3 (cyclicity) correlates directly with G_2P2, and P4 (embodiment, perhaps activated by Davis's snaps) with G_2P1.

But let us return to the sense of disruption that makes the opening of this piece truly remarkable. The listener, of course, has no way of knowing how Davis's finger snaps are to be interpreted. Given the eight finger snaps, spaced at a temporal interval perfectly in keeping with our preferred level of the beat, the natural inclination is to take these as the beat. Garland's entrance forces a

[29] That Davis and the group had rehearsed this introduction is supported, indirectly, by Davis's comment to the engineer just prior to his finger snaps: 'I'll play it and tell you what it is later.' This suggests that Davis and the group knew quite well what the tune was, and how they were going to play it, but that this knowledge had not yet been shared with the technical staff on the recording. Davis also could have clarified the intent of his finger snaps by using a head nod or other gesture to signal the placement of the main beats relative to which his finger snaps were to be understood, but I am not aware of any evidence confirming that he did so.

double re-interpretation of the finger snaps: they are not only not the main counting beat, but they are divisions of the counting beat. I would not want to make too much of our preference to find the beat in the 600–700 millisecond range – after all, music can move at a variety of speeds – but I do find that accommodating both the main beats and Davis's divisions of those beats (once Garland has entered) gives a hurried feel to the music (the main beats and Davis's divisions occur about 312 milliseconds apart) which becomes attenuated once I move the metric framework completely to the main beats outlined by Garland's chimes.

Thus the disruption we feel when the metric frame is re-orientated by Garland's entrance can be attributed, at least in part, to our preference to locate the beat at what is the minim level in Davis's performance. Another factor, however, may be our expectation that metric cues given at the outset of a performance point to the counting beat, an expectation that seems to be of a different order from our preferred level for the beat. Once again, we could reflect this knowledge by adding a proposition to the basic conceptual model for rhythm, along the lines of:

P5′ One member of the group often counts in the others in live performance.

When we hear Davis's finger snaps, then, our default assumption is that he is setting out the basic beat for the performance, rather than the divisions of the beat that he actually indicates. That something like this is behind the jarring effect of Garland's entrance seems plausible: if we count double time from the point when the finger snaps start, the piano entrance is somewhat easier to assimilate, but we must still re-orientate the beat away from the finger snaps and onto the piano.

The opening of Davis's arrangement of 'If I Were a Bell' thus suggests that listeners bring a variety of knowledge to the understanding of grooves, including knowledge about performance practice. As my proposed expansion of the basic model for musical rhythm shows, listeners know (if only implicitly) that a groove is more than a large-scale, multi-layered pattern that involves both pitch and rhythmic materials; they know that it is also a consequence of a set of cultural practices that make music-making possible.

James Brown, 'Doing it to Death/Gonna Have a Funky Good Time'

There is nothing equivocal in the opening of James Brown's 'Doing it to Death', which he released under the name of Fred Wesley and the J. B.'s and which was also known by its opening line, 'Gonna Have a Funky Good Time'.[30] The recording starts with Brown's 'Hit it!', and in response the groove begins

[30] Fred Wesley, on trombone, directed James Brown's band during the early 1970s. 'Doing it to Death' was originally released in 1973, and has been re-released on *James Brown 40th Anniversary Collection*, Polydor CD 31543 3409-2, and on *Star Time*, Polydor 849 112-2. My thanks again to Paul Steinbeck, who not only brought this recording to my attention but also provided a transcription of the groove, upon which my transcription is based.

Example 5. First two statements of the groove for James Brown's 'Doing it to Death/Gonna Have a Funky Good Time'.

immediately, stopping only when the recording comes to an end some five minutes later. And a powerful groove it is, an amalgam of drums, hand claps, bass and guitars, all framed around a near-constant pulse of ♩. = 114.[31] The groove is built on the two-levelled quadruple metre which was basic to Clapton's 'It All Depends'. But in this case the quadruple metre subdivides by three, yielding the rolling 12/8 typical of the blues and blues-derived genres. (For the sake of simplicity I shall continue to refer to the main beats of the metric frame as if this were a straightforward quadruple metre.) As Example 5 shows, the bass drum, playing a steady ♩♪ pattern, anchors the groove, with the snare and hand claps providing the accents on beats 2 and 4. The bass guitar, for its part, contributes to the backbeat with agogic accents; indeed, without the context provided by the other instruments it would be very easy to hear the bass's long notes as setting out beats 1 and 3 rather than 2 and 4. Against this backdrop the second guitar uses two different strategies for grouping its attacks in the course of each bar. In the first half of the bar the guitar plays as though it were in 3/4 time, the three pairs of quavers and quaver rests equivalent to three crotchets. In the second half of the bar the guitar, putting itself in conformity with the other instruments, switches to 6/8 time. This strategy tends to destabilize the first half of the bar (with a grouping dissonance between the guitar and the other parts), and to stabilize the second half of the bar (when the groupings in all the parts agree with each other).[32]

[31] In his transcription Steinbeck notes that the tempo ranges between 112 and 116 beats per minute over the course of the recording – that is, ± 1.8%.

[32] Grouping dissonances of this sort are discussed in greater detail in Krebs, *Fantasy Pieces*.

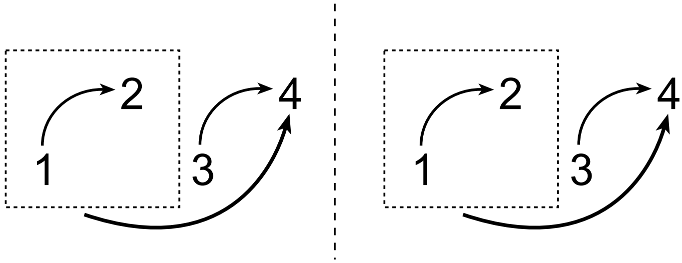


Figure 3. Dynamic shape for the groove of James Brown's 'Doing it to Death/Gonna Have a Funky Good Time'.

This pattern of stability and instability is diagrammed in Figure 3. The two-levelled quadruple metre basic to the groove is represented through placing beats 1 and 3 and beats 2 and 4 at different heights on the page. The sense of moving toward beats 2 and 4 provided by the bass's figure is represented by arrows from beat 1 to beat 2, and from beat 3 to beat 4. Finally, the instability of the first half of the bar suggested by the second guitar's rhythmic pattern is represented with an arrow from the box that encloses beats 1 and 2 to beat 4, meant to suggest the culmination of the rhythmic pattern on the last main beat of each bar. The result is an end-accented structure typical of some Western African rhythms – indeed, Figure 3 shows a bar with a dynamic structure that is the mirror image of conventional quadruple metres in which beat 1 is the most accented and beat 4 the least accented.

As a consequence of all this rhythmic activity the groove for 'Doing it to Death' provides four possible targets for bodily motion, three of which are distinct from one another and one of which is comprehensive. The first two targets are those established by the two-levelled quadruple metre; the third is set up by the rhythmic pattern of the second guitar, which toggles between dividing the first half of the bar in three and the second half of the bar in two; the fourth (and comprehensive) target is created by the dynamic shape of each bar, which culminates in a strong arrival on beat 4. In short, the groove presents a number of possibilities for bodily motion as the combinations of these different patterns are realized. For instance, a dancer could move his hips with beats 1 and 3, his arms with beats 2 and 4, and gesture with his head in correspondence with the rhythmic pattern set up by the second guitar. Another dancer could move her feet with beats 1 and 3 but then move her whole body according to the dynamic pattern diagrammed in Figure 3. When the various ways a dancer could move his or her body are combined with the four targets for bodily motion set up by the groove the permutational possibilities are truly impressive, suggesting why, despite a lack of memorable lyrics or a striking melody, 'Doing it to Death' rose to million-seller status.

As was the case with the other grooves I have considered, that for James Brown's 'Doing it to Death' is a complex, multi-layered pattern that involves both pitch and rhythmic materials. And yet, because of the way these materials fit together and because they are repeated with little variation over 130 times in the course of the recording, the groove does not represent an intellectual challenge. Its complexity is instead one so common in our cognitive lives as to be thoroughly unremarkable: a complexity of perceptual and proprioceptual information, bodily motions (both potential and actualized), introspective states of awareness, thoughts and feelings that contribute to the texture of our conscious lives.[33] But it is precisely because our apprehension of rhythmic structure involves higher-order cognitive processes of the sort that regularly make sense of this complexity that grooves like that for 'Doing it to Death' seem so transparent. It is only when we pause to consider why grooves are so seductive, and their rhythmic compulsion so inevitable, that this complexity becomes apparent.

Conclusions

There is a tendency, especially among the literate, to regard knowledge as that which is or can be written down. Although this reflects the importance of language and systems of representation to human thought, an importance it would be foolish to deny, it leads to certain difficulties when one comes to the study of popular music. Not only is music as a whole a para-linguistic medium, but much – indeed, most – of popular music is part of an aural tradition of music-making which has little if any use for symbolic representation. If knowledge is indeed limited to that which is or can be written down, then much of popular music is beyond knowledge: to ask what a listener knows when he or she knows a groove is to entertain a question that can have no answer. But this seems silly, and extraordinarily limiting, as it places a vital part of contemporary life beyond inquiry. We instead need to entertain an expanded view of the nature of knowledge, a view that follows from construing knowledge as basic to the prospect of culture itself.

According to this view, the knowledge that is central to culture is organized through relatively basic cognitive structures that act as guides for reasoning and inference, structures that I call conceptual models. Conceptual models are used for both the understanding and the production of music. Important for all kinds of music, they come to special prominence when we consider how music of aural traditions manifests cultural knowledge. To the extent that someone is a member of a musical culture – whether that culture be so intensely local that it extends to only a small group of musicians and listeners, or so global that it encompasses an entire continent – he or she shares conceptual models with other members of that musical culture. Such sharing is never exact, but is part of a dynamic process through which culture is realized. The knowledge organized by

[33] On the complexity and efficacy of consciousness see Merlin Donald, *A Mind So Rare: The Evolution of Human Consciousness* (New York, 2001). On the relationship between feelings, emotions and consciousness, see Damasio, *The Feeling of What Happens*.

conceptual models is rarely propositional (although I have used a loose notion of 'proposition' to characterize the structure of the conceptual models I have discussed) and is built on information derived from perception and proprioception, as well as from cognitive structures more typically described as 'conceptual'. For a listener, knowing a groove means being able to summon conceptual models that can be used to guide behavioural or cognitive responses to the groove.

Among the models a listener might summon is a basic conceptual model for musical rhythm of the sort I described above. Such a model plucks out the salient features of a sequence of sounds that would allow them to be categorized as musically 'rhythmic' and provides a basis for response to these sounds: knowing that rhythm concerns regularly occurring musical events suggests the anticipation of such events; knowing that rhythmic events are differentiated suggests a heightened attention to the things that differentiate various elements of a specific sequence of events; knowing that rhythmic events are cyclic allows a response to a sequence of musical events that plays out over a larger time frame; and knowing that musical rhythm is associated with a strong sense of embodiment suggests that the most proper response to musical rhythm is to move. This is, of course, not all that is needed to make sense of a groove – the propositions I added to this basic model to accommodate aspects of Clapton's and Davis's grooves suggest that more is needed to make sense of many grooves – but it is knowledge of this sort, organized into coherent, holistic cognitive structures, that is essential to knowing a groove.

Conceptual models are used for understanding grooves, and they are also used for producing grooves. The models used by musicians may have a quite different structure from those of members of their audience, reflecting the intellectual and physical specificities of musical performance. The propositions of the models I described for Clapton's 'It All Depends' and Davis's 'If I Were a Bell' connect with the propositions for the basic model for musical rhythm, but reinterpret and reformulate these propositions in accordance with the demands of performance. In a somewhat similar fashion, my descriptions of how listeners and musicians model the groove fit with some but not all of the features of conventional theories of musical rhythm (which place more emphasis on a sounding beat as a basic unit of measurement for rhythmic understanding). More specifically, I have argued that listeners can make sense of a groove (as a large-scale, multi-layered pattern that involves both pitch and rhythmic materials) without reference to an explicit beat; an implicit knowledge of rhythmic frameworks (including but not limited to a knowledge of regular beat patterns) may help guide the process of making sense of a groove; and multiple patterns of accent, especially where these are correlated with the traditions of dance, can obtain within a rhythmic framework. This argument not only pushes the framework for understanding rhythm and metre beyond the sounding surface, but also makes a place for embodied knowledge within rhythmic theory. Our understanding of rhythm is shaped not only by our tendency to locate rhythmic periodicities within a somewhat limited range of temporal intervals, but also by our regard of rhythmic patterns as targets onto which we can map real or imagined bodily motion. A willingness to do such mappings adds dimensionality to the way we move with a groove, for, as we saw with the groove for Brown's 'Doing it to Death', a good groove offers a number of targets for bodily motion.

The conceptual models I have outlined are first approximations of the knowledge listeners use to make sense of grooves, and that musicians use to produce grooves. A fuller understanding of this knowledge will require more detailed models, a more elaborate account of the origins of conceptual models within perceptual symbol systems and the context within which they operate, and a more complete description of how conceptual models change over time. Nonetheless, this approach allows us to glimpse how we might confront the problem of modelling the groove, but now with groove understood as a phenomenon roughly equivalent to 'swing'. This sort of groove is rather more complex than the relatively straightforward patterns with which I have been concerned in the foregoing, for groove as a feel is a quicksilver thing as changeable as music itself. Even so, musicians must still have a conception of the basic framework which provides an opportunity for the creation of this sort of feel, a framework that includes knowledge about how rhythmic and pitch materials are organized and how members of a musical ensemble will realize this organization. They have to know how to model a groove.

What does someone know when they know a good groove? Quite a lot: they know what makes for musical rhythm, how the body might respond to rhythm, and the context within which large-scale, multi-layered patterns of pitch and rhythmic materials are produced. In short, they know music.

ABSTRACT

A musical groove is most typically created by a small group of musicians working together, each contributing parts to the whole. Characterizing the knowledge behind such interactive ventures has proved to be challenging. This article attempts to characterize the knowledge basic to grooves first by concentrating on 'the groove' as it is practised in soul, rhythm and blues, jazz fusion and various other popular genres, and second by focusing on cognitive knowledge structures called conceptual models. It is argued that musicians rely on such structures to produce grooves, and that listeners make use of similar structures to understand them. Grooves from the music of Eric Clapton, Miles Davis and James Brown are discussed, and conceptual models for each are developed.