NAVIGATING MUSICAL PERIODICITIES:

MODES OF PERCEPTION AND TYPES OF TEMPORAL KNOWLEDGE

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ABSTRACT

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This dissertation explores multi-modal, symbolic, and embodied strategies for navigating musical periodicity, or "meter." In the first half, I argue that these resources and techniques are often marginalized or sidelined in music theory and psychology on the basis of definition or context, regardless of usefulness. In the second half, I explore how expanded notions of metric experience can enrich musical analysis. I then relate them to existing approaches in music pedagogy.

Music theory and music psychology commonly assume experience to be perceptual, music to be a sound object, and perception of music to mean listening. In addition, observable actions of a metaphorical "body" (and, similarly, performers' perspectives) are often subordinate to internal processes of a metaphorical "mind" (and listeners' experiences). These general preferences, priorities, and contextual norms have culminated in a model of "attentional entrainment" for meter perception, emerging through work by Mari Riess Jones, Robert Gjerdingen, and Justin London, and drawing upon laboratory experiments in which listeners interact with a novel sound stimulus. I hold that this starting point reflects a desire to focus upon essential and universal aspects of experience, at the expense of other useful resources and strategies (e.g. extensive practice with a particular piece, abstract ideas of what will occur, symbolic cues)

Opening discussion of musical periodicity without these restrictions acknowledges experiences beyond attending, beyond listening, and perhaps beyond perceiving. I construct two

categories for various resources and strategies: those which involve dynamic symbolic encoding (such as conducting patterns and *tala* gestures) and those which utilize static theoretical information (such as score-based knowledge and calculation of abstract relationships). My primary means of revealing and exploring these additional resources involves instances of "metric multi-tasking," in which musicians keep track of multiple non-nested periodicities occurring simultaneously. One of the reasons these situations work so well at revealing additional resources is that attentional entrainment offers no explanation for how one might be able to do such a thing (only that attention is insufficient for the task). I do not make these moves in an attempt to significantly alter the theory of attentional entrainment. Rather, I frame that model as but one mode of temporal perception among many. I also leave room for types of temporal *knowledge* which may not be perceptual at all, but are nonetheless useful in situations involving musical periodicity. Pedagogical systems already make use of dynamic symbols and theoretical knowledge to help with temporally *difficult* tasks, and generally not virtuosic feats of metric multi-tasking. With these ideas in mind, I return to more straightforward "mono-metric" contexts and reconsider what to do with the concepts of "meter" and "perception."

TABLE OF CONTENTS

LIST OF EXAMPLES

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INTRODUCTION: NAVIGATING MUSICAL PERIODICITY… OR METER PERCEPTION?

As a music scholar, I often come into contact with pieces by first reading about them in articles and books. An author conveys some noteworthy characteristics of a piece to me through her prose, often accompanied by clarifying diagrams and figures. I am likely to then find a recording of the piece, in order to hear whatever effect she describes. But if her point is subtle, difficult to hear, or simply occurs too quickly, my next step is likely to find a score (or lead sheet). That document gives a lot more information to peruse, and (unlike a recording) I can explore it at any pace. I can pause over each sixteenth-note, despite the fact that they might have quickly flown by on the recording. I can do this abstractly (i.e. "in my head") or sit down at the keyboard and get a sense of the passage. By playing a piece through myself, I can hear relations at any pace I want. I also come into contact with physical and mental challenges required to play the piece, and those may be distinct from when I simply listen to the recording.

Can reading an analysis of a piece of music you've never heard be a "musical" and "metrical" experience? Can studying a score? What about playing a piece at an electronic keyboard *with the sound turned off*? Because these interactions don't involve sound, we might say they relate to music, but only indirectly. The analysis and score include information *about* music, perhaps, and the silent performance involves only physical mechanics. In music theory, I don't think we give these non-sounding experiences much weight, or we sideline them on the grounds of being "unmusical." That marginalization reflects the disciplinary history of appeals to musical experience for the validation of theoretical claims. With the expansion of post-tonal theory in particular, theorists justified an analysis of such-and-such a set class as not an arbitrary

group of pitches, but one which is (or can potentially be) *experienced*. The appeal to experience probably emerged out of some degree of paranoia that theorists—surrounded by books and scores—might not be finding relationships relevant to music *sound*. The charge might be "who cares whether you *see* such-and-such an aggregate if you cannot hear it!" Justin London takes on this sort of problem in his critique (2009) of "modern and post-modern music" from the perspective of musical psychology, in which he defines music perception as an experience of sounds unmediated by (for example) knowledge of a score. However, the fact that something is not *heard* does not preclude its being productive and meaningful in a particular musical situation. Sometimes to know about a relationship, without being able to hear it, may be an aesthetically meaningful experience. And some musical features can be better "heard" after being seen, done, felt, and abstractly calculated. Without an awareness of our many musical resources, we may fail to grasp our own potential.

To perceive a *visual* object, such as a painting, you can manipulate its distance by moving closer or stepping back. By contrast, when listening to music sounds, temporal relations are not so easily manipulated. Candace Brower's "Memory and the Perception of Rhythm" (1993) notes how distinct forms of memory (echoic, short-term, and long-term) may be in operation for different rhythmic distances (i.e. timespans), and how tracking longer time-spans involves more counting and abstraction. Nonetheless, the temporal organization of a piece cannot be paused in time and still be heard. Two related passages (such as an exposition and recapitulation of a sonata) cannot be heard simultaneously for comparison without sonic interference between the two. These are all possibilities afforded by scores. Scores are atemporal

objects.[1] You can view separate passages alongside each other, and pause upon individual pitch symbols regardless of how quickly they actually occur when sounded.

Digital and mechanical tools can also contribute to musical knowledge. In transcribing "exotic music," ethnomusicologists Otto Abraham and Erich von Hornbostel noted the value of using a phonograph to capture things which the ear did not (Abraham and von Hornbostel 1994, 446). Similarly, Nazir Jairazbhoy (1977) praised automatic transcription technology for being able to fill in items which we cannot hear, or which we cannot hear with adequate precision. Jairazbhoy argues that these details revealed through transcription machinery are musically meaningful despite the fact that they might be difficult to hear. More specifically, he argues that automatic transcription may help to avoid the distortions of a Western notational system and reveal nuances that that notation fails to capture. Modern technology has additional capabilities. Software can slow or speed up an example. When transcribing Brad Mehldau's interpretation of "Anthropology" (discussed in Chapter 3) I could not hear every temporal relationship at the blistering tempo of the performance until artificially slowing it down in the program Transcribe!. With that program, on the other hand, specific durations can be precisely measured and compared even if they fall below "just noticeable difference" thresholds on perception as determined in laboratory experiments. Even if we consider the artificially slowed version as a different piece (though we need not), working with it nonetheless changes how I hear the recording at the original tempo.

All these forms of engagement—studying a score, performing a passage, listening to a manipulated recording, and transcribing—contribute musical knowledge and rely on specific

[1] Scores may signify a temporal object or an experience of that object, and the experience of a score may be temporal. Nonetheless, the score itself does not change in time.

practice time and effort with a piece of music. Having that time and effort to work with a piece develops expectations about what occurs later. It also readies optimal strategies which respond to specific challenging aspects.

Discussions of meter typically explore engagement with musical periodicity as a form of perception, which occurs by listening for cyclical events. That perception is considered as a process of entrainment, in which one's attention (or expectations, or neuronal oscillations) synchronize with regular events of a sounding object. Although a listener may be a performer, the activities and resources distinct to performers are not central. And motor behavior such as foot tapping, is treated as a reflection of some internal activity.

This project has two goals. The first goal is to highlight how certain trends and norms in discussions of musical periodicity are unduly limited. The second goal is to discuss musical periodicity without those restrictions. This means identifying and exploring resources and strategies which are *potentially useful* for navigating musical periodicity as opposed to ones which are essential or universal components of experience. These activities are generally not considered to be part of listening—although some of them may be undertaken *while* listening—but affect musical experience nonetheless. Accordingly, the assumption that meter must be a matter of listening is brought into question. Rather than reframe meter from the outset, I use "navigating musical periodicity" instead of "meter perception" to de-familiarize what we take for granted. Terms such as "meter" and "perception" carry with them baggage full of the very same trends and norms from which I attempt to break free, and some contexts I discuss might not be "perceptual" at all. I will use the terms "meter" and "perception," but without any requirement that the terms always apply to the phenomena under discussion. Redefining meter is not at the absolute center of this project. Rather, I consider that task a corollary from the expanded contexts

and strategies for which I make room. To use the seafaring term "navigate" also brings out other fitting ideas, such as the use of instruments and maps, or the priority placed on not getting lost.

"Meter" not only has substantial baggage, its definitions are also inconsistent. Most usage involves temporal periodicity along with some degree of structural hierarchy.[2] However, "meter" may refer to music-notational constructs, sound organization, or a particular kind of experience. The categories are entangled with each other, but also nonequivalent. On the one hand, notational conventions involve the representation of sound organizations which in turn may be experienced by a perceiver. On the other hand, there is "virtually unanimous agreement" that meter signatures are often not consistent with the ways in which rhythms are perceived and/or performed, and "the main disagreements have to do with how metric patterns are perceived or subjectively organized" (Russell Jones 1985, 54). Although pedagogical sources may be more likely to treat meter in terms of its notation, most definitions in music theory treat it as either an attributed property (which may be perceived) or as a way of perceiving itself.

Neutral, "objective" definitions of meter refer to hierarchy or periodicity *in some object*, usually sounds, though possibly also brain activity. "Psychological" definitions of meter consider it as a type of *experience*. Objective definitions do not prescribe any manner in which periodicity is experienced, but psychological definitions do. Psychological definitions may hold that it is a

[2] There are two notable exceptions to the general concept of meter as involving hierarchy. William Benjamin states that his inclination "is to think of meter as not necessarily, although normally, hierarchic and to speak of a single level of pulsation as a metric level, as I have been doing" (Benjamin 1984, 371). Harald Krebs' (1999) definition of meter is a bit more idiosyncratic. As he defines it, "meter" subsumes *all* periodicities of a work, including "interpretive layers" which do not need to align with each other. And yet, Krebs also seems to step away from his definition in actual usage. He refers to dissonance as involving interaction between "metrical" and "anti-metrical" layers, for example (Krebs 1999, 31). With this dichotomy, he implies meter is not *just* a union of all temporal layers. Clearly, some layers—the "metrical" ones which align with each other—have more to do with meter than the "antimetrical" layers which don't.

way of perceiving which responds to a periodic stimulus,[3] that the way of perceiving is itself periodic,[4] or both.[5] An experiential requirement upon meter helps fundamentally align the term's definition with its common usage. One fear might be that taking away conventional experiential requirements leaves open the possibility of regular sunrises and sunsets having "meter." I think such a fear is unfounded, though I would also be open to such a possibility. Leaving experience out of a definition, does not remove experience or perception from discussion, however. There is also another option, to define meter "in the music," but also require that periodic structure to be potentially experienced in some way. Ironically, music psychology generally defines meter in "objective" terms,[6] whereas theory has recently shifted toward more "psychological" definitions.[7] I prefer the objective definition of meter, because it seems to allow for both more freedom and more precision with it. Instead of defining meter as an experience which includes only certain contexts, the objective definition allows for distinct possibilities such as metric perception, unperceived meter, unperceivable meter, and metric knowledge.

It can be easy to conflate the objective and psychological definitions of meter. Justin London, for example, defines meter as "a perceptually emergent property of a musical sound,

[3] Claire McCoy and Mark Ellis define meter as "the perception of beat grouping caused by regular patterns of strong and weak beat accents" (McCoy and Ellis 1992, 37).

[4] Peter Keller and Denis Burnham define metric frameworks as "multiple levels of pulsation that are generated within an individual" (Keller and Burnham, 630).

[5] Justin London defines meter as "a stable, recurring pattern of temporal expectations, with peaks in the listener's expectations coordinated with significant events in the temporally unfolding musical surface" (London 2002, 531).

[6] See for example, Patel et al (2005, 227)

[7] Roger Grant's "Four Hundred Years of Meter: Theories Ideologies, and Technologies of Musical Periodicity since 1611" (2010, see especially 298-300) explains tension between these definitions as well the recent shift in music theoretical discussions toward perceptual definitions.

that is, an aspect of our engagement with the production and perception of tones in time" (London 2004, 4). He treats both definitions as equivalent, claiming meter is both objective (a property of sound) and psychological (an aspect of our engagement with it), although his objective definition requires it to be perceivable (i.e. "perceptually emergent"). There have been other, less trivial confusions, leading to distorted transmission of ideas, perhaps ultimately shifting the definition. Robert Gjerdingen's article on "Meter as a Mode of Attending" has commonly been misrepresented as putting forth the idea that meter *is* a mode of attending.[8] However, Gjerdingen's article uses meter to mean periodicity. His precise point is that attention itself can also be periodic. That is, attention can—like the music it responds too—also *have* meter in the objective sense. His ideas were obviously attractive. Many researchers took his model as a given, and the meter definition shifted to reflect that starting point, at least in much music theory.

As Roger Matthew Grant (2010) traces in his dissertation—and Ève Poudrier's dissertation (2008) laments—there has been a disciplinary shift from talking about meter as a property of sound to a form of experience. However, the way that *conversations* have shifted does not necessitate a parallel shift in the term itself. They have both shifted, but the change in definition seems to be a byproduct of repeatedly restricting contexts of discussions. Poudrier, whose research explores meter from a psychological perspective, advocates *against* such "psychological" definitions for meter. She criticizes that "it is currently fashionable to define meter based on psychological models, and thus to regard meter as the cognitive product of the listener's mode of attention," and goes on to demand that "meter must be situated in the music (as a hybrid product of a score and its performance) as well as in the mind" (Poudrier 2008, 31).

[8] For example, see Rundall 2011, 11 and London 2004, 4.

Neither Poudrier (2008) nor Jacob Rundall (2011) are very picky about permissible methods and contexts for perceiving meter. Both also (relatedly, I would argue) seek to explore issues surrounding polymeter.

This project explores instances of "metric multi-tasking"—in which musicians keep track of multiple non-nested periodicities occurring simultaneously—because those examples motivate the use of alternative resources and strategies. With those possibilities in hand, I later return to consider their use in more straightforward tasks.

OUTLINE

In the first chapter of this dissertation, I explore trends in music theory and music psychology which have given rise to a narrow notion of metrical experience. To do this, I will characterize several disciplinary assumptions, priorities, and dichotomies which may be easy to overlook as conceptual moves at all. Section 1.1 explores the assumption that metrical experience means not just perception but also listening. Section 1.2 considers music theory's problematic dichotomy between the "internal" and "external," and between metaphorical "mind" and "body." Section 1.3 recognizes the complex relationships between musical notation and experience, and the frequent erasure of notation's usefulness. Section 1.4 acknowledges the lack of specific training for participants in many psychological experiments and questions this as a desideratum. And Section 1.5 summarizes the dominant model of meter as attentional entrainment, which emerges from those various trends. Section 1.6 comments upon how the metrical mainstream reflects more general (and gendered) biases of music theory. I acknowledge these various trends and assumptions at the outset of this project to highlight many restrictions upon the discussion which might otherwise go without notice.

The latter part of this dissertation explores musical periodicity without these restrictions and assumptions in place. Chapter 2 expands the mainstream notion of temporal experience with two broad categories of temporal resource. Dynamic symbols and actions form one category and serve to tie events to a temporal structure. The second category involves static symbols and theoretical knowledge which provide useful (actionable) information *about* temporal structure without itself "happening" or changing in time. Chapter 3 offers analyses of several compositions and recordings which involve "metric multi-tasking," in which musicians navigate

more than one temporal hierarchy at the same time. In these cases, extra resources and strategies are required for performance or offer some particularly meaningful experience of the piece which might otherwise be unavailable. Although the resources I detail are undervalued and often defined out of music theory and psychology, Chapter 4 explores how symbolic codes, embodied patterns, and other temporal resources already form part of pedagogy. The conclusion returns to fundamental theoretical concepts such as meter, perception, and attention in light of the expanded strategies discussed and offers avenues for future research.

CHAPTER 1: APPROACHING METER IN MUSIC THEORY AND PSYCHOLOGY

1.1 Meter Perception and Listener-centrism

> The approach to meter being developed here is squarely based on the listener's perspective: more precisely, meter involves the perception of an occurrent musical passage. This is different from metric aspects of remembered musical experience (such as simply knowing that a particular song was in triple meter) or from the audiation of musical passages in "the mind's ear." Moreover, it is presumed that listeners do not normally have access to other, non-auditory information, such as a score or the scansion of song lyrics. Metric audition requires only the musical sounds themselves and the listener's temporal capacities, both innate and learned. (London 2004, 23)

Justin London's words from *Hearing in Time* do well to encapsulate general trends, assumptions, and contextual restrictions in psychological accounts of meter. His approach focuses on the activity of perceiving as listening and cleans it up by eliminating "nonauditory information, such as a score." Also, for London, listening must involve an *occurrent* musical passage. His perspective admits the experience of acoustic sound reverberating through the air to our ears, but not memories of sound. We can break this perspective apart into three "listener-centric" assumptions: (1) that music be limited to a sound object, (2) that musical experience be perceptual, and (3) that musical perception occur by listening (but not remembering). Such a starting point seems rather obvious and straightforward. After all, I would consider listening to sound the default, or perhaps the most important way of experiencing music. It is this seeming obviousness and straightforwardness that allows these "listener-centric" assumptions to be put forth casually or without discussion. The major point of this section is to point out that they are not such obvious givens. Such assumptions occur at a cost, ignoring or excluding other useful contexts and sources of temporal information on the basis that those contexts and sources do not involve listening or are not perceptual. Showing how music discourse is "listener-centric" may

seem like a rather banal exercise at first, but doing so will help lay out the conceptual norms and commitments of a complex discipline and better understand their ramifications.

In an early study of meter psychology from the 1980s, Longuet-Higgins and Lee take "the perception of musical rhythm" as their starting point, limiting their scope to the perceptions of a listener. They state that "there are any number of regularities to be found in a piece of music; here we are concerned only with those that are perceptually apparent to the listener" (Longuet-Higgins and Less 1982, 117). This statement can be interpreted in two ways. It could mean that listening is a requirement for musical perception, in which case "perceptually apparent to the listener" simply underscores the identification of listening and perception. However, "to the listener" could further qualify what sort of perception Longuet-Higgins and Lee are referring to. Stating that something must be perceptually apparent *to the listener* would then imply that regularities could be perceptually apparent in another way, such as by looking, or by knowing something by drawing an inference from it, but that any other way isn't important enough to merit discussion in their article—or at least is too different from perception by listening to be part of the same discussion. Whichever interpretation we take—of music perception as listening, or of listening as a more specific type of music perception, Longuet-Higgins and Lee limit music perception to the act of listening.

Clarke and Krumhansl's study "Perceiving Musical Time" (1990) includes more or less the same type of restriction and a similar lack of discussion. However, Clarke and Krumhansl are more explicit about visual information being excluded from their concept of musical perception, and their proscription of visual information includes tacit acknowledgement that such information might be experientially meaningful. Their experimental design stipulates that participants perform temporal segmentation "without reference to the notated score, so that their

judgments were based as much as possible on auditory rather than visual information" (Clarke and Krumhansl 1990, 224). Evidently, the authors must have believed that visual information in a score could affect people's judgments. Otherwise, there would be no need to forbid it. However, such an experimental restriction implies the stated topic "perceiving musical time" is likewise limited to judgments based on auditory information (i.e. listening). They provide no additional discussion about *why* visual information ought to be omitted. There could have been practical reasons for omitting visual information, but the authors don't mention any, leaving us to assume the restriction is a matter of definition.

The identification of perception with listening also emerges from distinctions between listening and performing. Mari Riess Jones' work, for example, distinguishes between performing and listening, and then uses the term "perception" more or less synonymously with "listening." Her "Temporal Perspective Model" assumes that "a performer (with the knowledge of meter) attempts to communicate to a listener a particular perspective from which melodic and rhythmic forms may be perceived" (Riess Jones 1987, 164). Jones' model downgrades performance to a means of transmission to a listener, with the listener as the one who does the perceiving.[9] This is a common set-up for the idea of music perception: the performer transmits music-sound to the listener, who *perceives* it.[10]

Joel Lester sets up a similar alignment of perception-as-listening with a clearly privileged status of listeners' perspectives over performers'—even his own perspective as a performer. His

[9] Interestingly, "meter" is something that both performer and listener both share. The performer also has "knowledge of meter," but it isn't clear what Riess Jones means by "knowledge" here, beyond the idea that it is distinct from a listener's perceiving. Whatever knowledge the performer has remains peripheral to her project.

[10] See, for example, London (2004), 23, writing about meter, or Meyer (1994), who writes more generally about meaning in music.

article “Notated and Heard Meter” (1986) grapples with differences between a listener’s perspective on the one hand, and that of a performer, theorist, or composer on the other. The discussion there stems from personal experience as a violinist playing Milton Babbitt’s *Composition for Four Instruments*. Lester as a performer had practiced his part in relation to its *notated* metric framework and could hear the music with “a memorized silent click-track” to make it sound almost “jazzy.” Months later, however, he was struck by the fact that, without the score, or memorized version in his head, he couldn’t hear the notated meter. In his article, Lester *could* have considered his performer self’s knowledge to have more validity, but he does not. Instead, he subordinates his performer self to the later listener self.

> Are the metric calculations of the performer as unintelligible and irrelevant to the listener as some apian dance would be in helping us locate a particular wildflower in a meadow? Are the rhythmic-serial computations of the theorist (or the composer as well) equally irrelevant to the listener? (Lester 1986, 117-118)

Posing this question reveals Lester’s priorities: the listener perspective trumps other ones. This is quite unusual, because in his anecdote being the listener actually involved knowing *less* than he had as a performer. To have the “listener” experience, Lester needed to *forget* about memorized aspects of the piece that gave rise to the silent click-track in his mind and the “jazzy” syncopations that went with it (Lester 1986, 117). This is the sort of way in which listener-centrism can become restrictive. Being a listener, for Lester, meant having neither a physical score, nor some memorized version of it. Babbitt’s music in particular was deemed “not accurately perceptible” (Lester 1986, 117), because listeners who have never seen the score (or have forgotten it) would not be able to re-construct it—its meter as notated, that is—only by listening (Lester 1986, 226). Perceptibility, in other words, rests only on information scoreless listeners can gather. The critical issue is that a score (or some internalized memory of it) does

provide information. It does not merely summarize what many scoreless hearings might construct, either. And, importantly, that information has a qualitative effect on experience: in this case, it gave the music its "jazziness."

In this opposition between listeners and performers, Lester's use of "perceptible" to mean "perceptible to the (scoreless) listener" launches a critique of modern compositions. However, if we set aside that skepticism, the article underscores how (post)modern music can highlight dramatic differences between the perspectives of listeners, performers, theorists, and composers. Babbitt's notated metric layout may have been designed to do something for the performer (such as put beginnings of a new pitch-class aggregate on a downbeat), without an intention that such a metric hierarchy would correspond with a listener's experience. I do not think that's a problem, but the solution Lester offers is that "commonly-held conceptions of rhythm in this music need to be reassessed from the bottom up" (Lester 1986, 117). It isn't clear if he issues that solution half-heartedly, as a rhetorical jab, but that idea will stand very much in line with the aims of this project. Aspects of modern music *can* make us reassess our commonly-held conceptions. However, Lester doesn't seem to loosen his grip on the commonly-held conception that a scoreless listener's perspective dictates what is perceptible.

Finding explicit justifications—as opposed to simple assertions—for a view of music as sound and perception as listening is less common, but in Fred Lerdahl and Ray Jackendoff's *A Generative Theory of Tonal Music* (1983)—and in subsequent work by Justin London (2002, 2004, 2009)—a rationale is offered, based upon *essential*, universally applicable aspects of music. The stated aim of *A Generative Theory of Tonal Music* is to describe the musical intuitions of a listener, and the authors consider that aim synonymous with the goal of music theory. For them, "a comprehensive theory of music would account for the totality of the

listener's musical intuitions" (Lerdahl and Jackendoff 1983, 8). In other words, the book is non-comprehensive only because it doesn't discuss *all* the intuitions a listener might have. The authors justify this listener-centric perspective by first discussing the general nature of music. Or, more precisely, they first define out what *cannot* be considered a piece of music. "A piece of music is a mentally constructed entity… not a musical score, if only because many musical traditions are partially or completely unwritten… not a performance, because any particular piece of music can receive a great variety of performances" (Lerdahl and Jackendoff 1983, 2). Interestingly, the authors slough off scores and performances because they are dispensable and variable, *not* because they lack meaning. The fact that much music does not involve scores does not make scores musically irrelevant: it makes them musically *nonessential* (and nonuniversal). Similarly, the fact that many performances can all be "the same piece" makes those performances messy and difficult to handle, again nonessential, but also not irrelevant. Perhaps the authors saw the avoidance of performers' perspectives as a weaker argument to make, and so bolstered it with a casual appeal to traditional priorities of music theory: "Music theory is usually not concerned with the performers' activities" (Lerdahl and Jackendoff 1983, 2). This, of course, is not a very good justification, but it allows them to move forward.[11] Relying on these reasons to jettison scores and performances, the authors do not define the field of inquiry around what *can* be relevant to music interactions. Instead, they only consider *essential* types of interaction relevant to *all* contexts in some way.

There might be good reason to set up limitations such as these. Doing so cleanly limits the scope of inquiry to "universals." But the authors do not represent this move as a narrowing of

[11] It is worth noting that in the decades following that 1983 publication, there has been music theory which foregrounds performers' activities. Cusick (1994) provides an example of this perspective as something which might help construct feminist music theory.

their topic. Just the opposite: seeking out universals allows the project to be presented as fundamentally more whole, even though it isn't. It may be worth breaking down this argument. The authors restrict the concept of music to what they describe as its fundamental type of interaction: listening to sound. Then they recast this restriction with a tone of universality: listening to sound is common to all music. Then—and this is a leap—musical interaction and experience comes to be defined only in terms of aspects universal to all music. Other types of interaction (seeing, reading, performing) are not viewed as a true part of music theory, because they aren't universal. Consequently, a music theory which only explores listening to sounds can be seen as a comprehensive one.[12]

Lerdahl and Jackendoff's perspective has concretized into a foundation for the work of later scholars.[13] A case in point is the work Justin London, with a conceptual framework that is often rather similar.[14] Like Lerdahl and Jackendoff, London, in his article "Temporal Complexity in Modern and Post-Modern Music: A Critique from Cognitive Aesthetics" (2009), makes a case in certain terms about what the nature of "music" is, although he brings in the notion of

[12] Lerdahl and Jackendoff do acknowledge scores and specific performances, but only as "partial representations" by which a piece may be transmitted, not an actual transmission of "the piece," something that only happens by listening. Recognizing scores and performances are partial representations does grant them quite a bit of meaning. However, "partial representation" is used mainly as a criticism. It doesn't point out that these things can positively represent *something*. Instead, it faults their relation to music for lacking something else substantial (acoustic vibrations). To the authors, the representation is not very good because it is only indirect. "Partial" is not valuable for the "part" it conveys, but instead, weak because of its incompleteness.

[13] David Lewin offers a compelling contrast when he draws his own scope for music theory, but its reactive tone underscores the presence of a mainstream to which he responds (1986, 377). His article even addresses Lerdahl and Jackendoff's *Generative Theory* directly and offers some measured qualification (Lewin 1986, 380).

[14] London's most recent experiment (London et al., 2016)—which considers how listeners' tempo judgments are affected by visuals of dancers—is a notable exception.

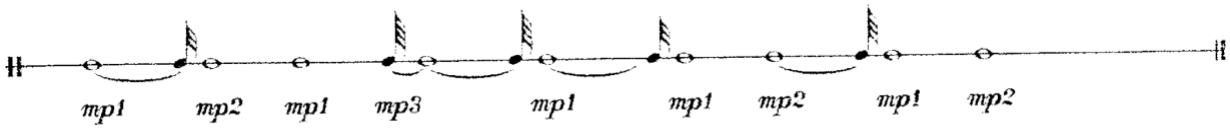
"perception" more prominently than Lerdahl and Jackendoff did. He also continues the trend, manifested in Lester's article, of using his conceptual framework to construct deep flaws in modern compositions. His article begins by defining "aesthetically relevant" properties of an artwork, drawing upon aesthetic critiques of Gary Iseminger. Artworks "afford appreciation," and this appreciation "involves the *experience* of the artwork." London then continues that genres of art should be considered "in terms of the materials used in their composition, and correspondingly in terms of the sensory and cognitive faculties with which we perceive and understand them." This by itself isn't very restrictive, but London then goes on, explaining that "aesthetic experience and communication are strongly tied to the experience of the primary medium of the work." And furthermore,

> It reasonable to presume that musical works involve the organization and presentation of sounds in time—sounds being the 'primary medium' of music. If the primary medium of music is that of sounds, then a proper experience of a musical work involves hearing those sounds. Thus, while musical scores may be interesting in their own right, their physical/visual properties are not of primary aesthetic relevance. Any relevance that the visual aspect of a score may have must supervene on the underlying experience of the music-as-heard. (London 2009, 46)

There is a leap here not too dissimilar from Lerdahl and Jackendoff's. London begins with the idea that aesthetic experience is strongly tied to a primary medium, but then proceeds as though aesthetic experience is *only* tied to the primary medium. Or, in other words, he uses an idea of "primary" medium, but without entertaining any possibility that there could be any "secondary" medium of music. Having set up that sounds are the only relevant medium, he explains that a proper experience means *hearing* them. This precisely encapsulates the main thread of this

section. By assuming music to be sound,[15] obtaining knowledge about that sound is also assumed to happen by listening. London's language also offers a glimpse of disciplinary norms. Listening to sounds is not simply the way to experience music, it is the *proper* way to experience it. This might be a tacit acknowledgment that there are plenty of other experiences out there, but judging that they simply aren't "proper." Listening is how you are supposed to experience music.

London's position is poignantly reflected through a thought experiment involving a piece of music he calls the *Subtle Etude #1*, reproduced below.



Example 1.1, London's *Subtle Etude #1*

His etude is based upon subtle changes that fall below thresholds of "just noticeable difference" found in psychological experiments. If you were given a precise performance from a computer, London states, then "what you see is what you hear, even though you can't hear it. Any distinctions we think we might hear in listening to the MIDI realization will be misperceptions, perhaps influenced by the presence of the score" (London 2009, 64). In other words, we might *think* we hear subtle differences, but—because they wouldn't be noticed without the score—we wouldn't actually *hear* them. The difference between perception and misperception is the same as the difference between "hearing" and "thinking we hear." Interestingly, this distinction cannot

[15] This—defining music as sound—is slightly different from Lerdahl and Jackendoff, for whom "music" or "a piece of music" is a mentally constructed entity. Nonetheless, their assumptions based upon seeking musical universals are rather similar.

be based on the quality of experience, because, by definition, *thinking we hear* dynamic changes means that the experience feels like we are hearing them. If it felt otherwise, we wouldn't think we were hearing it! And the distinction between perception and misperception is not based on accuracy, either. In London's *Subtle Etude*, the score-influenced knowledge is, paradoxically, a misperception, despite being a *more* precise appraisal of the sound object. Ultimately, London's distinction is based on the *source* of information. To perceive something means not just to get information *about* sounds in time, but also to get that information exclusively *from* sound sources. What we hear in the wrong way, with the contribution of visual information, is downgraded to what we only think we hear, thus ruled out of the realm of hearing. This is how London excises "second-order knowledge" (London 2009, 60), or things we only *think* we hear. The "proper" experience of music is restricted to the perception of sound (music's primary medium), and information-gathering must occur by listening. To gather information about sounds, but not through listening, gives rise to "misperceptions" whether or not they are accurate, even more. A musician who *thinks* she hears subtle changes influenced by score knowledge will be doomed to "misperceive" a piece until she can forget that abstract knowledge. Only then will the musician be "perceiving" the piece, even if those perceptions yield a less accurate temporal assessment of its goings-on!

We can twist London's ideas a bit here if we let go of categorizing what should count as "music" or a "perception." His thought experiment reveals that scores and analyses (i.e. "second-order knowledge") are capable of providing information beyond what can simply be heard. Perhaps these resources should be bracketed off as "improper" (if that's possible), but they still may provide something which hearing does not or cannot. What's more, they can do this in the context of experiences that feel roughly the same, because we might still "think we hear" such-

and-such a change. London does speak of analytically-informed listening as something valuable, but only if it is scrutinized by empirical verification. In other words, participants must be able to hear an analysis without the aid of the abstract (or has he calls it, "second order") knowledge. If they cannot, the analysis fails. But we could also speak of a flipside to this. If participants were to think they heard something which they could not hear without the analytical help, this becomes proof of the potency of that "second-order knowledge."

The disciplinary norm of listener-centrism excludes potentially worthwhile techniques of gathering information, based either upon the source of that information not being occurent sound, or upon the means of gathering that information not being properly perceptual. Limiting the perspective of music theory to that of listeners marginalizes motor behaviors and visual symbols. For example, in London's *Hearing in Time* he states that "as listeners we are not directly involved in the production of movement trajectories" (London 2004, 32).[16] Aligning the concept of perception with listening makes motor behaviors a reflection of perceptions, but not themselves perceptual acts. When London states that "perception is not only for deriving representations of reality; perception also serves to guide our behavior" (London 2004, 5), he takes the perspective that perceptions guide behavior, but not vice versa.

Even more broadly, listener-centric perspectives on meter emerge from assumptions about experience as perception. The quotation from London at the outset of this section defines a listener's perspective as involving *perception* of a musical passage. Taking perception as the starting point is evident just by probing article titles and abstracts in music psychology, such as

[16] While the first edition defines movement out of what it means to be a listener, the second edition is slightly reworked. "Although we may not be directly involved in the production of movement trajectories, listening in part entails recovering movement information from the musical surface" (London 2012, 32). It is not clear, however, whether "recovering movement information" refers to metaphorical motions or actual physical actions.

Longuet-Higgins and Lee's "The Perception of Musical Rhythm" (1982) or Clarke and Krumhansl's "Perceiving Musical Time" (1990). It is also connected to the psychological approach in general. Those two articles were published in the journals *Perception* and *Music Perception*, respectively. In fact, the foreword to the first issue of *Music Perception* uses music perception synonymously with listening, presumably as a way of bringing the discipline of music theory into the larger psychological enterprise. For psychologists, music provides another medium (sound) to reveal aspects of our brain function. By compartmentalizing music as sound, it sets up comparison and contrast with, for example, research on visual perception. Music as a research tool for getting information about brain mechanics becomes troublesomely complicated when viewed as multi-modal.

Music theory's high value on perceptibility may also trace back through its own disciplinary history. Appealing to perception has long been the primary means of justifying the validity of claims.[17] It was a way of claiming that Schenkerian graphs and conglomerations of pitch class sets were not merely products of abstract calculations nor obscure connections between pitches. Perceptibility stood to mean that such-and-such a musical device had experiential meaning. However, this logic does not work in reverse. We should not be left thinking that a device which is not conventionally perceptible cannot be experientially meaningful. That assumption about perception goes hand in hand with listener centrism. To say that something is not perceptible may actually mean that it is not perceptible *in a specific context*. When perception is assumed to involve a perceiver gathering information about some external object, this paradigm fits perfectly onto the situation of listener responding to external

[17] This is not universal to all of music theory's disciplinary history. Appeals to the ear would align with Aristoxenus, but not Pythagoras, who made claims based upon the perfection of certain ratios.

acoustic sounds. But is not so intuitive if the subject is a performer, actively involved in creating the object of study.

1.2 Meter and "Internal" Perception

Studies of meter often refer to metric processes as being "internal" or "underlying" as a way of distinguishing perceptual experience from observable physical action. For example, psychological experiments on temporality have purported "to gain insight into the internal representation of temporal patterns" (Povel and Essens 1985, 411) or to investigate "the underlying timing mechanisms in a sequential analysis of performed patterns" (Beauvillian and Fraisse 1984, 488). In a survey of the many "tapping" experiments, Bruno Repp summarized the dominant information-processing approach as a way of "describing hypothetical internal processes underlying behavior" (Repp 2005, 970) and rhythm perception was viewed as a form of "covert synchronization"(Repp 2005, 978). And Justin London's theory of metric perception is based on the premise that "our attention literally 'moves with the music,' and this engenders and encourages our bodily movements" (London 2012, 5). However, it is unclear—and varies from source to source—what exactly is meant by adjectives such as "internal" and "underlying" (or sometimes "covert"). Is it *by definition* that metric processes are "internal," or is an assumption of internality based on certain contexts? How does it relate to perception? To observability? To physical anatomy?

In this section, I view disciplinary trends from a different viewpoint, offering examples in which a notion of "internality" forms a part of metric discussions and arguing that it ties into a longer historical trend of a metaphorical mind being separate from—and valued more than—physical and metaphorical bodies. I construct what I consider to be a music theoretical mainstream, using sources which lack much self-awareness about the implications that come from a reference to something being "internal." Assuming that perception and meter are

"internal" or "underlying" constructs a wedge between observable actions and temporal knowledge, for example. I'll begin by looking at early experiment-driven psychological studies on meter perception in the 1980s. Then I'll trace how those assumptions have persisted and concretized in recent work, while also acknowledging countercurrents.

Just as Longuet-Higgins and Lee's 1982 "The Perception of Musical Rhythm" set up a persistent equivalence between music perception and listening, Povel and Essens's 1985 investigation of the "Perception of Temporal Patterns" constructed an idea of temporal perception as internal through reference to an "internal clock." Thirty years after Povel and Essens's experiments, the findings seem rather banal. They found that participants' reproduction of rhythmic patterns is significantly better when a pattern is more easily integrated with a regular beat than when it is not. Additionally, they found that a 12-beat pattern of onsets will be heard as a different pattern when paired with isochronous low-pitch beats of three pulses each than when paired with beats of four pulses each. However, it's important to note that—although I'll be showing how their notion of perception is now restrictive—it was, at the time, an attempt to *open* the notion of perception to be more subjective. Their work sought to eliminate the idea there was only a single possible perception given a sounded temporal pattern. In their words:

> Most essential is that it does not make sense to speak of *the* perception of a temporal pattern without further qualification. We have given evidence showing that the internal representation of a pattern completely depends on whether, and which, clock is internally induced (Povel and Essens 1985, 437).

The fact that perception is now treated as subjective and contextually malleable can be taken as a sign of their project's success. That said, it is worth digging into their conceptual substrate, as it has concretized into the foundation for later scholarly work.

Povel and Essens explained that the purpose of their experiments was "to gain insight into

the internal representation of temporal patterns, [by studying] the perception and reproduction of tone sequences." Their basic assumption was "that perceivers try to generate an internal clock while listening to a temporal pattern." And further, "it is assumed that if a clock is induced in the perceiver, it will be used as a measuring device to specify the temporal structure of the pattern" (Povel and Essens 1985, 411). They use "clock" simply to mean something that measures temporal intervals. For them, "a basic notion underlying the development of the present model is that time, and therefore sequences of temporal intervals, can only be assessed by means of a clock" (Povel and Essens 1985, 413). For Povel and Essens, "clock" broadly means anything that measures time, but more specifically anything consisting of a periodic pulse and counter. However, for temporal perception in music, they qualify this notion of clock as being "internal," and justify the qualification by stating that temporal intervals in music simply cannot be assessed by means of an external clock. Presumably the qualification that perceptual clocks be "internal" is primarily a marker that "clock" is not being used in the everyday sense. It does not refer to the physical time-keeping machines on our walls and wrists, but rather refers to a sort of human counting potential. However, they fail to offer much clarification about what they mean by internal, and not having done so, strap additional baggage to the concept of perception. They *could* have characterized our biological counting potential as, for example, an "embodied clock," which would also distinguish it from clock machines in the everyday use of the term. Opting instead for "internal clock" yields other associations. Even if they only meant internal clock to mean "not a machine," it takes on additional meaning, such as "not external" and "not observable."

Theorizing the concept of an internal clock can obscure the relation to the observable actions from which these studies draw their information. For Povel and Essens, "it is well known

that the foot tapping of music listeners, itself interpretable as reflecting their internal clock, is mainly determined by the occurrence of accented events in the music" (Povel and Essens 1985, 414). Foot tapping (an observable action) is assumed to *reflect* metric perception (the "internal clock"), but the details of such a correspondence aren't made clear. The set-up seems to construct a separation between actions such as foot tapping on the one hand, and internal representations (and perceptions) on the other. The authors could have allowed foot tapping to form *part* of one's (internal) metric clock, in that it provides the periodic pulse to be counted. This is an idea I would argue. Technically, that isn't necessarily ruled out by the quotation, but it takes a rather generous reading to arrive at some sort of integrated embodied concept from a statement like that one. The more straightforward reading of their statement is that foot tapping is *not* internal, and not part of one's internal clock. In this reading, foot tapping is an *external* representation of a temporal pattern, facilitated by one's internal clock. The observable actions are, in other words, valuable for providing information about the "internal clock" without constituting part of it.[18]

Robert Gjerdingen's "Meter as a Mode of Attending" (1989) also moves the discussion of meter to the realm of the "internal," but it does so as matter of possible context by focusing anatomically on activity of neurons in the brain. Much like Povel and Essens, Gjerdingen looks for a "metronome inside of us… capable of ticking to the beat." And to find such a timepiece, "if it is in the mind that we fashion a musical metronome, that metronome must in all probability be constructed of interconnected neurons" (Gjerdingen 1989, 70-71). He constructs a model of an

[18] There is good reason to view foot tapping as a *non-essential* part of metric perception, because foot tapping isn't necessary to perceive musical periodicity. However, being non-essential should not eliminate it. This is the sort of distinction I discussed previously in relation to Lerdahl and Jackendoff's concept of a "comprehensive" music theory and London's argument for a "primary medium" of music as sound.

oscillator for this neuronal activity, without being too restrictive that this be *the* way of processing periodic information. His article is delightfully self-aware of its exploratory nature. "The point of the preceding simulations has not been to suggest that anyone knows exactly how the human brain is able to synchronize itself with a musical meter. Nor is any claim made that the brain keeps the beat with these exact neural mechanisms" (Gjerdingen 1989, 78). Gjerdingen's main point was to allow meter to *also* be in the brain. It was a way of saying that human physical biological rhythms, like acoustic music, can have "meter" (by which he means being periodic and hierarchical). He never defines musical meter as *only* in the brain. Instead, he posits how it *might* be in the brain, and limits his discussion to hypothetical brain activity. We can summarize his work's "internality" as a matter of scope (not of definition) and of physical anatomy (since he is concerned mainly with neuronal activity). That internality is never assumed as a matter of fundamental definition. As such, Gjerdingen's article can be understood as *opening* the discussion of meter as regularity not just in music sound, but also in us.

This search for that meter "in us" can generally characterize the interest of music psychology. However, Gjerdingen's exploratory tone of possibility has been lost in music theory. A major premise of Justin London's work, for example, involves fundamentally defining meter as attentional entrainment. For him, meter is "a stable and recurring pattern of hierarchically structured temporal expectations" (London 2002, 529).[19] Such a definition of meter as expectation likely reflects the psychological focus of London's work. The psychological experiments on which that theory is drawn, on the other hand, generally do not use an experiential definition of meter. Those experiments are sometimes rarely based on recent and

[19] This definitional shift of meter as experience has been traced in Roger Mathew Grant's dissertation "Four Hundred Years of Meter: Theories, Ideologies, and Technologies of Musical Periodicity since 1611" (2010).

nuanced music theory, but, more importantly, the interest in (internal) perception from the start does not require any change of definition for "meter." In other words, meter need not be defined as perceptual in order to study the perception of periodicity.

As the focus of studies shifted toward internal perception, observable actions, such as tapping, have been put in an awkward, secondary position. The position is awkward, because experiments on temporal perception cannot involve direct observation of a participant's attention. Researchers instead *infer* information about those internal processes via external actions such as tapping. The rationale for such inferences rests on an assumption that one's internal attention *facilitates* synchronized tapping. London, for example, states that "tapping studies involve not only attention but also action, a behavior (tapping in synchrony) that depends on rhythmic attending" (London 2004, 12). In studying cross-cultural difference in meter perception, Beste Kalendar, Sandra Trehub, and E. Glenn Schellenberg similarly note that "although such music may sound irregular or 'jerky' to Western ears, listeners in those cultures perceive the tactus in the music, as reflected in their tapping or dancing." (Kalendar et al 2013, 196). In other words, if you're physically tapping to the music, you must have been perceiving the beat.

It's easy to slip into epistemological trouble here. To conceive of metric perception as "internal" presumably makes those external, observable tapping actions *not* internal, and not perceptual, at least not directly. And yet, those very same actions are also viewed as deeply entangled with perceptions, so much so that taps performed in experiments are treated as isochronous indicators of internally felt beats. And there isn't much other information to use besides those external actions. The trouble here may be a relic of constructing metric perception as an "internal clock" and pushing physical actions into a separate category, despite needing to

draw an equivalence when analyzing experimental data. This sort of tension reflects a deeper disciplinary bias toward metaphorical and physical minds over bodies and aligns with feminist critiques by Suzanne G. Cusick (for example, "Feminist Theory, Music Theory, and the Mind/Body Problem," 1994).

David Lewin offered an early reaction against the mainstream notion of perception in music theory along with an call to expand what constitutes perception. Lewin criticized the "X/Y" paradigm in which "a 'listener' X is 'perceiving' some 'music' Y that is demonstrably other-than-X." His solution was to open theory to include not just musical perception but also "a broader study of what we call people's 'musical behavior'" (Lewin 1986, 375). Lewin's proposal was to consider musical *behavior* as a worthwhile category of perception. He cautioned that "one cannot simple-mindedly divorce constructive creation from perceptive understanding, as if the one could occur without the other, or at least without some experience of the other" (Lewin 1986, 380). Reacting specifically against previous perceptual theories, such as Lerdahl and Jackendoff's, he aimed to bridge this gap by considering musical actions *as a mode of perception*. He gives the example of returning home after a concert and playing excitedly at the piano as an *act* of perception, rather than a mere aid to perception, or an aid to the memory of a perception.

Approaches under the umbrella of "embodied cognition" align with Lewin's expanded notion of perception, though they have not yet become typical in studies of meter.[20] As Margaret Wilson (2002) explains, "embodied cognition" emerged against traditional cognitive science

[20] Approaching meter through the lens of embodied cognition is not *typical*, but it is also not entirely uncharted. Among others, Mariusz Kozak (2015, for example) brings embodied cognition research into the area of metric theory. His work involves motion capture technology to provide analytical information about the experiences or particular pieces of music.

approaches in which perceptual and motor systems merely provide input and output for the central processor of the mind. She depicts embodied cognition generally as involving "a growing commitment to the idea that the mind must be understood in the context of its relationship to a physical body that interacts with the world" (Wilson 2002, 625). Appealing to the biological and evolutionary importance of motor behavior for perception, embodied perspectives blur the distinction between centralized, abstract cognition on the one hand and input and output modules of sensorimotor processes on the other. However, as Wilson also notes—and in fact, it is the primary point of her article—"embodied cognition" is not a single idea. It has come to involve multiple different claims, including the ideas that we off-load cognitive work onto the environment, that cognition is for action, and that offline cognition is body based (Wilson 2002, 625). Experimental data has corroborated that a relationship between metric perception ("mind") and physical entrainment ("body") is entangled beyond some central processing that facilitates action. In a neurological study of the brain, Daniel Cameron and Jessica Grahn (2014) found that listening to music with or without a beat creates widespread activity in the cortical motor system, and in the supplementary motor area and premotor cortex more specifically (Cameron and Grahn 2014, 111). This neurological linkage aligns generally with the embodied notion of cognition being for actions. But there is additional research suggesting that action can be, or can aid in, perception. Jessica Phillips-Silver and Laurel J. Trainor's study "Hearing what the body feels: Auditory encoding of rhythmic movement" (2007) found that instructions to move (by bending at the knees) influenced perception of auditory rhythmic structures. The researchers argued that auditory input can give rise to sympathetic movements, but so too can movement influence the processing of auditory information. Hence their expression "hearing what the body feels" (Phillips-Silver and Trainor 2007, 544). Claire McCoy and Mark Ellis's (1992) experiments with

college-aged non-musicians support this possibility. In those experiments, participants were given tasks to discriminate recorded excerpts of music as metrically "duple," "triple," or "other," and their accuracy was compared with the type of instructions given. One group received verbal instructions (defining "meter," "duple," "triple," etc.). Another group was given a click track, faded in and out as the excerpt played. And the third group was instructed to engage in various large muscle movements along with music (marching to the beat, stepping to the pulse while tapping the thigh or clapping accented pulses, stepping on the accented pulse and clapping unaccented pulses, and pulling ropes with a partner such that changes of direction coincided with new measures). Although all groups showed some improvement against a control with no instructions, the students who engaged in "large muscle movements" showed the best results.

Disability studies by Jessica Grahn and Matthew Brett (2009) in a study of patients with Parkinson's disease corroborate this point. They found that dysfunction in the basal ganglia—which is the part of the brain involved in coordinating movement—was associated with impaired ability to perceive and discriminate between beat-based rhythms. The discrimination tasks did not require physical actions of the kind that participants had difficulties coordinating. The implication is that action forms a productive part of perceptual processes, *whether or not an action is actually performed* in the task at hand. Parkinson's disease patients did not need to observably move in order to carry out those judgement tasks, but nonetheless their motor limitations correlated with difficulty making sense of temporal information.

Recent work by Mariusz Kozak (2015) incorporates embodied cognition into studies of musical temporality, though not meter studies specifically. His inquiry starts from the assumption that individuals' "bodily experiences meaningfully structure their understanding of musical sounds" as opposed to simply being external reflections of internal processes. He

positions his work generally in line with Carolyn Abbate's notion of "drastic" real-life performative experience (Kozak 2015, 1.8) and more specifically with David Lewin's active "transformational" notion of perception. Lewin's model considers listeners as actively *going* from one place to another or *doing* something to a *Klang*, rather than passively witnessing motion and change in something else. Kozak notes that Lewin's transformational gestures are used metaphorically, but do not fully reconceive of perception as "a process that is integrally yoked with action" (Kozak 2015, 2.6). Kozak extends Lewin's sentiment by exploring the movements of real, embodied listeners using motion capture devices. However, Kozak makes a point that his approach does not represent the music theoretical mainstream and that incorporating listeners' actual bodies into music analysis also poses its own set of challenges.[21]

In light of experimental findings such as Cameron and Grahn's and Phillips-Silver and Trainor's, the notion of an "internal clock" should be aligned with notions of embodied temporality to avoid sidelining actions as mere output of a perceptual system. We should attempt to clarify when "internality" is employed to mean unobservable, without implying or defining perception as *only* internal. This makes room for possibilities of embodied cognition, in which actions form a more productive part of the perceptual system. I will suggest that the notion of internality can also be a qualifier that expands the relevance of embodied actions. Given the psychological and neurological findings pairing temporal perception with sensorimotor behavior, it may be worth considering temporal perception as involving internalized action. In other words, we may "go through the motions" of synchronizing our body with music without actually moving our bodies. For this reason, our brain neurons would fire up for movement just the same.

[21] Kozak notes that gestures may be "attenuated…or too fleeting and idiosyncratic to contribute to a rigorous theoretical inquiry (Kozak 2015, 1.7).

There is already value placed on embodied action in metric pedagogy. Dalcrozian pedagogy, for example, teaches rhythmic development through movement. How often is a music's temporal structure difficult to follow until having physically tapped out beats? Or, imagine the common situation of a student unable to find the meter of a piece until *after* being asked to conduct along with it. I would like to consider such motions as themselves serving as counting mechanisms of an embodied clock. Once you (or the student) are able to follow metric structure without needing to move, we might say that those actions have simply become internalized. And perhaps *that* would be the best way of characterizing perception as an "internal clock."[22] Motor neurons in the brain would "have" meter as they imagine physical entrainment with music, even if they don't actually send out axonal signals for muscles to contract. Chapter 4, returns to these questions as relates to existing pedagogical methods.

[22] This rebranding of "internal" as internalized action, need not only be applied to *temporal* issues in music. In teaching melodic perception, singing is often used an aid to ear training. One might consider melodic dictation as involving some degree of internalized singing. Indeed, I recall being terrible at dictation despite extensive experience listening. Only once I focused on my ability to sing, did melodic dictation improve.

1.3 Notation and Perceptual Representation

Modern Western staff notation (henceforth "notation")—as well as some other forms of music notation—is a static, visual object which can represent dynamic, sounded events. As such, it has a complex relationship with music. Its visual medium has led to charges of "unmusicality" and to omission from experimental designs (for example, London 2009, Clarke and Krumhansl, 1990). And the fact that it is not a universally necessary component of music subordinates its status in music theory (for example, see the previous discussion of Lerdahl and Jackendoff 1983). Even with the starting point that notation is *not* music(al), it nonetheless has a range of important musical uses. Notation can give instructions to performers about what notes to play, in what order, and for how long. It can also express musical structures associated with concepts embedded in the entire Western notational-pedagogical system. If someone says "I hear the high note as the downbeat to a measure of 3/4," they are expressing temporal experience using the language of the Western notation system, though the reference may be only to an imagined score. Engagement in music theoretical discourse takes for granted a fluency in the Western notational system. Notated analytical examples abound, if often with qualifications, reservations, or larger critiques. In this section, I present issues surrounding Western notation, in particular: 1) variability in training and literacy, 2) cultural specificity, 3) its simplistic representation of sound objects, and 4) its inadequacy in reflecting musical experience. These issues motivate caution and criticism, but do not warrant exclusion.

For Western art music, learning to read staff notation involves a specialized sort of training which usually goes hand in hand with instrumental music lessons. Notation gives the order and length of pitches to be played, providing partial instructions for a performance. As students

progress, reading staff notation begins to involve more theoretical and aural knowledge. It requires an abstract grasp of the system, such as what combination of notes will last a measure of a certain meter, or that G# and Ab are played on the same piano key. It also involves connecting abstract "mathematical" relationships to aural experiences about how intervals and rhythms will sound and feel. This could mean following a score to a piece of music as it is played. It might also mean singing the notes given on a page or "internally hearing" a new piece of music given only the score. By representing sound, notation can also communicate aspects of heard music to others, through transcription, for example. All these skills are aspects of notational literacy, and "literacy" can refer to those aspects individually as well as their total. Achieving literacy is intertwined with the formal Western music training apparatus and varies widely in degree. Because of the many different skills associated with notation—sight reading and singing, dictation and transcription, and score analysis—variations in literacy are not a simple spectrum from better to worse. This all adds up to the point that notation is esoteric and variable even among the initiated. Along with the fact that it is not an acoustic sound object, it is a messy variable for controlled laboratory experiments.

Western notation has limitations which give rise to its cultural specificity. It excels at providing a symbolic shorthand for the order of notes and durational ratios, but struggles at representing subtleties of intonation and rhythmic timing. Indeed, the idea that a rhythm can be represented by notes at all, with perfect fraction durations, and discrete note names turns a continuous spectrum of pitches into discrete quantities. Wrapped up in Western music pedagogy, notation is both subjective and intertwined with culturally specific concepts, such as "note" and "meter." As such, ethnomusicologists have been wary that using it for non-Western music might be forcing that object to fit a Western mold. Charles Seeger wrote that

> In employing this mainly prescriptive notation as a descriptive sound-writing of any music other than the Occidental fine and popular arts of music… we single out what appear to us to be structures in the other music that resemble structures familiar to us in the notation of the Occidental art and write these down, ignoring everything else for which we have no symbol (Seeger, 1958, 186)

Part of Seeger's concern arose from his consideration of notation as *prescriptive*, telling performers what to do, as opposed to *descriptive*, representing the musical object. His concern was that elements of music which are not given notational symbols are in danger of being ignored or undervalued. Twenty years later, Jairazbhoy (1977) comments that this fear may be overstated. As ethnomusicologists have made attempts to immerse themselves in the musical cultures they study, they look for musical aspects which Western notation fails to acknowledge. One attempt at solving this problem has been to simply construct new symbols (Jairazbhoy 1977, 270). Otto Abraham and Erich von Hornbostel codified a larger set of notational possibilities which ethnomusicologists might use in the transcription of field recordings. However, they note that the stopgap of creating additional symbols falls short for indicating various tone colors (Abraham and von Hornbostel 1994, 433-434). They suggest using either verbal annotations, such as "trumpet-like," or constructing a lettered key for the specific piece of music being transcribed. Using annotations in addition to special symbols provides more detail, but is not entirely sufficient.

The desire to explore aspects of music ignored or warped by symbolic notation has been a recurring source of discussion for theorists as well as ethnomusicologists. When ethnomusicologist Charles Keil sought to explore the "engendered feeling" of "groove" or "swing" that induces movement in listeners, he criticized music theory for lacking adequate language to describe it. Part of the problem for Keil was that the sense of groove did not emerge from anything that might be represented by standard rhythmic notation. In response, he

constructed a framework of "participatory discrepancies" to describe that expressive microtiming (Keil, 1994). Theorists such as Matthew Butterfield (2006, 2010) have expanded upon his work. Similarly, Fernando Benadon's "Slicing the Beat: Jazz Eighth-Notes as Expressive Microrhythm" (2006), explores the variety of timing differences among notationally equivalent "swung" eighth-notes.[23] The complexity of music sound beyond what standard notation expresses has not received as much attention from psychologists, on the other hand. In exploring the "nonharmonious" relationship between music psychology and theory, Nicholas Cook (1994) details criticisms of perceptual psychologists for being insufficiently trained in music to understand its complexities: they assume that music is simply "made out of notes" (Cook, 1994, 81).[24] No doubt, assuming music to be "made out of notes" helps clean up the discussion and results, but it continues the trend of psychological approaches simplifying the musical objects of study. This is understandable, as psychologists typically use music as a means of exploring aspects of brain function, as opposed to exploring nuances of musical objects.

Notation, in addition to being an imperfect representation of sound, has also been used as a representation of the *experience* of those sounds. Longuet-Higgins and Lee's paper "The Perception of Musical Rhythm" (1982) states, for example, that "musical notation provides a very strong clue as to what relationships are perceived when one hears a melody; more precisely, we feel that the concepts of 'beat,' 'metre,' and 'bar' are of central importance in the perception of music" (Longuet-Higgins and Lee 1982, 115). Similarly, Povel and Essens assumed that,

[23] Benadon's (2006) discussion of rhythmic nuance uses the term "expressive microrhythm," no "participatory discrepancy."

[24] Cook notes that the tension between music psychology and theory goes both ways. Theorists criticize psychologists for simplistic views on music, while psychologists are critical of the cavalier usage of "perception" (among other things) by theorists (Cook, 1994, 67).

given a metrically ambiguous stimulus, notation could induce "musical intuitions" based upon a score (Povel and Essens, 1985, 437). Joel Lester's struggle with Babbitt's *Composition for Four Instruments* (1986, discussed previously in section 1.1) stemmed not only from non-correspondence between perceptions of performers and listeners, but from the possibility that a scoreless listener might not perceive what is given in the composer's score. He questions: "how could a listener ever know to subdivide that measure-long pulse into twelfths (eighth triplets) so that that listener could understand the duration from the downbeat of measure 3 to the cello Ab as 5/12 of that measure pulse?" (Lester, 1986, 123-4). And he follows up with a rhetorical challenge for any listener who has never seen the score of Babbitt's piece to recreate it only by listening to the piece (Lester, 1986, 126). His concept of notation involves subjective interpretation of sound structures, and one which should reflect the experience of those sounds by a scoreless listener.

Lester's concern over metric notation reflecting perception is rather general. His issue was that a scoreless listener's temporal perception of Babbitt's music would bear little resemblance at all to the composer's score, and he places the burden of responsibility primarily on the composition. Inquiries by other theorists have taken a more detailed approach in comparing metric notations to perceptual experience. Russell Jones (1985), for example, compared approaches to meter by Serafine, Gordon, Cooper and Meyer, and Yeston and came to the conclusion that "there is virtually unanimous agreement that meter signatures are often not consistent with the ways in which rhythms are perceived and/or performed. The main disagreements have to do with how metric patterns are perceived or subjectively organized" (Russell Jones, 1985, 54). In subsequent decades, various models for temporal perception have emerged out of this starting point that metric notation is deficient in some way.

Justin London (2004) constructed circular loop notation, because "what is never fully notated in our familiar system…is meter." His problem with traditional notation is that it is essentially "a continuous graph of pitch and time" (or "a long ribbon") which obscures the cyclic nature of entrainment (London, 2004, 60). He does not claim that a patterned ribbon *cannot* represent cyclicity, but that a ribbon simply makes it less apparent. As London points out, analysts in the past have updated notation in several ways to provide metric information. Riepel, for example, used numbers below the staff. Lerdahl and Jackendoff constructed hierarchies of dots. And Zuckerkandl added metric "wave" annotations (London, 2004, 62-3). Christopher Hasty (1997) has also taken issue with static set of homogenous grids associated with notation and with these normative metric perspectives in general. His book *Meter as Rhythm* approaches meter to highlight the experiential process of becoming (through what he terms "projection"). His project aims to incorporate in meter the "creativity, spontaneity, and particularity that we often ascribe to rhythm" (Hasty 1997, 6), and critiques scientific theory for importing ideas which fail to account for the aesthetic, dynamic experience of perceiving music in time. For Hasty, constructing a set of metric types and grouping examples into categories such as "3/4," for example, ignores processes specific to individual pieces.

Notation—along with the general Western musical concepts associated with it—is in a difficult position in music theory. Its role as a set of instructions for how to produce sounds is generally neglected. Instead, it straddles being a representation of sound and a representation of the way sound is experienced. And this awkwardness occurs in addition to fact that it involves translation of dynamic sound and aural-temporal experience into static symbols. Some aspects are standardized and normalized while others are ignored entirely. Theorists and ethnomusicologists discussed in this section have criticized notation for its imperfect

representations and non-aural medium. Psychologists have been criticized for treating music sound like its notation (Cook 1994). And psychological experiments on music go out of their way to avoid giving participants notational information. How often have we been told that the notation is not the actual music? Or that to merely *read* and *look* for relationships in a score is insufficient without a proper aural experience of sound. These are valid complaints, but they can also obfuscate productive features of notation. Some "imperfections" of representation can also be special features to exploit.

For all the critique that Western notation gets, it is worth also considering its active role in shaping the way we experience sound. Notation may focus upon aspects of sound and discretize continuous spectra, but its thorough intertwinement with our musical educational system means that those distortions and omissions may become real parts of our experience, at least for those thoroughly trained in the Western system. Uninterpreted sound may not be "made out of notes," but if we're trained to hear notes, it can be experienced as such. Notation may actually represent musical experience better than it has been given credit, but only as we *learn* to experience what is notated. This may relate to Diane Persellin's (1992) interviews with first, third, and fifth graders about musical memory. She found varied answers in terms of modality were affected by age. Some relied on hearing, others on printed visuals, and others on kinesthetic memory. Younger students (first graders) were less engaged with the visual stimuli, suggesting notational aptitude may change significantly around these ages.

Respecting notation as more than a caricature of sounds begins by taking a performer's perspective. Scores and notation provide incomplete instructions (though no instructions are complete) and their "distortions" can be productive and meaningful, despite being culturally

specific constructions.[25] At some point, we moved away from notation as a trace of something you *do* whether or not the person reading that notation is the performer of the piece. Nicholas Brown is sharply critical of this move as an erasure of the link between sound and gesture.

> Indeed, it is tempting to recall the development of Western music, its close historical ties to the church with its Augustinian denigration of carnality, and the maturation of music from pure performance into the dualist, notation-authorized program that provided a platform for the Stravinsky-Schoenberg legacy and score-based 'accounts' of the musical experience. Modern notation reflects this 'misunderstanding of the being of the human body'. As an elaborate system, it makes a kind of musical scientism that exerts a level of control over natural phenomena, whether sounds, or the human gestures that comprise their origin. (Brown 2006, 42)

Brown's criticism stems from the value placed on listeners' perspectives at the expense of performers', and his argument fits with this project by pushing for a more "performative" conception of score, which links gestures to sounds. Brown also connects this problem to larger-scale disciplinary scientism and cultural erasure of bodies which I address in section 1.6. In subsequent chapters, I allow scores a more fundamental role in musical experience, but without assuming that a score-based account is adequate for all musical variables. Additionally, scores factor in alongside complementary embodied accounts, and those accounts help avoid the erasure of human gesture which Brown condemns.

[25] Joseph Dubiel offered a good analogy to spoken language on this point. Transcribed speech may involve breaking apart a continuous stream of sound into discrete words, but I can't imagine considering this a "distortion" of the sound. Instead it is a necessary move that helps move toward linguistic meaning.

1.4 General and Specific Training for Temporal Tasks

Music psychologists usually acknowledge the musical background of an experiment's participants in a very general sense, as a potential variable which affects performance. Olivia Ladinig's study of meter in "adult listeners without extensive music training" found that mental representation of meter "does not require advanced formal training" while also conceding that this "does not rule out the possibility that …[it] can be improved by musical training" (Ladinig 2009, 385). Other researchers such as Clarke and Krumhansl, in a study on meter perception (1990), made a point that their participants were "musicians with a considerable amount of performing experience," but offer only a vague sense that this "may also be significant" (Clarke and Krumhansl 1990, 250). Comparative studies differentiate between participants as "novices" (people with little or no formal musical training) or "musicians" (often undergraduate music majors) to explore performance differences between the groups (Küssner 2014, Vuust et al 2005). Music theorists also make this sort of general distinction between musicians and non-musicians, though with greater preference toward the experience of musically trained people (like themselves). The basic premise of Lerdahl and Jackendoff's *Generative Theory of Tonal Music* was to formally describe "the musical intuitions of a listener who is experienced in a musical idiom" (Lerdahl and Jackendoff 1983, 1). For them, "a listener without sufficient exposure to an idiom will not be able to organize in any rich way the sounds he perceives." (Lerdahl and Jackendoff 1983, 3). In all of these cases, having a musical background is clearly important, but it remains unclear what constitutes "sufficient exposure," "experience," "expertise," or "training." These variations in terminology are frequently given vague or overly broad definitions. Defining musical training as a number of years of study, for example, does not

provide much detail about *what* was studied during that time, nor to the quality of that study. Considering musical background very broadly as something you have or do not aligns with psychology's goals toward generalizability, but there have also been efforts (particularly in the last twenty years) toward exploring more individuated categories of musical background.

Among terms such as "musical training," "musical experience," or "musical background," little fuss has been made trying to give these individual terms distinct definitions, presumably because their definitions are rather fuzzy anyway. For this reason, I will not make much effort to distinguish between the variations in terminology. Among these variations, Kuck et al's (2003) definition for "trained musicians" is rather typical. They define musical training according to the number of years of formal training one has had. In their article, the threshold is five or more years of formal musical training on a melodic instrument or singing in choir. (Curiously, none of their participants played percussion.) Other definitions are broader. Nozaradan et al.'s study of neuronal entrainment used eight participants who all had "musical experience," either as performers with fifteen to twenty-five years of practice, or "as amateur listeners or dancers" (Nozaradan et al. 2011, 10234). Including amateur listeners is an unusually broad concept of musical experience indeed. Amateur listeners *are* exposed to plenty of music, but perhaps not in the same way (or degree) as someone with fifteen (or twenty-five) years of performance practice. Mari Riess Jones et al.'s experiments on attentional flexibility also divided participants based upon musical experience, by separating 199 undergraduate psychology students into "high-skill" and "low-skill" categories. The "high-skill" group was comprised of students who had played an instrument for at least ten hours in the last month and had four or more years of formal musical training on an instrument. The "low-skill" group included only students who had not played a musical instrument in the last month and who had had less than two years of formal music

training (none of which could be recent). Jones' category for "high-skill" requires a minimum threshold for training, but there's no upper limit. There is no differentiation between someone with four years of training and someone with fourteen. Participants who noodled around for ten hours in the past month fall into the same category as someone engaged in ten hours of structured practice *per day*. An undergraduate music minor would be considered "high-skill" alongside the prodigy guest soloist touring with a major orchestra.

The concept of "musical experience" not only includes variations in degree (i.e. how long you've been doing "music"), it also lumps together different types of training. Classical violinists, jazz drummers, and pop guitarists may have had the same amount of training (in years of study), but their training is qualitatively different. All have "musical backgrounds," but spend time developing distinct musical skill sets. This wide range of traits subsumed under the heading of "musical experience" is an asset when one's goal involves studying general cognitive skills and capacities—as much psychological study does. Maintaining a broad label such as "musically trained" helps argue for general applicability of a study to a wide range of people. Nozaradan et al.'s paper is just that sort of study. It seeks to show that neuronal entrainment is a general and observable phenomenon, and a broad sample set and general concept of musical training works in favor of that goal.

At the same time, Cameron and Grahn's survey of neuroscientific studies of rhythm includes criticism regarding the comparison of musically trained and untrained groups. They considered distinctions based only on years of musical training as an imprecise first step. "In the normal human population there is a wide range of abilities and traits related to rhythm perception… Accounting for individual differences is becoming an increasingly apparent issue, with a wide range of rhythm abilities present in the normal population." (Cameron and Grahn

2014, 114). Cameron and Grahn point to a couple of studies which are more sensitive to individual difference, but the point is made within the discussion of "future direction" for research. Roger Grant's dissertation tracing the history of meter makes a similar point. He notes that interest among cognitive scientists in acknowledging and incorporating "local and individual knowledge" is growing, and he suggests that meter research is now "moving on from its generalizing moment" (Grant 2010, 288). That shift is evidenced by increasing numbers of studies which account for cultural specificity (e.g. Kalendar, Trehub, and Schellenberg 2013, Jacoby 2017). The esoteric strategies of smaller musical populations do not have as much immediate general applicability. However, they become relevant for people willing and able to engage similar sorts of training as those musical subgroups. Studying a few extraordinary cases will not serve to describe what most people already do, but it can serve to guide pedagogy in what people *might be able to do* if they undergo similar musical training. That aim is an important part of this dissertation.

It is difficult to tell which cognitive tendencies and limits found by psychologists are "fixed" in our biological system, and which result from individual training. In her editorial for the opening issue of *Music Perception* (1983), Diana Deutsch grappled with this problem as a possible issue for music psychology as a whole. The burgeoning field lacked (and still does) an absolute way of differentiating "fixed" or fundamental cognitive limits from those that result from training. Deutsch conceded that no clear answer can be obtained by laboratory experiments. "Negative results would not be conclusive, since it could always be argued that many years of long-term exposure might have produced positive results instead." Her recommendation was that researchers instead make "inspired guesses" regarding the role of experience on cognitive capacity (Deutsch 1983, 2). She also urged an acknowledgement that experimental results may

end up reflecting the historical-cultural moment in which participants (we) live.

All these differences in musical training refer to ways individual participants are *generally* prepared for the tasks that might be given by researchers in an experiment (or not). However, little attention has been paid to *specific* practice for tasks given. Or more precisely, experimenters often make a point that participants are *not* given any specific practice. If a task is familiar, the particular stimulus is new (e.g. Beauvillain and Fraisse 1984, Clarke and Krumhansl 1990, Tillman et al 2011). Even in Bruno Repp's tapping studies, participants selected on the basis of being highly skilled ("master") tappers—i.e. demonstrating a high degree of consistency and control over their tapping—did not enter an experiment knowing exactly what they would hear. It is often desirable to test participants with an unfamiliar stimulus. With the goal of observing the effects of certain aural variables on performance, giving participants time to practice does not advance that pursuit. Instead, practice time maximizes the success of an individual's performance, potentially minimizes the sorts of deviations that experimenters want to find, and throws an extra variable into results.[26]

Psychological experiments might have little stake in getting participants the best possible performance, but that is precisely what musicians seek. That is why, when I have trouble following something's temporal structure, I go back and try again. Cases where we come into contact with a piece over and over again can be aesthetically problematic when an important aesthetic effect is one of surprise, but in most cases extra study enriches musical experience. The first time I listened to the Mehldau and Rossy trio's improvisation on "Anthropology," I had an acute sense that my experience was somehow "wrong." In their recording, the group

[26] This point would not stand if *practice itself* were the variable to be tested. Experiments could determine which tasks are substantially affected by practice, and which not, but this avenue has received little attention.

superimposes a triple meter feel over an underlying 32-bar structure based on "rhythm changes," and I let the superimposed meter whisk me away. I lost a grip on the underlying song form. Being able to follow that passage took practice, transcription, and some listening to artificially slowed versions of the original recording. I, a percussionist with considerable training, am well prepared *in general* to confront metrically challenging music such as this, but my experience was unsatisfying until I found time for *specific* practice. During that practice time, I found special strategies to facilitate difficult temporal navigation. If I were asked to tap along before and after this specific practice, the results would no doubt be quite different.

Existing experiments which do not give participants specific practice do well to explain my unpracticed "failed" attempt at tracking Mehldau's solo upon first hearing. In Treffner and Turvey's work on "resonance constraints," participants performing a regular action were instructed to continue that action while another competing stimulus was introduced. The study explored changes of the action to resonate with the competing stimulus, and the authors found that participants tend to make adjustments that simplified polyrhythmic ratios. In "Anthropology," Mehldau's superimposed triple feel introduced a competing stimulus which interfered with my ability to continue following the original song form. According to Treffner and Turvey's experiment, I did what people generally do when given competing stimuli. In this case, the most natural tendency was not the best course of action. The path of *more* resistance is sometimes preferable. I argue that it is the difficulty provided by the metric competition which makes the improvisation more aesthetically powerful. It presents a challenge which is gratifying to overcome.

In sum, familiarity and specific practice can alter our responses to music and create a messy variables for psychological experiments. How much familiarity and practice does each

participant enter an experiment with? Did participants practice in different ways? Taking away that familiarity effectively levels the playing field and makes results easier to read. Doing so is also practical: participants perform a new task and finish without having to commit to practice time (or, in the case of compensated experiments, be paid for it). There are cases where a lack of prior knowledge is absolutely necessary. Studies on the learning of new timing patterns (Dell 2010, Tillman et al. 2011) need to present fresh stimuli in order to witness the acquisition of new temporal pattern under controlled conditions. However, the main problem with this *modus operandi* begins when it occurs at the expense of acknowledging highly practiced tasks and responses to familiar pieces. Some musical contexts demand a high amount of work (practice) to experience a certain aesthetic possibility. In many cases, the most natural, naïve response to a musical passage is not the most desirable one.

1.5 Attentional Entrainment in Music Psychology

Discussions of temporal periodicity in music generally consider meter, perception, and listening together: to experience *meter* means to *perceive* temporal hierarchy by *listening* to sounds. With this sort of conceptual underpinning, work by Robert Gjerdingen (1989), Mari Riess Jones (1981, 1985, 1986, 1995, 1999, 2006) and Justin London (2002, 2004) has yielded a metrical theory of attentional entrainment, or "attending," in which one's attention synchronizes with the periodicities of external sound stimuli.

Mari Riess Jones (1976, 1981, 1985, 1986, 1987) pioneered the idea of meter perception as involving metrically modulated attention, and subsequently tested and honed it through various controlled experiments (1995, 1999, 2006). Her initial writing on meter perception ("Only Time Can Tell: On the Topology of Mental Space and Time" 1981) did not use the concept of attention in any central way. Instead, it focused on dynamic expectancies toward future events based upon invariants in a stimulus. Her goal early on was simply to have psychological theory account for future-oriented expectancies (which represent "positive time") as well as retrieval and storage of codes in memory ("negative time"). At the time of her writing, this was a new move. She criticized existing research for failing to acknowledge "positive time-based processes" and being preoccupied with "negative time." She urged psychologists to formally represent "dynamic attentional energies, which thrust forward toward targets in the future and backward toward things past" (Jones 1981, 576), and that hope was primarily followed through her own subsequent work.

In Jones's later research, attention (and attending) became more central. In her article on "attentional rhythmicity," she outlines how previous approaches to attention (which were not

specifically about music) had not made adequate use of stimuli which were themselves rhythmic. She traces previous research in the 1950s through 1970s in which attention is considered as a filter, a resource of limited capacity, and a part of schema theory. Early models of attention as a filter were relatively simplistic. The regulation of informational flow through filters was treated as "all-or-none." You either attend something or you do not. However, following Kahneman (1973), the model of a filter was scrapped in favor of one in which attention was treated as a resource of limited capacity. Thus, when experimenters introduce competing tasks for participants, performance declines in comparison to execution of tasks without the distracting variable. Resource capacity models were given subsequent refinement. Navon and Gopher (1979) considered the possibility of modality specific resource pools. They found that auditory signals present more interference for auditory tasks than with visual ones. Posner and Snyder (1975) added an additional distinction between "automatic attending," which is not limited by attentional resource capacity, and "controlled attending," which is. Their proposal for a concept of "automatic attending" accounted for the performance of highly practiced tasks without much awareness. "Controlled attending," by contrast, described situations in which is more focused and requires an "original response."

As Jones points out, these theories critically fail to address what "attentional energy" is, and what determines the limits on that capacity. In her words, "it is not clear from whence the resources, as attentional energy, come. Nor is it clear why and how these resources are actually task specific." (Jones 1986, 15-16) For Jones, one problem is that the theories lack much predictive value. They give a banal finding about how distractions burden attentional resources (whatever those are), without being able to say much about the degree to which those resources will be burdened by various types of distractor. Another problem for Jones is that Posner and

Snyder's distinction between "automatic" and "controlled" attending ends up being a simplistic dichotomy. It considers tasks that are performed either as expert or beginner, without room for intermediary stages or the development of skills through practice. In the 1970s, Ulrich Neisser offered another model for attention which offered a better account of skill development. Neisser tied attention to acquired perceptual schemas (drawing upon theory from Sir Frederick Bartlett). It's a subtle difference, but his theory essentially argues that performance is determined by level of skill (i.e. the acquisition of schemas), not some fixed pool of resources. This avoids the vague concept of a "resource pool," but that vagueness is essentially transferred to the concept of the "schema." Jones points out that schema theory, just like a theory based upon attentional resource pools, similarly lacks predictive value beyond the idea that people improve through practice.

A recurring problem for filter, resource, and schema models of attention is the lack of temporal contexts they incorporate. More specifically, Jones points out that "time" was incorporated in terms of "processing time" ("the amount of time required to encode an isolated item") or "absolute time" (the rate at which successive stimuli are given). However, these models did not acknowledge the effects that temporal patterning of events (i.e. rhythm and meter) might have on attention. Jones's desire to incorporate rhythmic and metrical stimuli reflects her disciplinary affiliation to music. The omission of temporally patterned stimuli in attentional theory is rather obvious only after shifting "attention" from general psychological inquiry to *music* psychology. Jones's larger career project involved setting up various experiments on attention in which the stimuli were temporally patterned. Her approach also attempted to concretize the concept of "attentional energy" from previously vague usage. Instead of allowing attention to be metaphorical, she required it to be "potentially measurable in terms of heightened amplitudes (or increased recruitment) associated with excited brain rhythms of particular

frequencies." (Jones 1986, 20). In other words, whenever you are paying more attention, it must be potentially observable in brain activity. That may not be a completely satisfying concept of what attention is (or from whence it comes), but it does make a point of discussing attention in terms of neurological observables.

Drawing upon Jones's early exploratory work, Gjerdingen's article "Meter as a Mode of Attending" (1989) offered a possible neurological model connecting meter and attention. At the outset, Gjerdingen notes that the concept of attention in psychological literature is a bit of "a catchword for the many diverse aspects of human information processing that focus, filter, or otherwise guide our perceptions" (Gjerdingen 1989, 68). Among the many ways in which attention can be allocated, he considers one such mode—one "mode of attending"—that might be directed toward metrical patterns. This formulation remains rather open-ended. He claims only a certain mode of attending can be directed toward metrical patterns, but does not define meter perception as attending. The article focuses upon the idea that low-level processing in the form of neuronal oscillation might allow for complex perceptions.

Later discussions by Jones (and London) fused the link between meter perception and attention. Jones's 1999 article on "The Dynamics of Attending" (in collaboration with Edward Large) explains:

> Coordinated attending rhythms fashion a crude mime of an event's rhythm, an adaptive attentional cartoon of its shape in time. Thus, by virtue of dynamic mimicry, the attender "participates" in the rhythm of a remote event. Entrainment means that parts of an attender literally "match up" with certain time spans in the remote event, and in this sense attending is participatory. The resulting synchrony with temporally structured events functions as a form of direct knowing. (Jones and Large 1999, 153)

Their work presents dynamic attending the mode of tracking time-varying events, without acknowledging the possibility of other modes of perception. Importantly, these "attending

rhythms" are defined as "internal oscillations" (Jones and Large 1999, 119). For Jones and Large, the "literal" match-up of these neuronal oscillations should be observable with brain scan technology, but physical gestures are not a direct component of the theory. Large clarifies this point in a related article "On Synchronizing Movements to Music," proposing that "most likely, when people listen to a musical rhythm, they perceive a beat and a metrical structure in the rhythm, and *these perceived patterns enable coordination with the music* (Large 2000, 527 italics added). More recent experiments by Jones and other collaborators add nuances to the theory of attentional entrainment. In "Effects of Auditory Pattern Structure on Anticipatory and Reactive Attending" (2006), Jones, Moynihan Johnston, and Jennifer Puente, manipulated instructions given to participants to show that people have some control over their attention. Attention is not an entirely automatic, stimulus-driven response.[27]

One reason for involving the concept of attention in meter theory to begin with may be that it allows meter perception to happen internally. People can "feel" the beat of the music, even when not observably moving. Invoking attention may also be more intellectually attractive, injecting into research a sense of humanity and consciousness. Writing about attention in the general field of cognitive science, Bernhard Hommel commented on how conference papers dealing with attention seemed rather popular.

> Cognitive scientists love attention as a topic. In contrast to sensory and motor processes, say, which rather smell like hardware and mechanics, the concept of attention seems to directly connect to what makes us human… The drawback of this attractiveness is that concept is more often than not used as a wastebasket, a container that serves as a pseudo-explanation for the phenomena we still fail to understand. (Hommel 2010, 121).

Hommel's comments are essentially a stronger, more critical version of Gjerdingen's admission

[27] Other work such as Carlile 2014 addresses this "cognitive steering" of participants.

that attention is a bit of a psychological "catchword." Whether a catchword or wastebasket, it's worth being aware that the application of attention might not be doing as much explanatory work as it seems to. Simply referring to *internal* entrainment might be good enough.

Regardless, the concept of attentional entrainment has since become less tentative, no doubt related to the existence of a more robust corpus of relevant laboratory experiments and theories which draw upon them. London's *Hearing in Time* (2004)[28] presents the most prominent theory of this sort, and draws explicitly upon Jones. London's central premise is that meter is a form of entrainment in which a listener's "attentional rhythms" phase lock with regularities of music sound (London 2004, 12). There is an important shift from Gjerdingen's "Meter as a Mode of Attending" and Jones's early research. First, London's definition of meter is different. For Gjerdingen, "meter" refers to periodicity which might be present in music or in neuronal activity that perceives it. For London, "meter" *is* the perception of those regularities in music. Additionally, London's concept of meter-as-perception is limited to attentional entrainment. There are no other ways to perceive musical periodicity.

London repackages Jones's research (including reference to work by Gibson, Neisser, and Kahneman) for music theorists, including her point that "attention" corresponds to real brain activity. However, even if attention is potentially observable as neural brain activity, the primary source material involves bodily movement from which "attention" is deduced with the epistemological awkwardness discussed previously in relation to meter perception's "internality." An important concern of London's is to outline various cognitive constraints upon attention. For example, he puts forth a "temporal envelope" on the intervals "that we can hear or perform as an element of a rhythmic figure" ranging from 100 milliseconds to 6 seconds on the

[28] Note that London 2004 refers to the first edition. London 2012 is the second edition.

(London 2012, 27), and points to experimental evidence which found significant changes in behavior around these thresholds. Synchronizing one's taps to interonset intervals (or IOIs) of around 5 to 6 seconds becomes more "reactive." Participants consistently tapped just *after* the stimulus. London admits that cognitive constraints and thresholds are "heavily dependent on task and context," (London 2012, 27) but changes of context do not fundamentally alter these constraints. For him, context may affect the precise numeric limits, but not the general ranges and order of magnitudes (London 2012, 28).

London's theory of attentional entrainment, at least in its original 2004 version, denies the possibility of polymetric perception. Attention may only admit nested layers of oscillation which combine to form a single hierarchic "ground" for various rhythmic figures. Limits on attention are extrapolated based upon well-formedness rules of a figure-ground paradigm. London claims that "the need to maintain a single coherent ground seems to be universal" and that "thus, there is no such thing as a poly*meter*" (London 2004, 50; italics in original). Although he withdrew such strong wording from the second edition, it is important to trace where this proscription comes from. London's meter is not just regularity, but a form of perception involving the synchronization of attention. In addition—although he does admit the potential for conscious control of attention—London's usage focuses upon "the automatic and subliminal process of metric entrainment." He bases this choice of focus on what he considers a typical musical situation, in which "we reflexively entrain to a rhythmic surface without conscious effort or volition" (London 2012, 68). This meter-as-attention, in other words, does not involve paying very much attention! Following metrically conflicting streams, on the other hand, is precisely the type of situation that *does* require effortful and active strategies of temporal navigation. With this conceptual background, his statement about polymeter could be qualified: so-called "polymeter"

is not perceptible by only passively attending without conscious effort.

The prohibition of polymetric perception is notably absent from London's second edition of *Hearing in Time* (2012), which acknowledges recent embodied theories of meter perception. The newer edition also steps away from a concept of *internal* attention always guiding external actions. London nods toward the alternate possibility that metric entrainment not only "engages our sensorimotor system" but "may be the direct synchronization of our movement(s) to external rhythms." (London 2012, 12). This offering takes into account more recent research, but following up on that possibility in any significant way remains beyond the scope of London's work.

1.6 Situating Metric Theory Trends into Music Theory's General Biases

> It is now generally known that in all arts and disciplines, it is more honorable to be a person who works from true understanding, rather than manual labor. Thus it is far better to know how to do something, than it is to do something but not know how it is done. Indeed, physical activity is tantamount to slavery; reason, however, rules like a mistress. For unless the hand follows the will of reason, all will come to naught. Where could it be more evident that it is better to possess rational understanding than to be a creator of a work or a practitioner, than in the science of music? It is just as much more noble than the mind is superior to the body because it is only reason that separates the expert from the servant. (Boethius, *Fundamentals of Music* ca. 520)

> Music theory is usually not concerned with the performers' activities… The present study will justify the view that a piece of music is a mentally constructed entity, of which scores and performances are partial representations by which the piece is transmitted." (Lerdahl and Jackendoff, *A Generative Theory of Tonal Music*, 1983, 2).

The trends in recent metric and temporal theory both reflect and contribute to norms of music theory as a whole. It is our duty as responsible theorists to acknowledge and interrogate the biases and preferences which seep into meter studies and radiate from it. From Boethius to Lerdahl and Jackendoff, theorists equate the role of performers with that of servants and transmitters of pieces. By contrast, listeners (and theorists) occupy the superior role of rational contemplators. Giving priority to theorists-as-listeners may help explain some of the trends discussed throughout this section: of musical experience as perception, of music perception as listening, of perception as in some sense "internal," and of metric perception as attentional entrainment. However, assuming such a focus reflects and contributes to a disciplinary erasure of bodies from discussion. Additionally, when Lerdahl and Jackendoff define "music" as an abstract "mentally constructed entity of which scores and performances are only partial representations," they do so at the expense of real, individual experiences. Often couching their ideas in feminist theory, Fred Everett Maus, Suzanne G. Cusick, Carolyn Abbate, and Marion A. Guck identify

general problems in music theory which do not address studies of meter specifically, but help shed light on the trends in meter research explored in preceding sections.

Maus' "Masculine Discourse in Music Theory" (1993) explores patterns in music theoretical writing—patterns of *omission*, in particular—which reflect "a desire to avoid *discourse that might seem unmanly*" (Maus 1993, 265 italics in original). He discusses several gendered oppositions which map onto, on the one hand, a music theoretical mainstream of "Schenker and sets," and diverse alternative approaches which form a marginalized, feminine "permanent penumbra" in the discipline. Drawing upon oppositions in John Rahn's "Aspects of Musical Explanation" (1979), Maus notes that a mainstream preference for science-like, atemporal, concept-driven, piece-oriented discourse over more literary, in-time, data-driven, experience-oriented alternatives reflects a gendered power dynamics of masculinity and femininity. Maus also relates an opposition between "concept" and "data" to form and matter, mind and body. That gendered opposition between metaphorical mind and body becomes a more central topic in Cusick's "Feminist Theory, Music Theory, and the Mind/Body Problem" (1994). In that article, she criticizes the typical "mind-mind" conception of music in which composers' "minds" transmit a work to listeners "minds" with performers merely serving as vehicles of transmission. Cusick constructs what feminist music theory might look like by incorporating in-time, embodied, physical actions into analysis. She considers "Aus tiefer Not" from Bach's *Clavierübung* in particular for the extraordinary physical tension it creates in its performer. That physical tension contributes to the piece's musical meaning, but is not conveyed by sounds. You feel the tension by performing the piece (or imagining yourself performing it), but you cannot hear it, nor even see it in the notation. Musical meaning is found within the body. It essentially

reverses the power dynamic of performers serving the will of "reason" (for Boethius[29]) or some "mentally constructed entity" (for Lerdahl and Jackendoff).

Meter psychology's priority upon generalizable results also erases individual subjectivity from discussion. Guck's "A Woman's (Theoretical) Work" presents a relevant gendered critique of music theory with a focus upon what constitutes authorized speech. Drawing upon work by Donna Haraway on situated knowledges, Guck points out the frequent omission of personal experience from analyses which gives an illusory impression of objectivity. Part of a "woman's theoretical work" involves speaking personally about individual perceptions. On the other hand, psychological studies seem intent on erasing, or at least smoothing over the variety of participants' musical backgrounds. Once entered into an experiment, participants become fitted with simplistic descriptors: musician or non-musician, man or woman, left-handed or right-handed. To underscore the value of individuals and the particularity of experience, Carolyn Abbate invokes another worthwhile binary distinction between the "drastic" and "gnostic," to reinforce the importance of subjectivity in music theory (and elsewhere). She uses the terms to highlight music theory's focus upon shared knowledge among an initiated few about abstract hypothetical performances (the gnostic) at the expense of "real-life" performative (drastic) experiences of actual music making. Indeed, Lerdahl and Jackendoff's quotation given at the outset about music theory does well to encapsulate exactly what Abbate responds to. Their stance that music theory is not generally concerned with performers' activities and that performances only serve as partial representations of music leaves music not as an actual sound object, but an abstract mentally constructed entity. Abbate's point was just the opposite, to say that we *should*

[29] It's worth noticing that "reason" in Boethius's example is depicted as feminine ("like a mistress"), although it occupies the culturally masculine, dominant position of "ruling."

be concerned with real, individual performances (and not only the ones that are recorded, nor ones that lead back to some score!).

An important question remains, since these writings are now twenty years old: does feminist theory still form a marginalized disciplinary penumbra? I think these various alternative approaches which Maus depicts as unmanly and outside the mainstream have been able to garner more prominence. Feminist theory is respected at least within the theoretical circles I find myself, but I think it would be overly optimistic to think that that sort of research is now part of music theory's "core." Mainstream psychological approaches to meter continue perpetuating many of the patterns Maus critiques. Work on embodied cognition presents an important countercurrent. Mariusz Kozak's work is particularly refreshing, in using motion capture technology to explore not just physical motions of participants dismembered into tappers, but complete, individual, moving human beings. His 2015 article "Listeners' Bodies in Music Analysis: Gestures, Motor Intentionality, and Models" cites Cusick and Abbate as highly influential and points toward burgeoning interest in the area. The marginalized feminist alternatives which Abbate, Cusick, Guck, and Maus describe have, in other words, made their way in from the fringes of the discipline. These are progressive shifts, to be sure, but it is difficult to say just how fundamentally the discipline has changed since those writings.

Mainstream and normative perspectives on meter perception repeatedly scapegoat "post-common-practice" and "(post)modern" music. (This is very different from Maus's critique, which took aim at the language describing Babbitt's music and not at the music itself.) Both Justin London (2009) and Joel Lester (1986) take aim at Babbitt's music for failing their test of perceptibility. Lester's critique of Babbitt's *Composition for Four Instruments* for the imperceptibility of its notated meter led him to ask whether we ought to reassess "commonly-

held conceptions of rhythm." That question was surely rhetorical, but valid nonetheless. Taking difficult, metrically non-normative[30] music seriously may entail a reassessment of fundamental assumptions about our experience. Diana Deutsch was aware of this issue for new music in her editorial (1983). As she points out, psychological approaches to music cannot differentiate cognitive limits which are fundamental from those that are experiential. In other words, it is impossible to know whether a participant simply needs more exposure and practice to follow such-and-such an aspect or idiom of music. Music psychology, rooted in testing what people do *now*, is set up to favor the status quo in established music. Deutsch refers to the Monteverdi-Artusi controversy to illustrate her concern. She notes that, at the time, Monteverdi's music was criticized for not appealing to the established modes of listening. Babbitt's music, similarly, can involve experiences outside expected and established norms. In this way, it is less surprising that music psychologists approach his music with skepticism.

Remarkably, Babbitt's music seems to generate criticism on multiple fronts. On one side, London's psychological approach charges it with imperceptibility. And from another, Maus' feminist critique dislikes "the science-like, objectifying framework that Babbitt's methodological views support" (Maus 1993, 265). These may seem like opposite problems, but I think they both stem from an assumption that the experience of Babbitt's music involve "first-order" perception of some complex mathematical relationship composed into the musical object. For different reasons, London and Maus both dislike the sorts of abstract calculation that Babbitt's music seems to solicit. In "What's the Use of the Twelve-tone System," (1997) Joseph Dubiel criticizes

[30] By metrically "non-normative," I refer to music for which meter is not clear and notated score would not align with the hearing and transcription of a scoreless listener. Babbitt of course comes to mind, as his music figures largely in Lester (1986) and London (2009), but so too might the music of Feldman or Webern, among many others.

conversations about Babbitt's music for being overly concerned with the mechanics of finding the series of a twelve-tone piece. For him, simply identifying tone row manipulations does not satisfyingly describe his experience of listening to the music. However, Dubiel does not fault Babbitt or the compositional system. Instead, he attempts to steer analytical inquiry away from the "regulation and control" of deterministic unity (which Maus also criticized) and focus instead on the openness that the twelve-tone system affords. Dubiel's article may seem a bit afield from this project, but I point to his work as a model of openness to many sorts of musical experience worth exploring.

Maus states that one of his goals is "to encourage the development and empowerment of alternative approaches," because "an aspiration to masculinity has distorted many writers' images of music, insulating their account of music from common facts of musical experience" (Maus 1993, 265). Perhaps the masculine aspiration for clean, generalizable results in meter theory has led to insulation from visual resources, intersubjective experiences, and many other social-cultural issues that could be left to historians and ethnomusicologists. However, I have become increasingly aware that such an insulation occurs at the expense of aesthetically meaningful musical encounters and practically valuable musical tools. To begin incorporating feminist critiques into studies of meter, it may help to take on more individual and performative perspectives. This move adds embodied complexities into our understanding of musical experience, but that is not my main reason for doing so. The strategies and resources which performers use are of practical value and often *necessary* for overcoming difficult temporal hurdles. I think these tools reflect some of the "common facts of musical experience" which have been ignored or defined away, despite being worthwhile for performers and scoreless listeners who know what to do. To highlight these "alternative" approaches (and I use quotations, because

the approaches are more widespread than we might realize!), I consider temporal navigation of difficult passages as a problem to be solved by any means necessary. What constitutes "difficulty" is relative to the person engaging with a piece of music. I analyze music which I believe will pose challenges to music professionals and my intended readership. However, more straightforward passages might also be considered "difficult" for people with less musical experience, and they require similar sorts of strategies to grapple with that challenge.

CHAPTER 2: METRIC RESOURCES BEYOND ATTENDING

2.1 Introduction

My means of highlighting varied temporal resources, contexts, and strategies involves particularly challenging examples of what I call "metric multi-tasking." I am not attached to the concept of "meter" embedded in that term, because of the baggage associated with it. Similarly, I do not advocate a concept of what might constitute a proper musical experience. I make no contextual restrictions about music-as-sound-perceived-by-listening-and-attending. Nor do I require that musical objects be treated as novel, or that perspectives I offer apply broadly to many most people (or most musicians). Instead, my motivation stems from the practical concern of how musical periodicities may be navigated. So long as a strategy or resource is useful, it is worthy of study. I incorporate strategies which may result from extensive practice by specific people, including preparation for the metrical "obstacles" analyzed. In order to highlight various active strategies required by a situation, I take the perspective of a performer. I will not claim to know what actual performers did, nor try to construct what some idealized performer ought to do. My analyses describe my own experience trying to perform, or follow along, the examples given.

Ève Poudrier and Bruno Repp consider the possibility (and difficulty) of metric multi-tasking in their article "Can musicians track two different beats simultaneously?" (2013). Much like this dissertation, to approach that question motivates several moves away from restrictive trends in music psychology and theory. The experiments they constructed provided participants with two concurrent temporal patterns, each with a distinct metric framework and pitch. Participants were then confronted with a probe tone (far higher than the other two pitches) and

asked to determine whether the added tone fell on a beat (or not). For the authors, "tracking a beat" essentially means metric perception,[31] but their theoretical framework is open. Their concepts for meter and polymeter include its "descriptive" and "psychological" senses (Poudrier and Repp 2013, 372), meaning meter may either be "in the music" or "in the perceiver." Furthermore, they define metric entrainment as "the dynamic process by which internal or external periodic processes (such as oscillatory brain activity, attention, expectations, or motor activity) are aligned with one or several… periodic pulses" (Poudrier and Repp 2013, 370). That's a very open definition, because synchronization may involve either internal *or* external processes. Alignment of motor activity with a pulse constitutes metric entrainment, without requiring "internal" notions of attention and expectation accompany it.

Additionally, the article has a positive tone of possibility. It asks what can people potentially do (and how), as opposed to what do people do already, or what are people's fundamental cognitive limits. It also avoids a priority on general applicability by asking if *musicians* can track two different beats. The musicians who participated in the study were not generic undergraduate music majors, they were graduate and post graduate students at the Yale School of Music. They also were regular participants in Bruno Repp's lab on synchronization and rhythm perception, meaning that tapping along in an experimental context had been practiced prior to the experiment. The participants were also prepared with detailed descriptions of what to expect including musical notation of the rhythms they could expect to hear (although that notation was taken away during the testing phase).

[31] "The present research is one of the first attempts at studying polymetric perception empirically" (Poudrier and Repp 2013, 385).

Perhaps surprisingly in the context of previous psychological research[32]—but unsurprising in the context of this dissertation—Poudrier and Repp found that musicians can indeed track different beats simultaneously. In keeping with other research, they found that performance was not as good as tracking a single pulse stream and that it suffered as the complexity of phase relationships increased. Through post-experimental interviews, the experimenters also found participants employed many different strategies. Some participants constructed composite rhythms, but strategies more often involved "some form of divided synchronization." Participants reported many synchronization strategies, such as head nodding to one beat while listening to the other, or foot tapping to one rhythm while conducting to the other. Given the prevalence of these strategies, the researchers suggest that "divided attention might be successfully supported by systematically matching different beats to different motor or perceptual systems." In some cases, participants also reported strategies which "are best classified as 'analytical,' that is responding…based on some specific feature of the polymetric structure" (Poudrier and Repp 2013, 387-388).

The resources and strategies I put forth in this section—e.g. counting, coding movement, and calculating—are similar to those strategies reported in Poudrier and Repp's study. One notable difference here is the frequent preference for performers' perspectives. Although the strategies may be employed by listeners (as was the case in Poudrier and Repp's study), they can be jettisoned too easily when taking the perspective of a listener. Listeners can be lazy. Without any catastrophic effects, a listener's mind can wander (or their person can literally wander about) as music plays, or they can fail to follow music's temporal structure (and perhaps even fault the

[32] Poudrier and Repp refer in particular to London (2004) and Keller and Burnham (2005), as well as many polyrhythmic studies in which participants

music for such a failure). Performers' tasks, by contrast, carry more urgency, responsibility, and connection with the musical material. If a performer's mind wanders during a performance, the intended temporal structure may fall apart. These performative resources and strategies are available to listeners, even if they are not *necessary* components of that listening. Recognizing them could mean opening up the concept of "listening" to include many non-aural relationships with music. Or, we might want to leave "listening" as a relatively tight concept. In that case, we could say that listeners can *also* engage in other sorts of metric navigation *while* listening. Such a distinction is admittedly a low priority much like determination of something as "musical" or "perceptual." The following sections outline resources and strategies which are *useful* in some context, for some individuals.

2.2 Dynamic Symbolic Coding and Embodied Off-Loading

In our everyday lives, we monitor the passage of time using clocks (whether they be watches, wall clocks, smartphones, or computers). This temporal relationship between person and clock has several important features. First, checking a clock requires specific learning. You need to know how to read dials on an analog watch, how many minutes make up an hour, how many hours make up a day, AM and PM, etc. Given that learning, reading a clock allows us to check in on something we haven't paid much attention to, which is (usually) something beyond our capacity for attentional entrainment. The fact that it allows checking in on something we haven't precisely followed is its point: the device keeps track of time when we do not. There is an element of trust—perhaps risk—in using this tool, because it is a fallible mechanism. It is not guaranteed to be accurate. It may slow down, reset, malfunction, not have been updated for daylight savings, and so on. What I call "dynamic symbolic encoding" involves a broad category of clocklike resources which provide time-dependent information contextualizing various moments in time. As long as you know how to read them, clocks provide information about what is happening *now* and facilitate off-loading of temporal information.

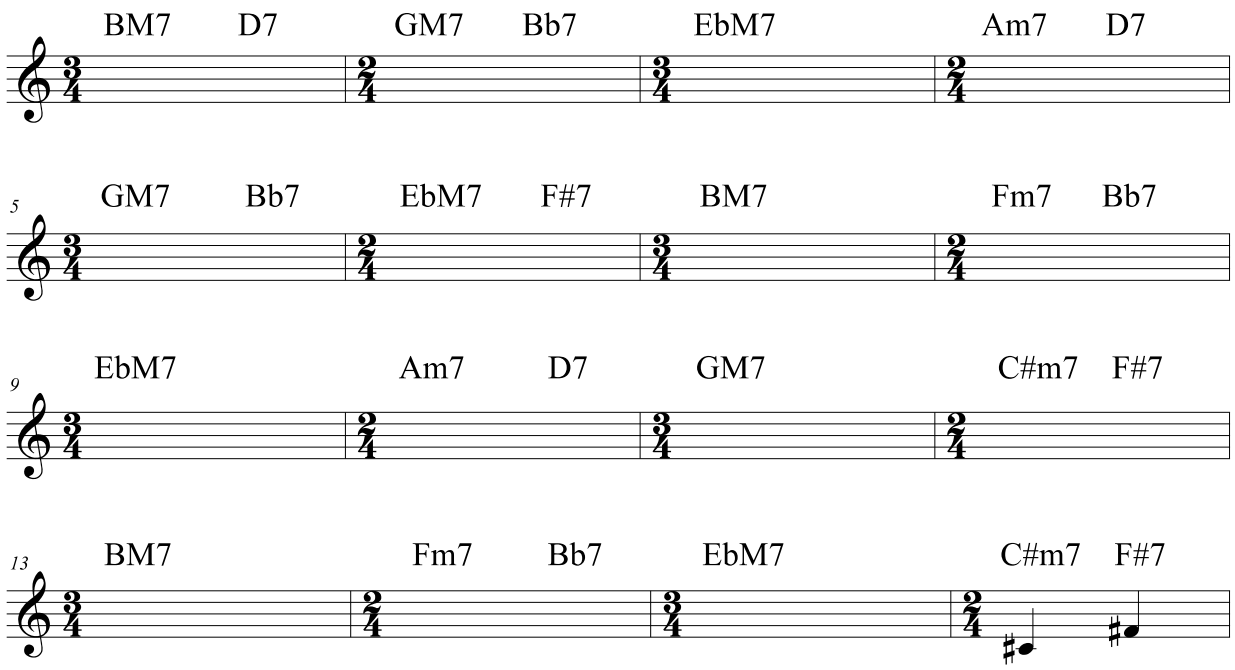
There are some musical contexts in which musicians rely on conventional clocks (i.e. everyday devices to display seconds, minutes, hours) for timekeeping. Performers of John Cage's *4'33"* use a clock or stopwatch to make sure the piece and its movements last the correct amount of time. Film scoring musicians and conductors may also make use of clocktime to coordinate musical events with on screen actions. However, musical situations of dynamic temporal encoding more often involve making some sort of "clock" that tracks an aspect of the music at hand. Musical clocks synchronize with some temporal units in the music, as opposed to

absolute seconds and minutes. If you've ever counted measures as they occurred (aloud or in your head) you've created a musical clock. (I often think about poor percussionists tasked with waiting many, sometimes over sixty measures, for an entrance.) To count measures requires attentional entrainment in order to time each consecutive natural number with downbeats, but by encoding measures with numbers (symbols), one can follow large hypermetrical groupings while "feeling" durations only a measure in length. This technique relates to the memory problem put forth in Candace Brower's "Memory and the Perception of Rhythm (1993, 31-33), namely that high-level "background" rhythmic structures last too long to fall within the working memory of the psychological present.

In other situations, temporal events may occur within the threshold of attentional entrainment, but lack sufficient previous activity to make a periodic structure apparent without symbolic markers. Consider the situation of a pop musician cuing a song (presumably in 4/4) by shouting "Two, three, four!" or maybe just "Three, four!" In either case, the durations between the words set up a tempo, but the words themselves do not form an entire metric unit. There is no sounded downbeat from which to project a hierarchical organization, and indeed whether two words are used or three does not make a substantial difference. The words *signify* metric locations in relation to a temporal hierarchy which has not yet formed. They imply a previous downbeat and a hierarchical group which has not occurred. This is a substantial addition to a person's temporal resources. Metric theory by scholars such as Christopher Hasty (1997) and Danuta Mirka (2009) focuses upon "finding meter" as a process in which previous timespans "project" potential periodicities which may or may not be realized. They also continue a trend which goes back to psychological studies of meter such as Longuet-Higgins and Lee's. By assuming that relative durations of events provide sufficient information to the listener for

determining meter, they leave other sorts of information unexplored. These starting points reflect the listener-centric perspectives of those scholars. Listeners may find meter after the music proper begins, but performers must be synchronized from the moment they begin to play.

Melodies and rhythms may also signify temporal information. Consider for example, the arrangement of "Giant Steps" by the Jean-Michel Pilc trio. The group features Jean-Michel Pilc on piano, Ari Hoenig on drums, and François Moutin on bass. All are regular collaborators in jazz clubs (often in the context of Ari Hoenig's Monday night residency at Smalls jazz club in New York City), and known for metrically difficult and playful interpretations of standards. Their arrangement alters the meter of the standard, replacing measures of 4/4 in Coltrane's original with alternating measures of 3/4 and 2/4, and creating a larger period of five beats. In the final measure of the sixteen-measure song form, the changes set up the return of B major with a ii^7-V^7 which the group blatantly underscores with a unison flourish of an ascending fourth, C# to F#. These hits, in the context of their arrangement, are given in Example 2.1



Example 2.1, hits as symbol in the Jean-Michel Pilc interpretation of "Giant Steps"

Importantly, the performers repeat these hits in almost every chorus. Their improvisations involve more florid, active material, meaning that, when the hits occur, the brief change of texture is obvious. The song form is quite difficult to follow during the solo section, but hearing the ascending fourth signifies “this is the last measure!” and “the next beat is the top of the form.” This knowledge makes position finding far more manageable.

Gestures too may be encoded with metric information. Imagine the situation of an orchestral musician looking to the conductor to start. The conductor takes a breath while raising her hands and, as they come down, the musicians begin. In this situation, there are no sounds, only gestures encoded with meaning.[33] You must know that the hands-up gesture means “the

[33] There are not sounds in the sense of musical instruments playing, but the conductor’s breath could be audible. That sound may be provide symbolic information about metric location

next beat is the beginning of the measure!" in order to enter at the right time along with everyone else. *When* the gesture occurs is important (along with how quick it is), but it does not involve entrainment in a traditional sense. Its information content about periodicity does not stem from being periodic. A single gesture provides the upbeat, not the fact that that gesture occurs every so often. (The "upbeat" gesture may occur regularly thereafter, but at the beginning of a piece there's no previous reference point to be attuned to.) Once the music is underway, a conductor's gestures provide information to musicians *about* metric cycles. Importantly, musicians do not entrain and attend to all of a conductor's signals. They can glance around from instrument, to score, to conductor. Each gesture provides information *about* cyclic processes, whether or not musicians see a complete gestural cycle. The use of symbolic temporal gestures is well known in practical and pedagogical contexts. Most ear training and musicianship courses will require students to do a bit of conducting along with exercises; however, Bruno Repp's survey of "tapping" literature notes that conductors' movements have not yet been investigated in detail by music psychologists (Repp 2005, 986).

Dynamic symbolic encoding of meter serves as a form of off-loading: storing temporal information for access because attention is divided, because durational spans fall beyond what may be passively "attended," or because temporal stimuli are insufficient to make correct judgement without such symbols. In the previous examples—reading a clock, looking to a conductor, listening for a bandleader's count-off—temporal information is stored and provided by someone else (or something else). The storing and off-loading of metric information can also occur in *one's own* gestures, and this possibility may be considered in relation to work in

much as the gesture does, with the difference being one of medium: it is heard, not seen. (Or it is heard *and* seen, if you hear her breath and see her lungs expand, for example.)

embodied cognition. Given the many meanings of "embodied cognition" (see Wilson 2002), I will use it here to mean that physical, observable actions are not simple byproducts of a central processor. They actively aid perception or—in contexts involving temporal knowledge that is not necessarily perceptual—temporal navigation in some broader sense.

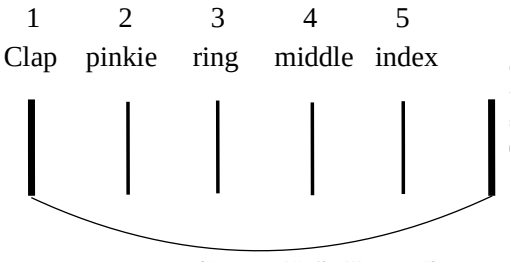
Psychological studies corroborate that embodied actions not only reflect but also *help* in metric perception. As discussed in section 1.2, metric discrimination tasks are easier when participants are given instructions to bend at the knees or engage in large body movements (McCoy and Ellis 1992; Philips-Silver and Trainor, 2005 and 2007). Conversely, participants with motor disorders often perform poorly in metric judgement tasks even if those tasks require no observable movement (Grahn and Brett 2009). For professional musicians, it may be difficult to realize just how beneficial moving to meter is. The studies cited involve distinctions between simple rhythms, or duple and triple meter which—for the professionals—are highly practiced, requiring little cognitive effort. The point may become apparent for people with more musical training when the discrimination tasks become more difficult. When finding the metric structure of Bulgarian folk music with an "odd" meter, for example, one of my first instincts is to tap out possible configurations (such as the 2+2+3+2+2 of a *kopanitsa* or the 2+2+3 of a *ruchenitsa*, etc.) to find out whether the music aligns with one of them. If I cannot easily entrain with a piece of music, I can (literally?) feel around for it! This is admittedly a bit of trial and error, but it helps to have a set of possibilities "in hand" which are mostly to occur. This strategy is in keeping with psychological models of entrainment. However, instead of some internal "first step" which facilitates action, exploratory actions form the first step which may be monitored and adjusted until synchrony is achieved.

Action such as tapping, swaying, and bending one's knees may aid temporal awareness by strengthening the form of entrainment that occurs, recruiting not just one's attention but also a physical action. Such action may also be considered a very simple type of metric encoding. Each action signifies "here begins a new unit." This simple symbol provides the foundation upon which the "tapping" literature is built: tapping signifies the tactus. Exploring these simple metric motions seems a desideratum in music psychology for its quick applicability to "novice" listeners and for the lack of training required. In McCoy and Ellis's experiment (1992) and Philips-Silver and Trainor's experiments (2005, 2007), the goal was simply to show evidence that movement instructions improved performance. They were not concerned with how to improve performance of difficult, more esoteric tasks, continuing the trend of avoiding tasks which require extensive specific training. With the right strategies and practice, more complex motions can track more complex metric structures, though. They become vital components of rhythmic, metric virtuosity.

South Indian (karnatak) classical music includes extraordinarily difficult temporal tasks as a typical feature of performances and relies upon cyclic gestures laden with temporal information. With the exception of rubato introductory material, a traditional composition will be in one *tala* (roughly meaning "meter") throughout, meaning it repeats a single metric framework from beginning to end.[34] Each *tala* is associated with a cycle of hand gestures (*kriya*), which can be performed by anyone whose hands are free to do so, including audience members. *Kriya*

[34] *Tala* typically translates to "meter" or "measure," but with a few caveats. A *tala* does not have an "accent" associated with its beginning. The most important point in a *tala* is the location where the text of a specific composition begins. This location (the *eduppu*) is usually the first beat (*sam*) though it need not be. *Tala* cycles can be quite long (up to twenty-nine "beats"), and they are also deeply entangled with an associated cycle of hand gestures. For more, see Nelson 1999.

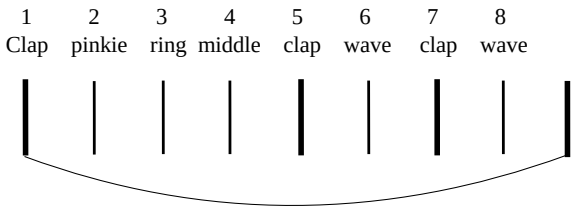
gestures involve touching (or clapping) one hand against the thigh or other hand as well as silent waving in the air for some *tala*. A composition in *khanda eka tala*, for example, has five gestures. The first gesture involves striking the full hand against the thigh or other hand (the "clap") followed by use of only the pinkie, then ring, then middle, and then index finger, as shown in figure 2.2. Each of these gestures, especially the clap, may produce some sound. However, the gestures do not occur with much volume, unless they are articulated with chimes.



Example 2.2, gestures for a five-beat cycle, khanda eka tala, based on Nelson 1999

This cycle of gestures has some features worth noting. Each beat is associated with a unique gesture. A full hand clap (whether audible or not) indicates the first beat of the cycle. Touching the pinkie alone indicates beat two, and so on. *Seeing* a particular finger immediately translates to a unique location in the cycle, without any need to entrain or feel a five-beat grouping.[35] Just

[35] Not all *tala* have one gesture corresponding to only one metric location. *Adi tala*, for example, is an eight beat cycle, beginning with a clap (1), followed by pinkie (2), ring finger (3), middle finger (4), another clap (5), a wave (6), another clap (7), and another wave (8), as diagrammed below (following the style of Nelson 1999).



as an orchestral conductor can communicate the final beat of a measure with raised hands, each finger communicates a temporal location within the cycle. Another key feature of the *tala* gestures is the fact that performing the five-beat cycle does not require *attending* to a five-beat cycle. The pattern itself can function like an automated set of commands, which just happens to repeat every five beats. A sense of tactus (i.e. "beat") is required, along with a sense of order in which the gestures occur. Performers must know to follow the pinkie with the ring finger, the ring finger with the middle finger, and so on. The pattern *yields* a five-beat cycle, whether or not you pay attention to its "five-ness." For practical purposes, this affords a remarkable possibility. After extensive practice, a set of *tala* gestures—having become nearly automatic—allows attention to be directed elsewhere. Just as I might look to a clock after losing track of time, so too can I look to my own *tala* gestures for information about the current location in that cycle. (I can also look to someone else's gestures, much like the orchestral musician looking to a conductor for information.) This seems necessary in passages of South Indian music which involve dramatic metric tension. For passages in which some other hierarchic framework is superimposed over the *tala,* it may help to direct attention toward that superimposed framework knowing that the *tala* remains visually or proprioceptively accessible. If I *see* a gesture of the index finger, it *signifies* the fifth beat of the cycle. A South Indian *sankirna koraippu* in *khanda eka tala* performed on Trichy Sanakaran's *Laya Vinyas* CD (1990) and transcribed in Sankaran (2010, 72-75) illustrates this point.

As in *khanda eka tala,* a ring finger gesture always occurs on beat 3, but there are two "waves," one on beat 6 and another on beat 8 (and also three claps.) Navigating this cycle requires a bit of context added to those gestures. Simply being a "wave" is not sufficient to identify a certain beat. However, knowing whether it is the first wave or the second wave of the cycle is sufficient to identify beat 6 or beat 8, respectively. Gestures still do signify metric locations, but only with an added contextual awareness.

A South Indian *koraippu* (meaning "to reduce") typically involves trading rhythmic materials between musicians in several rhythmic stages. In the first stage, a large rhythmic idea with many component parts is presented and repeated by other musicians. In subsequent stages, that idea becomes broken into successively smaller units leading to a fast-paced climax. But I will only consider the first stage here. This *koraippu* divides each beat of the *tala* cycle into four pulses. The first stage of a *sankirna koraippu* involves a phrase comprised of eight short rhythmic units of nine pulses each.[36] Figure 2.3 provides the ideas as *solkattu*, or spoken rhythms, but they could also be played on an instrument, such as a *mrdangam* or *kanjira*.[37] In this notation (in keeping with the style of Nelson 2008), a numeric subscript gives the number of pulses a syllable will last. Syllables without any numeric designation receive one pulse each. Syllables abbreviated to their first letter receive half a pulse. E.g., "k t T k t r k t" abbreviates the syllables "ki ta Ta ka ta ri ki ta" and indicates they occur twice as quickly.

[36] I will only be concerned with the first stage of the composition here, but complete realization is available in Sankaran 2010, 72-76. A complete *misra koraippu* in *adi tala* is available in David Nelson 2008, 70-75, as well as Sankaran 2010, 66-71

[37] Trichy Sankaran's recording *Laya Vinyas* does precisely this: rhythmic ideas are first performed as solkattu, then performed (traded) on a barrel-shaped *mrdangam*, and finally on a tambourine-like *kanjira*.

ta$_2$ din$_2$ ta din gi na tom
ta$_2$ din$_2$ ta din gi na tom
ta$_2$ din$_2$ ta din gi na tom
ta$_2$ din$_2$ k t T k t r k t tom

ta$_2$ din$_2$ ta din gi na tom
(ta$_2$ din$_2$ k t T k t r k t tom)
(ta$_2$ din$_2$ k t T k t r k t tom)
(ta$_2$ din$_2$ k t T k t r k t tom) [tam]

Example 2.3, *solkattu* syllables for the first stage of a *sankirna koraippu*[38]

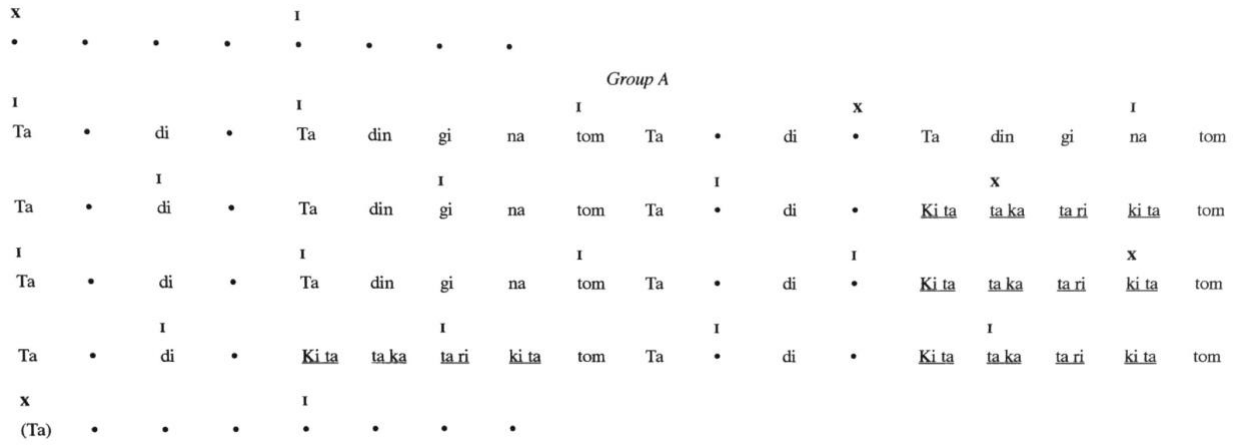
These nine-pulse ideas form two groups of four, and the full structure is eight nine-pulse units. For aesthetic reasons, each stage should end on the downbeat (*sam*), which is articulated with its own syllable or drumstroke (here as "tam"). Hence, because this stage totals 8 x 9 = 72 pulses, while the *tala* cycle lasts five beats of four pulses each, or 20 pulses, this stage will require four presentations of the tala cycle, lasting 80 pulses, and will need to begin after eight pulses, or two beats of the *tala*. A convincing performance of the nine-pulse ideas should not skew to reflect the underlying *tala*. If anything, it might give a little emphasis or dynamic accent to the start of each nine-pulse unit. Conversely, a weak performance would add accent to syllables which align with the beats of the *tala* (i.e *ta$_2$* din$_2$ *ta* din gi na *tom* ta$_2$ din$_2$ ta din gi *na* tom ta$_2$ *din$_2$* ta din gi na tom etc.).

Performing this stage requires an awareness of the underlying *khanda eka tala*, because the phrase must start on beat three of the *tala*. At the same time, a convincing performance also

[38] Following Nelson (2008), usage of parenthesis and brackets indicates of a *mora*, a type of South Indian rhythmic "cadence."

requires some freedom from that meter, which colleagues in my South Indian performance workshop described as "floating" between two hierarchies. Drawing on my own experience, finding (and beginning on) beat three only requires knowing the gestural location of that beat. It occurs with the ring finger gesture, just after the pinkie. This may require a bit of visual or proprioceptive awareness, but not very much. Meanwhile, more attention may be given to the superimposed structure. I can, in other words "feel" the superimposed hierarchy without losing track of the five-beat cycle. The idea that periodic hierarchy of a superimposed structure might receive more attention and structural focus than the underlying meter is reflected in both David Nelson's and Trichy Sankaran's notational styles, which are reproduced in Figures 2.2 and Figure 2.3, respectively. Nelson does not notate the underlying *tala* at all. In Sankaran's book, text justification is based upon syllabic groupings, two nine-pulse units fit on a single line, and the underlying *tala* appears as annotations ("X" for the full hand gesture, which begins each group of gestures together called a *laghu*, and "I" for each finger motion) which correspond to certain syllables (or between them).[39] This is precisely the opposite of Western notation, in which rhythmic durations are organized and broken up ("tied") in relation to measures of an underlying meter.

[39] His notation also makes room (literally) for each pulse. Syllables lasting less than one pulse are underlined.



Example 2.4, *sankirna Koraippu* in *Khanda Eka Tala* as notated in Sankaran (2010, 72)

The idea of performing a hierarchy of eight nine-pulse units while also tracking a five-beat *tala* complicates—but does not necessarily contradict—existing metric theory, such as Lerdahl and Jackendoff's metric well-formedness rules (1983), London's polymetric proscriptions in the first edition of *Hearing in Time* (2004), and Vuust and Witek's (2014, 7-8) notion of bistable rhythmic percepts, among others. These theories (among many others) rest on an assumption that only one framework may be perceived at a time. The example of a South Indian musician performing-and-*attending* one metric hierarchy, while maintaining an awareness of another by performing-and-*seeing* her own automated gestures, involves an *awareness* of two periodic frameworks, but "awareness" need not mean perception. In fact, it may be worth having a conceptual framework which acknowledges that following the two hierarchies involves two different strategies for doing each. We could say one is "felt" while the other is "counted" with aid of an embodied *tala* clock. Following London, I could argue that the superimposed framework is perceived through entrainment of one's attention, but the other hierarchy (the *tala*) is not "perceived" in such a way. Instead, the *tala* is performed and accessible when you pay

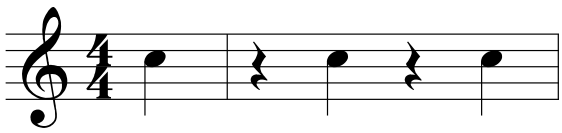
attention to the gestures performed which symbolize temporal locations. In many regards, this rings true to my experience of tracking two hierarchies, each with a separate strategy and qualitatively different experience. On the other hand, it may muddy the notion of "attentional" entrainment.

Attention is, in some way, directed to both hierarchies. Following Riess Jones, we can say that things competing for attention make the task of following any of them more difficult, but the label "attention" seems less adherent in London's sense. We would have to argue that "attention" in this sense synchronizes with the nine-pulse units, while attention of a more everyday sort occasionally checks in on the tala, like a driver glancing in her rearview mirror. Conceptually pinning down attention with much detail is an elusive task here. After all, if the norm is to view periodic tapping as observable evidence of attentional entrainment, does that not describe the *tala* gestures? I can't determine what attention brings to this discussion here beyond complication.

2.3 Static Theoretical Knowledge

Whereas dynamic symbolic of encoding involves time-dependent musical "clocks," static theoretical resources are perhaps more like schedules and calendars. The resources are static, meaning they do not themselves "happen." Instead, they provide information *about* things which happen in time, and the information given by scores provides an excellent example. Quite usefully, scores can be studied apart from the sounds they represent, at any pace. You can jump around and compare non-adjacent sections or pause over others which represent very fast passages. Physical, visual score objects are not necessary for the transmission of this sort of information. Memories of a score and simple prose can communicate the same. For this reason, "static, theoretical knowledge" includes both scores and score-like information as useful resources of abstract calculation. These are precisely the items with which Joel Lester struggled in "Notated vs. Heard Meter" (1986), which London (2009) considered to generate "misperceptions," and which Clarke and Krumhansl (1990) excluded from their study on perceiving musical time. I acknowledge up front that the use of these resources might not ultimately be allowed admission into the normative conceptual category of "music perception," but they constitute useful musical knowledge that can qualitatively affect musical experience and potentially aid perceptual ability regardless. Within Western musical culture, these resources are treated with suspicion—perhaps even considered "cheating"—while their place in South Indian music is more accepted. In the analyses that follow, it may be worth introspecting a bit regarding the effects of information being given. Some temporal structures are difficult to follow without an abstract description about their structure.

Score-based and score-like theoretical resources typically provide a relationship between sounding durations and a "metric" framework. This information includes temporal ordering of events, metric locations of specific events, and total duration for some set of events. Importantly, this includes information about events which have not yet occurred. Reading ahead of time that the first measure of a piece is three beats long depends on some degree of competence from musicians and on the accuracy of the score, but not on synchronization and attunement with occurrent sounds. Additionally, theoretical information may offer an organization of sounds which is in some sense preferable despite being more difficult than some other option. Consider for example, hearing three strikes of a snare drum equally spaced apart in time. This is precisely how the song "Ants Marching" by the Dave Matthews Band from the album *Under the Table and Dreaming* begins. *In the absence of additional information*, theories of entrainment (London) and projection (Hasty) would assume each of these events creates the impression of strong metric locations. Each drum stroke forms a beat. Experimental evidence suggests that listeners will also gravitate toward a duple hierarchy. However, the experience of those snare drum hits would likely be significantly different if I told you that they were on beats "4" then "2" then "4," or if, more precisely, I offered the transcription, given below in example 2.5.



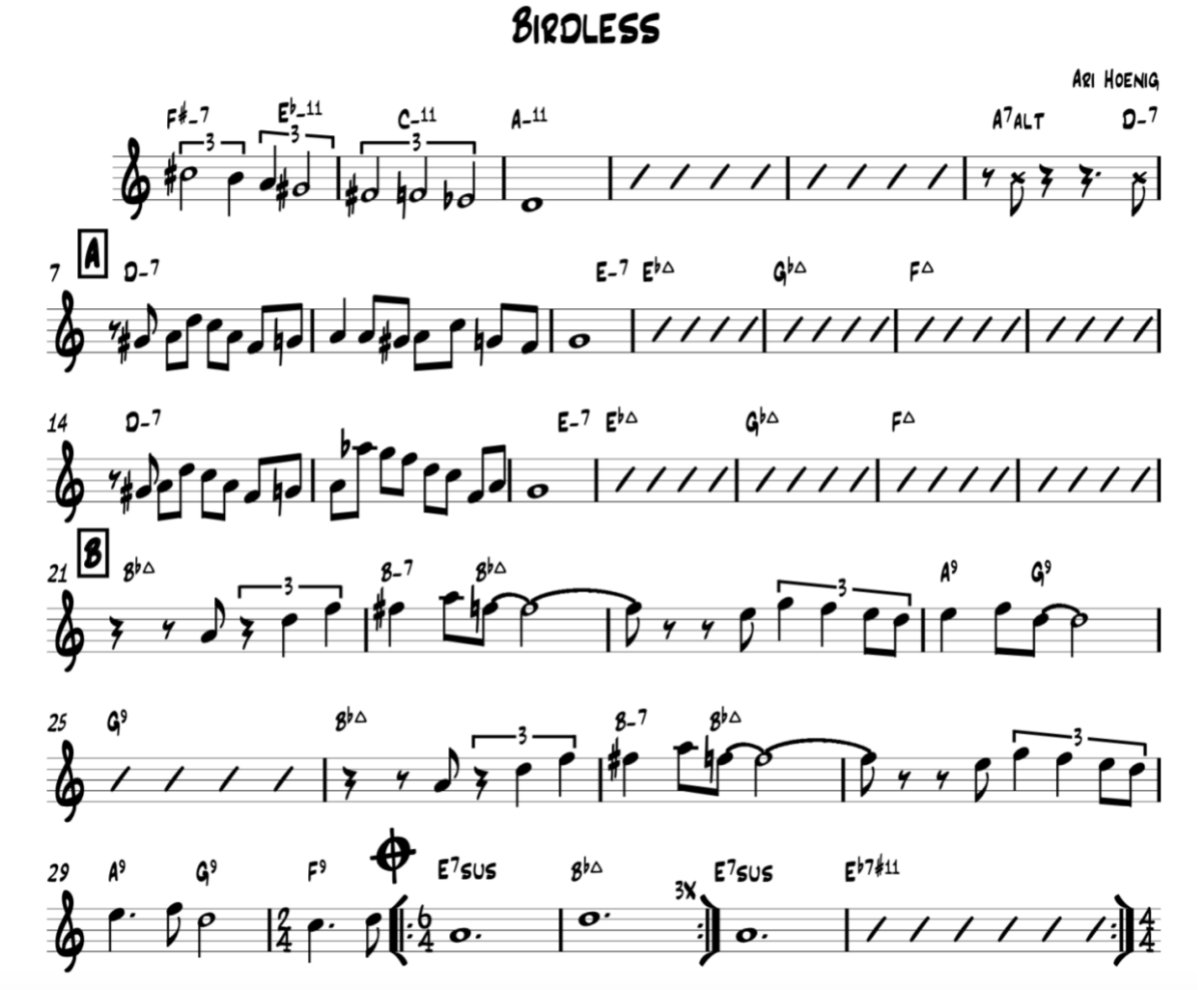
Example 2.5, transcription of the snare drum introduction to the Dave Matthews Band's "Ants Marching" from the album *Under the Table and Dreaming*

This sort of knowledge may also rely on remembering a previous hearing of the piece, without actually having a score in hand. Listeners who know the song well enough—or who have a

strong enough concept of snare drum strokes as providing a backbeat—without an ability to theoretically articulate a concept of, say, beats "2" and "4," still utilize this general type of resource, though the discussion becomes a bit more complicated. In the absence of this sort of information, a listener's experience would likely be different, and involve some retrospective shift once additional information is present to the contrary.

The effect of having a score in hand or being provided a set of relations is more aesthetically significant for music that is more difficult to follow. Drummer Ari Hoenig's composition "Birdless," for example, has a large-scale song structure which is difficult to grasp. As in canonical jazz, it is important to navigate the songform, because improvisations occur "over" and in dialogue with its chord changes. It may be worth first listening to the piece for its structure now before looking at the lead sheet provided. Both the version on the album *The Painter* and the one on *Ari Hoenig Punk Bop: Live at Smalls* will illustrate the challenge, but I will be analyzing the latter version.

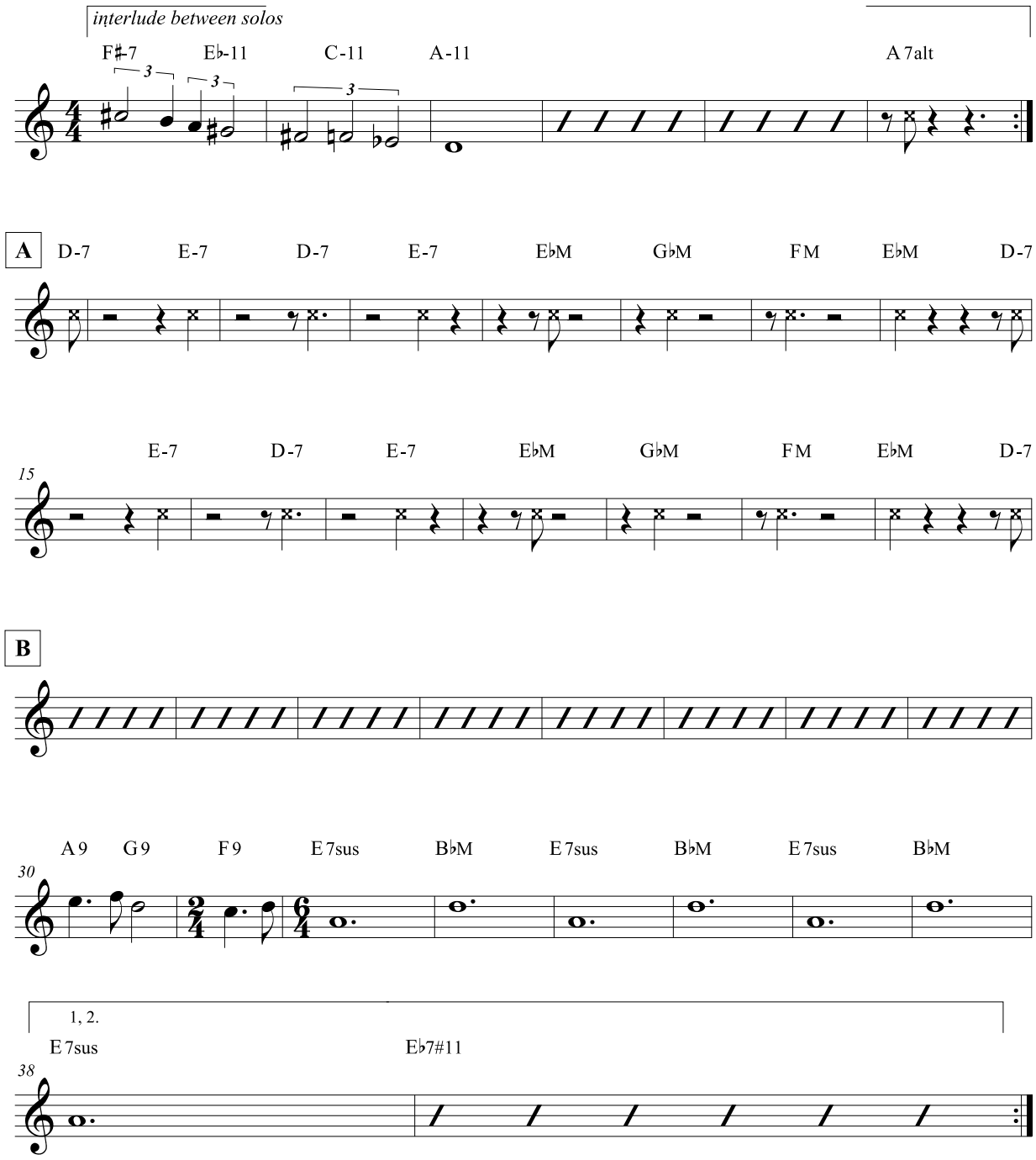
Part of what makes the structure less intuitive are its odd hypermetrical groupings. As shown in example 2.6, there is a six-measure interlude between solos (in lieu of the final two measures of the form) and an A-section comprised of two *seven*-measure phrases. The B-section has two sub-phrases in 4/4 which shifts into 6/4 "vamp" ending.



Example 2.6, "Birdless" lead sheet from *The Ari Hoenig Song Book*

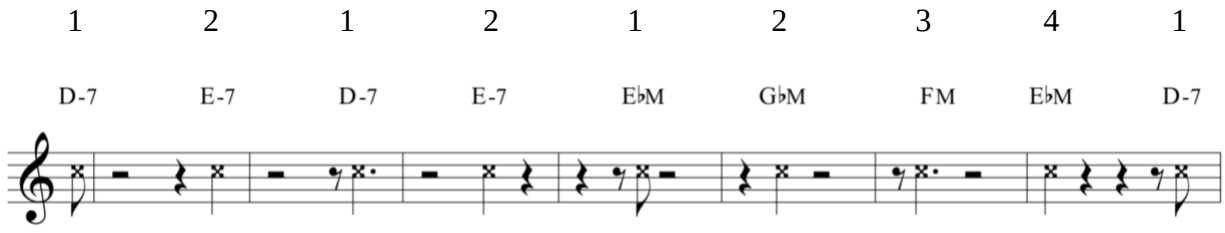
With the score, the challenge of following the form is more manageable, though it is still a challenge. Having the structure either in view or in memory allows preparation for shifts of meter and odd hypermetric groupings before they occur. Retrospectively putting together seven-measure phrases, for example, might be possible (though tough) during the "head," but it becomes extremely difficult during improvisations, as the group refrains from making the form obvious. Quite the opposite, they often revel in obscuring it.

A sublime example of the metric superposition occurs during the drum solo section (beginning at 7'41" on the album *Live at Smalls*). Again, it may be worth giving it a listen before reading and following along with my notation of the band's "hits" given below in example 2.7.



Example 2.7, "Birdless" songform for drum solo

In the A-section of the drum solo, there are eight hits *seven* eighth notes apart, in total spanning seven measures comprised of eight eighth-notes each. The harmonies of these hits—D-7, E-7, D-7, E-7, EbM, GbM, FM, EbM—overlay a relatively square 2+2+4 grouping structure on the odd phrase length, as shown in example 2.8.

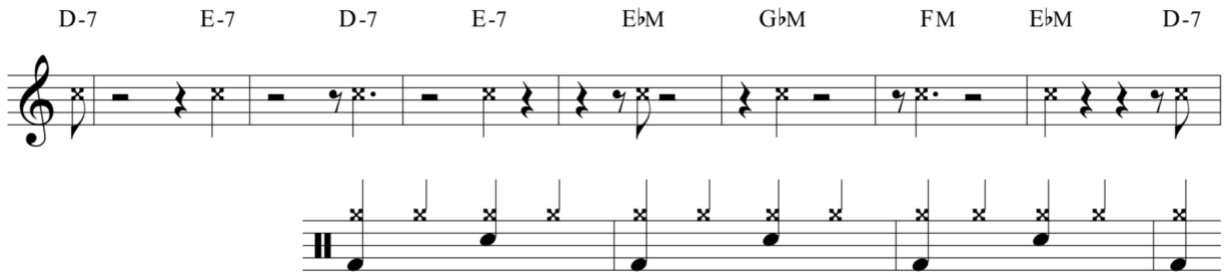


Example 2.8, duple structure of band hits during the drum solo of "Birdless"

Knowing the aesthetic tendencies of Hoenig and his groups, it is likely the seven-measure phrase length was designed specifically for the possibility of superimposing a large-scale polyrhythm which, seeming more "natural" would lead away from the underlying 4/4. Maintaining this underlying meter is made easier through an awareness of structural relationships between the two rates. This might entail, for example, knowing that the penultimate hit lies on a downbeat, or that the final hit lies on the last eighth note of the 4/4 meter. In fact, you can navigate this passage by simply "counting" hits as they occur. After once (or twice) through the progression of eight (or sixteen) hits, a d-minor seventh chord will always land on the final eighth note of the measure. This idea—that a d-minor seventh chord might indicate the final eighth note of a measure—requires theoretical knowledge of the section's structure to facilitate symbolic encoding of the staccato chord. Listeners (as opposed to performers) may also visually and gesturally encode the passage! Each time a hit occurs, physically point to it in the score. You will be pointing at the

metric location in which it occurs, whether or not you "feel" 4/4 meter in the way the notation normatively implies.

In the third and final chorus of the drum solo, Hoenig adds to the challenge of juggling the two rhythmic streams by employing the normative "rock" backbeat aligned with the superimposed band hits. The superimposed seven-pulse units are subdivided in half by the hi hat, and grouped in twos through alternation of bass and snare, as shown in example 2.9.



Example 2.9, "Birdless" band hits and rock groove played to align with superimposed "hits"

Here the notated meter is extremely difficult to maintain, likely because the groove's superimposed beat becomes so magnetic. But the structural features remain in effect just the same. The final d-minor seventh chord still falls upon the final eighth note of an underlying 4/4 measure. The penultimate "hit" is on a downbeat, and so forth. It does not last long, probably because of the extraordinary tension between the two frameworks, which Stefan Love (2013) terms "subliminal dissonance" (or alternatively "consonance," in scare quotes) to highlight that the non-alignment involves some unsounded ("subliminal") temporal structure. (No one plays on the downbeats of 4/4.) The difficulty keeping track of both, and tendency to "lose" listeners, is part of the point. To be "lost," yet know that the group was able to harness the temporal streams, is to acknowledge the virtuosity of the performers. This type of experience is somewhat

paradoxical. It involves knowing about something which is beyond our grasp.[40] Being able to keep track of the form becomes a euphoric triumph. And theoretical knowledge of the specific structure involved serves as one potential resource to keep track of the form.

In South Indian music, this sort of knowledge helps check in on passages which "float" over the *tala*, such as the *sankirna koraippu* in *khanda eka tala* discussed in the section 2.2. In that example, it helps to know that the composition starts on the third beat of the *tala* (the "ring finger" gesture), as well as that the composition's second group of four nine-pulse units begins on the *second* beat (the "pinkie" gesture), and that its final syllable falls on the downbeat (the "clap" gesture). Working out how certain rhythmic constructions will lay against the *tala*, or "calculation," has a more respected place in South Indian music than in the Western musical mainstream. Clever rhythmic manipulations are an expected part of classical South Indian performances, especially in a *tani avartanam* (percussion solo). By contrast, Western groups which consciously deal in such metric manipulation are more esoteric, receiving a mixture of cult-like devotion on the one hand, and, on the other, derision for an excess of "mathiness." In either case, conscious articulable calculations about temporal relationships seem to provide a shortcut to the end that could be reached through practice, namely knowledge about how temporal streams align. Performers may know when to begin a rhythmic idea or how to perform two periodic streams without being able to verbally articulate what they are doing. To an observer, there would not be much difference between this condition and the condition attained through calculation, and "intuitive" knowledge derived from practice could not be distinguished

[40] This may be a larger part of theory than we often discuss. Analyses can point out things in music we may not have noticed before. And pointing them out does not necessarily make them immediately perceptible. With work and practice, they could be, but I often find myself in the position of appreciating musical features by grasping that they exist, even if I do not hear them.

from “theoretical” knowledge. A key difference exists from the perspective of the performer. Abstract, articulated knowledge about periodicity may derive its usefulness primarily from its efficiency in bypassing potentially time-consuming practice. I leave open the possibility that scores—or the information they represent—do more than provide a shortcut through a more difficult process of learning. There may be cases where repeat listening cannot arrive at the “solution” put forth in a score. Lester’s (1986) struggle with Babbitt’s *Composition for four Instruments* is one of these instances

It is not immediately clear how fit these resources into the music theoretical conceptual landscape. To be given credible and actionable information about a temporal structure helps to understand it and changes musical experience. However, should this *knowing* be considered *perceptual*? Generally, I think knowing should constitute a wider conceptual category than perceiving. In this case, I would like to consider that being handed abstract information does not constitute perception in itself, but that it either substitutes for it or affects one’s perceptual ability by steering focus toward certain features.

CHAPTER 3: ANALYSES

In this part, I offer musical examples in which expanded resources aid temporal navigation, whether for performers or listeners. The most basic goal is to acknowledge what these resources are and that they are useful. To do that, I first consider how examples demonstrate an awareness of more than one temporal framework at the same time. Then, because of the challenge involved, I consider what might be involved in that "awareness." Although I will also argue that symbolic resources are meaningful in more temporally straightforward contexts, those simpler situations do not present such a strong motivation for finding additional temporal strategies. The second goal of this section is to explore the how additional resources may enrich our aesthetic experience of the music, and how some music might manipulate the strategies that involve them. In instances of metric multi-tasking there is an aesthetic payoff to engaging with varied types of knowledge and awareness. As explained in Ari Hoenig and Johannes Weidenmuller's practice book,

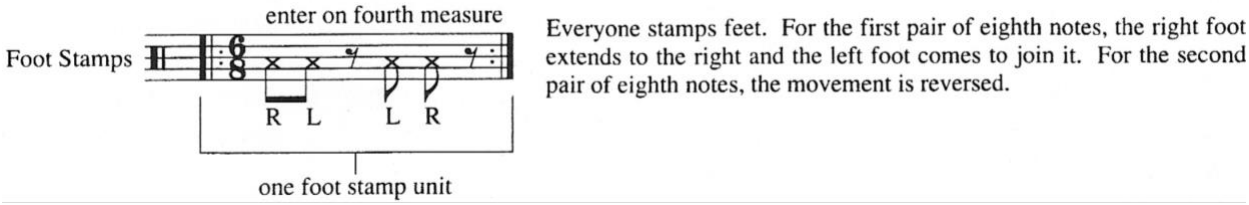
> One of the purposes of superimposing one groove or time feel over another is to create tension. Rhythmic superimposition creates two sets of pulses competing for your attention and therefore two sets of competing musical expectations. A form - any cyclical set of bars, with or without harmonic movement - provides an opportunity to raise the intensity of your expectations for resolution. Without a form over which to apply the new groove, you won't achieve the same amount of tension nor the effect of any subsequent release. Second of all, in order for musicians to communicate with one another, we must have some kind of a framework or road map as a basis of communication. A form can be that framework. (Hoenig and Weidenmuller 2009, 2)

This sense of tension and release to which Hoenig and Weidenmuller refer would be lost without following the form, either by choosing the experiential path of least resistance or not knowing that such a form is in operation. To find examples involving this sort of tension requires that there be a relatively stable framework against which other constructions are in dialogue. The

clave of Afro-Caribbean music and *tala* of South Indian music framework provide excellent examples; however most of the analyses here come from jazz. This is in part because the framework for jazz improvisations (the song form) is longer and includes harmonic and melodic components. Whereas a *clave* or *tala* involve a handful of beats, jazz forms often involves a local meter as well as a larger hypermetrical construction, and an associated tune and set of harmonic changes. As such, jazz examples more easily bring a greater variety of temporal resources into discussion. At the level of an entire song form, temporal structure is also too long to be available for echoic and short-term memory (Brower 1993) or conventional attentional entrainment. My intent is not to imply that jazz is more temporally challenging than other genres, or that the resources discussed are primarily for jazz.

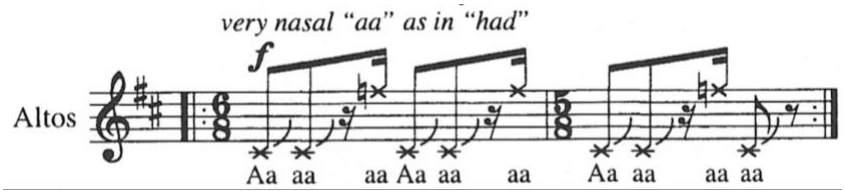
3.1 Metric Multi-tasking: Stamping, Clapping, and Singing "Panda Chant II"

Composer and choreographer Meredith Monk has pioneered works which involve music and movement, and her compositions are not only for hearing. They often involve physical (embodied) and visual components. "Panda Chant II" is such a work, a choral composition, that requires more than voices. All performers must rhythmically stomp and clap in unison while singing various other patterns. The pattern of stamps is an ostinato notated in 6/8 (beamed in 3/4) and performed by all singers throughout the piece, shown in example 3.1.



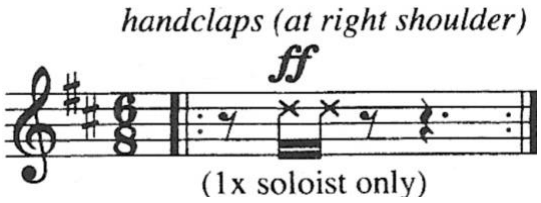
Example 3.1, stamping ostinato performed by all singers in "Panda Chant II"

After the tenors start looping their vocal pattern, the altos must enter with pattern given in example 3.2. Performing this is tricky. It alternates between measures of 6/8 and 5/8, which loop concurrently with the stamped 6/8 pattern.



Example 3.2, vocal pattern performed by altos in addition to stamped pattern

This metric juggling is unique to the altos. Tenors, basses, and sopranos layer parts into the mix with varying degrees of syncopation, but their parts loop patterns of six or twelve eighth-notes. They do not present large-scale periodic asynchrony in relation to the stamping pattern. For this reason, my analysis focuses upon the perspective of the altos. But there's more they must do in addition to stamping and vocalizing! After all individual parts have entered, an additional pattern must be performed: a quick pair of handclaps on the second eighth note of each 6/8 measure. As shown in example 3.3, a soloist first introduces the claps and the full ensemble then follows suit, all while continuing their individual vocal parts and stamping in unison.



Example 3.3, clapping pattern performed by all

The altos must somehow navigate two temporal frameworks, one in 6/8—which involves stamping, clapping, and conductor gestures—and one in 11/8, which is vocal. I describe these frameworks according to their notated time signatures (11/8 being a composite of 6/8 and 5/8), but do not invoke "meter" in its mainstream psychological usage.

In order to figure out what sorts of resources could be required to do this, I would like to offer a way of approaching this task from my own experience trying to do it. My starting point involves what it is like to be an active participant—to *do* "Panda Chant II"—not what it is like to simply listen and watch others doing it. This distinction is important not only for the felt, embodied component of the experience, but also to give proper attention to the performers'

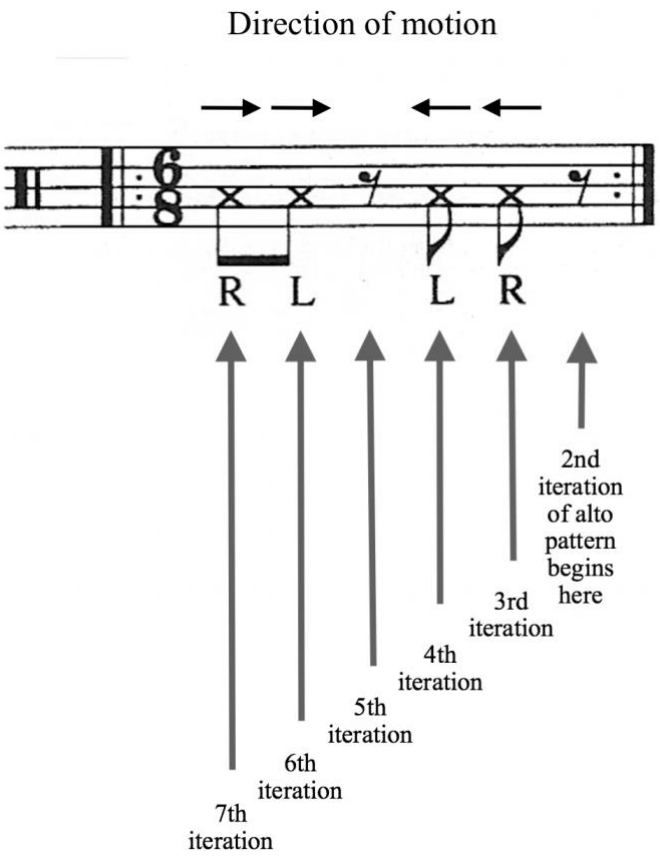
heightened responsibility in following the material. (Getting "lost" as performer has obvious consequences not present for listeners.) The piece serves as an excellent example of the value found through specific practice and preparation, symbolic temporal encoding, and abstract theoretical knowledge.

To perform "Panda Chant II," I repeated the foot stamp pattern many times. With enough practice, that pattern requires less and less concentration, but I was surprised at how little practice it took me to get the pattern going nearly automatically. This may have something to do with the fact that the foot stamps are not too dissimilar from walking, which is already a highly practiced activity. Part of what makes the pattern so "walkable" is that the pattern involves a change of location, first moving to the right, then to the left. That might make it easier than stamping in place. When moving to a new location the left foot simply follows the right, and vice versa. I am also well prepared *generally* to take on these sorts of coordination tasks, through my personal practice on drum set and pipe organ. However, specific practice was critical to get the stamps going automatically—i.e. to a point where they need little conscious control—so that focus may be directed elsewhere. In this case, the nasal "aa" pattern in 11/8 requires more effort. It is isn't particularly difficult by itself, but it is longer and asymmetrical. I would say that I *attend* to the vocal pattern more than the stamps, but it is not clear how to situate this instance in terms of London's concept of attentional entrainment. I will return to this issue later.

The stamping choreography can serve as embodied symbolic off-loading of the 6/8 cycles. Much as in South Indian *tala* gestures, each beat is associated with a unique motion (or lack thereof). To execute the stamping pattern does not require the feeling of a larger cycle. It requires only an eighth-note pulse which is associated with an ordered set of six actions. There are four unique movements: the right foot moving right, the left foot moving right, the left foot

moving left, and the right foot moving left. Each of these movements corresponds to a unique location in the notated meter: the first, second, fourth, and fifth eighth notes of the 6/8 cycle, respectively. As the "ring finger" motion signifies the third beat of a *tala* cycle, the left foot stamping left signifies the fourth beat of this cycle. The two rests also have unique embodied associations. The rest on the third eighth note occurs when the body is positioned to the right (from the perspective of the performer), and the rest on the final eighth note occurs when the body is positioned to the left.

This type of information can also be used to check that the patterns are being performed accurately, provided you have abstract theoretical knowledge which relates the cycles of 6/8 and 11/8 to each other. In this case, it helps to know how the vocal pattern of "aa's" *phases* with the stamped cycles of 6/8. Each cycle of 11/8 will begin one beat earlier than the last. Because each beat corresponds to a gesture, one may confirm that the correct phasing takes place by noting which stamping gesture occurs with the beginning of each vocal cycle. The second iteration of the vocal pattern should occur with the "no stamp" when the body is positioned leftward, since that occurs on beat 6 (one beat earlier in the cycle). The third iteration corresponds with the "right foot to the left" stamp (beat 5), and so on, as summarized in example 3.4. That's a rather abstract bit of information, but I find it helps. It is also worth keeping in mind that the 6/8 pattern functions as a ground for the vocal pattern which occurs over it, but only with intermittent conscious checks. The "ground" does not receive much attention.



Example 3.4, relation between stamping choreography with the beginning of the alto pattern

Adding the pair of claps on the second eighth note (given previously in example 3.3) presents an additional hurdle for the performer. It is neither consistent nor "walk-like" as the stamps are, and thus less prone to automation. Continuing to assume attention is mostly directed toward the "odd" vocal pattern, I propose to again use the stamping pattern as a set of symbols for metric locations in 6/8. The hand claps need not be felt in relation to a downbeat or periodic cycle. Instead, they may simply be assigned to the time when your left foot moves to the right, knowing that this motion corresponds with the correct location in the notated 6/8. Or, if you prefer, you could say that the clapping should occur on the beat *after* the one where the right foot moves to the right.

This approach takes physical practice and relies on symbolic and theoretical knowledge of the piece's temporal structures. But what can we say about attention, and how might this situation fit into Justin London's theory of attentional entrainment? In this example, I considered the stamping pattern to be practiced to the point of requiring little "attention." Instead, it encoded temporal information which could be accessed as needed. On the other hand, the comparatively difficult vocal pattern, required more conscious effort. My "attention"—in the colloquial sense of "paying attention"—was mostly directed at the vocal pattern, albeit with intermittent checks on the choreographed movements. The theory of attentional entrainment would likely argue that my experience involves entraining my attention with the 11/8 pattern, but *not* the 6/8 pattern. Importantly, my awareness of the 6/8 via gestural signifiers did not require attentional *entrainment* with those motions, even if attention in the colloquial sense was directed toward it. This point becomes particularly odd when considering that the 6/8 cycle to which my "attention" is *not* entrained is nonetheless something which I myself physically *do*. Not only that, those stamping motions serve as a conscious "ground" to which the vocal pattern is related.

I do not think this should motivate a full-scale reworking of the theory of attentional entrainment, but it does highlight that "attention" may have a particular meaning within that theory. And a lack of attentional entrainment does not preclude temporal awareness of periodic events. We might want to consider conventional "attending" as a form of *conscious* attention. In this instance, the "ground" of the foot stamps relies upon embodied cognition "in the feet." The fact that the foot patterns of the group occur in synchrony with temporally structured events of a 6/8 cycle constitutes what Jones and Large might call a form of "direct knowing." (Jones and Large 1999, 53). They introduce that notion to consider how physical entrainment generally reflects attentional entrainment. Here, however, the foot motions either do not reflect that

conventional “attention.” They constitute embodied knowledge (and possibly some other form of unconscious attention), which is monitored by yet another type of “attention.” And that attention which intermittently checks in upon the foot stamps relies upon symbolic meaning of each motion.

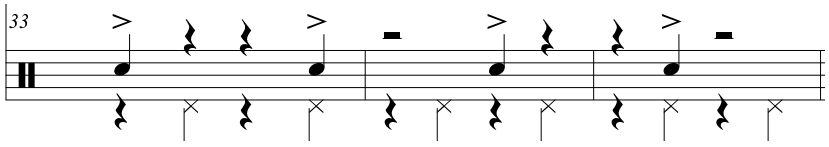
3.2 Changing Rhythms in Rhythm Changes: Mehldau and Rossy's "Anthropology"

Sometimes improvisation on a jazz standard emerges in dialogue with both distinct aspects of the composition and with other interpretations of it. A group of musicians may develop ideas in dialogue with previous recordings by other groups, or with previous interpretations by that group. Gigging jazz groups may continue to develop ideas in club sets from week to week, such that there is a long-term process built on cumulative, communal practice. The aura of spontaneity surrounding improvisation may obscure the fact that some rhythmic techniques are highly practiced, not just by individuals on their own, but also by groups regularly performing together. In this analysis, I invoke a performer's perspective with no claim that the performers themselves approached the passage in the way I describe. The individuals on the recording might have done so or they might not. The point is that one *could* do so. However, the goal of this analysis is not to find out how to perform the passage, but to find out how to follow the periodic streams, whether as a performer or not. More specifically, this analysis explores navigation of two periodic hierarchies in a group context, in which individuals display awareness of both streams.

Brad Mehldau's trio recording of "Anthropology" from the 1994 album *When I Fall in Love* follows some basic norms of mainstream jazz improvisation. The piece begins with a statement of the melody, along with its associated harmonic structure, and these together form a repeating framework around which improvisations occur. (A full transcription is available in the appendix.) Much like the foot stamps in Meredith Monk's "Panda Chant II" and the *tala* gestures of South Indian music, jazz form (or "changes") constitutes a repeating cycle for the duration of the piece to which other ideas relate. However, a jazz form is not comprised of gestures, nor even

any particular sounds. The melody in its entirety does not repeat, and chordal changes need not actually be sounded at all times. In fact, jazz musicians must often track form with remarkably *little* reinforcement. Rather, the form refers to a framework of ideas to draw upon at given points in time. This may involve pitch sets associated with particular harmonies (i.e. "the changes"), a melodic idea derived from the main melody, or typical "timekeeping" rhythms, such as a "walking" bassline. There is not such a clear and precise correspondence between event and form, making the situation more complex, but with added opportunity. There are multiple ways of revealing the formal structure, and realizing this variety can be a playful part of the formal brinkmanship with which some musicians toy.

In the case of "Anthropology," the underlying form is a 32-bar AABA "rhythm changes" form at a blistering tempo. At the beginning of the improvisation section, drummer Jorge Rossy obscures that form by playing the snare drum every *three* beats, against the underlying 4/4 meter. This superimposed three-beat cycle is not a fleeting feint. It continues along with the form for close to two minutes! For the entire duration of this "superimposed" passage, Rossy physically and sonically articulates *both* periodic streams. With his foot, he articulates the 4/4 meter, using a typical hi-hat pattern on beats 2 and 4. With his hands, he superimposes groupings of *three* on the snare drum, as shown in Example 3.5.



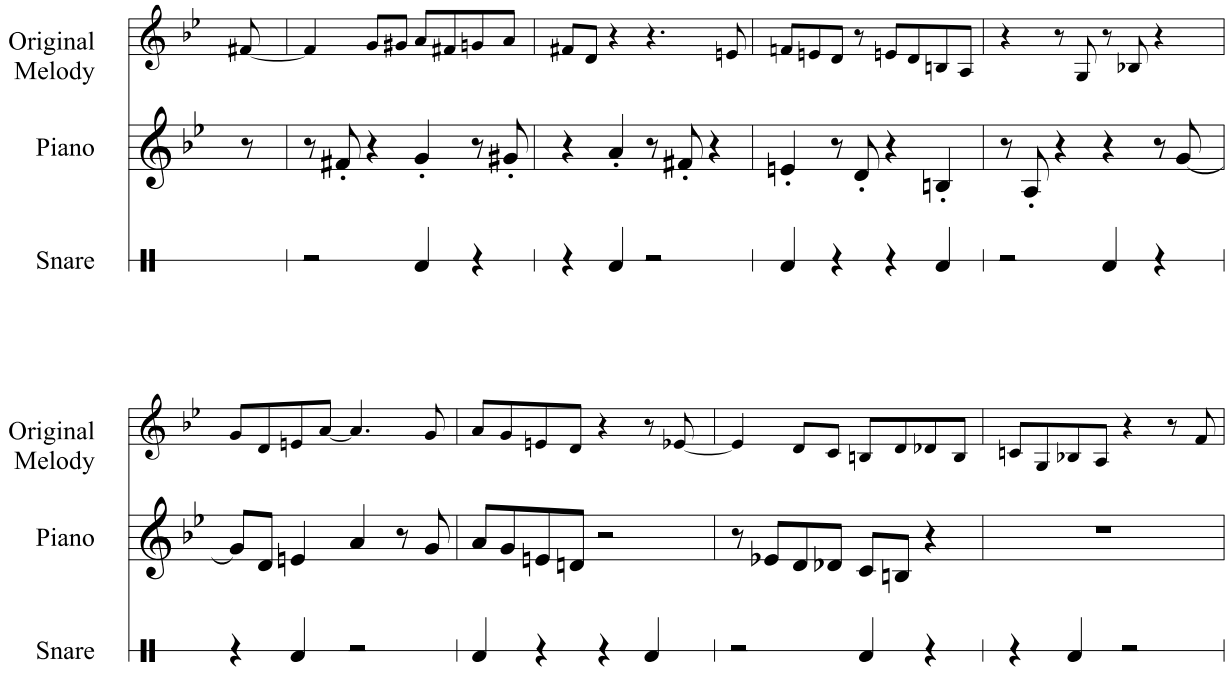
Example 3.5, drum pattern mixing both 4/4 (hi-hat) and superimposed 3s (snare drum)

In some respects, this coordination is similar to multi-tasking required in Meredith Monk's

"Panda Chant II" discussed previously. Much like the foot stamps there, the hi-hat pattern is highly practiced for a jazz drummer, and requires little effort or conscious maintenance to perform. The superimposed three-beat cycle is also somewhat like the 11-beat nasal "aa" pattern from "Panda Chant" in that it creates phasing. The first drum stroke occurs on beat 1, the next on 4, then 3, then 2. One obvious difference here is how incredibly quickly all of this occurs: three measures take about a second and a half. Another important difference between this phasing and that found in "Panda Chant II" is the relative simplicity of the snare drum pattern, which simply marks every third beat with a drum stroke. This affords the possibility that snare drum strokes be taken as symbols of "downbeats" to the superimposed pattern. In that case, bassist Mario Rossy and pianist Brad Mehldau need not continuously track the "threes." Instead, they may find the superimposed stream by simply hearing a snare drum stroke, as an absent-minded orchestral musician might look to her conductor for a metrically significant gesture.

There are several instances in which bassist Mario Rossy and Mehldau demonstrate awareness of the superimposed "threes" as well as the underlying 32-measure harmonic song form. This "awareness" is clearest when the rhythms of what they play align with the superimposed threes while the pitch content continues to reflect harmonic changes in 4/4. Perhaps the most distinct harmonic moment of the form is found at the arrival of the bridge. Whereas the A-sections sit nearly diatonically in Bb, the bridge begins with a D7 harmony. That harmony ultimately leads back to the home key via a chain of applied dominants (D7 – G7 – C7 – F7), but the moment of its arrival presents a shift in pitch material. The associated pitch set includes E, F#, and B rather than Eb, F, and Bb or the global key. And because this pitch material relates to the form, its occurrence reflects large-scale temporal structure. In this way, the

temporal structure may be signified by *pitch* content.[41] Mehldau's improvisation when the bridge arrives in the first chorus of his solo is extraordinary in this regard, for its use of material derived from the original melody and simultaneous alignment with the alternate pulse stream. Example 3.6 transcribes his solo, alongside the snare drum hits every three beats, and the original interpretation of the bridge melody for reference.

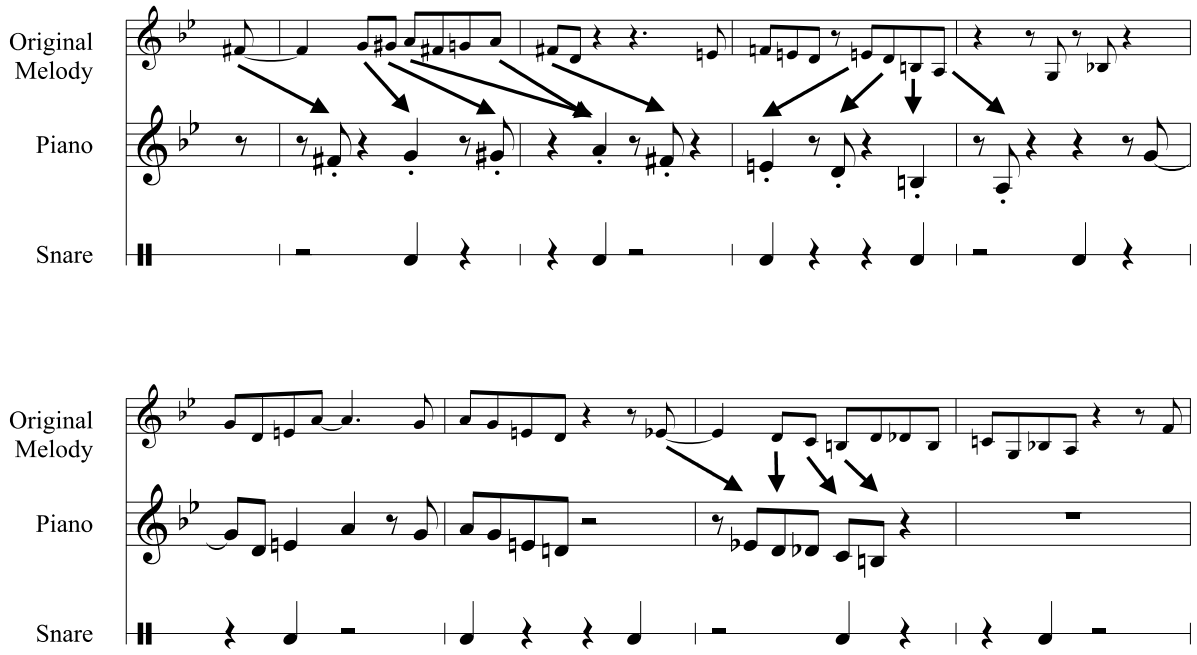


Example 3.6, Brad Mehldau's improvisation over the bridge of the first solo chorus with snare drum hits, and original melody for reference

Prior to the bridge, Mehldau plays syncopated rhythms without a clear relation to the snare drum pattern. However, he shifts to a staccato dotted-quarter rhythm to align with the snare drum hits

[41] Intriguingly, finding the bridge as a listener does not rely upon grouping smaller units (measures) together into larger units. You can know the bridge occurs without knowing where the downbeat is, for example. Of course, awareness of form would ideally involve both low-level beats and measures as well as the larger formal divisions.

precisely at the arrival of the bridge (or at least, as close to it as possible). That rhythmic shift itself aligns with the bridge, and includes a shift in pitch material, beginning with F# to highlight the D dominant harmony. Remarkably, Mehldau's phrasing also indicates the location of the underlying bridge by using lines derived from the bridge's melody. The improvisation offers a rhythmically augmented and altered version to fit the superimposed threes, but one which also stays true to the phrase lengths of the bridge melody. Some notes are expanded and others cut such that it does not stray from the eight-measure phrase length of the underlying form.[42]

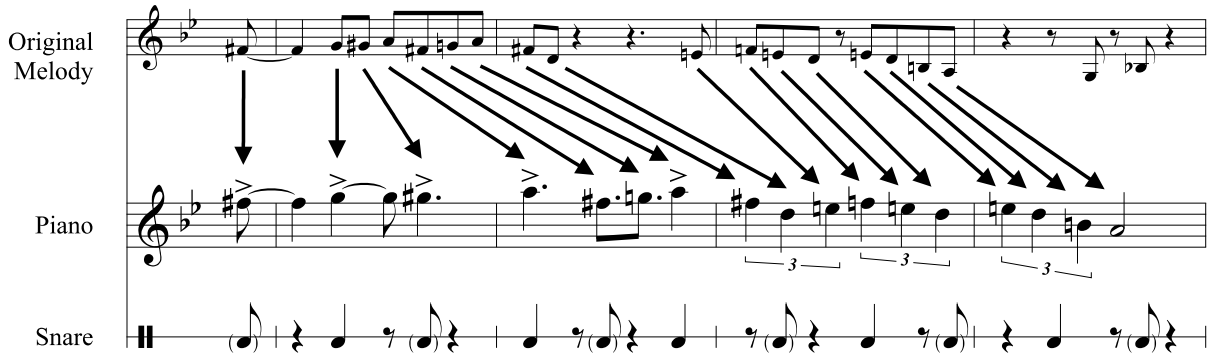


Example 3.7, Mehldau's first chorus improvisation, annotated to show relation with original melody

While it is clear that Mehldau manages to synchronize melodic shapes with the underlying form

[42] The second measure of the bridge solo also employs the rhythm—albeit hypermetrically displaced—for the original melody of "I Got Rhythm," the song from which "Anthropology" gets its harmonic changes.

and rhythmic figures with the superimposed triple feel, it is difficult to say exactly *how*. A possible strategy involves theoretical knowledge. One could theoretically know that the "threes" at the bridge of the first chorus will always align with the third beat of the first measure there. This need not be a conscious articulable sort of knowledge. It could instead emerge from extensive practice in a group context. However, this explanation is not very satisfying, given the way Mehldau rephrases the melody to fit with the alternate pulse rate in the bridge two choruses later.



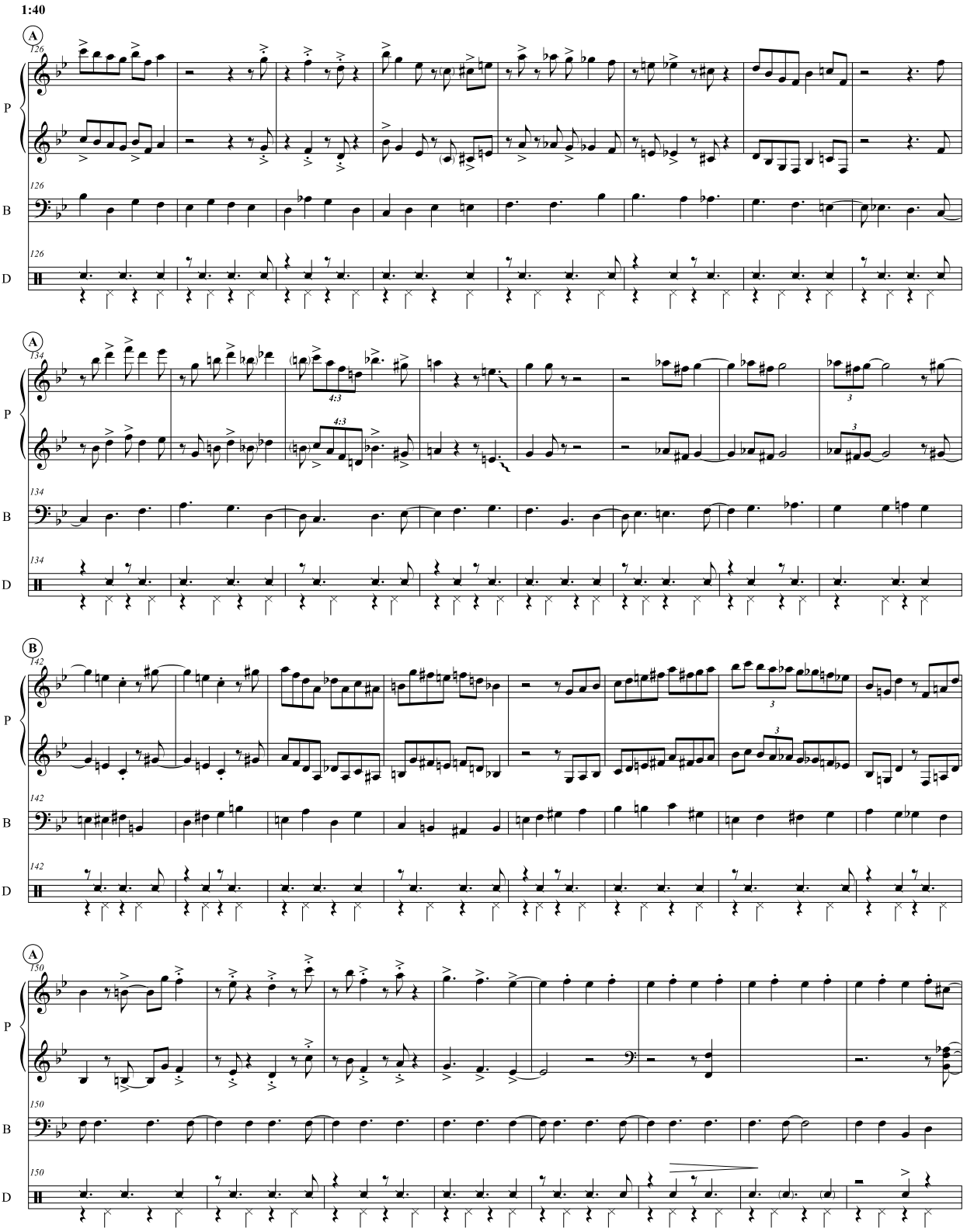
Example 3.8, Mehldau's improvisation and snare drum hits, and original bridge melody for reference

As shown in Example 3.8, Mehldau's improvisation in the third bridge of his solo again aligns with the snare drum hits (now in "double time," with an accent on every second strike of the drum), but the relation of those hits to the underlying meter is different. In this third chorus, the snare pattern and Mehldau's improvisation both align with the rhythm of the original bridge melody (an eighth-note pickup). This affords an opportunity to quote the original phrase in its entirety, with the first two pitches' metric locations preserved. Interestingly, Mehldau's phrase here also reproduces the bridge's pitch content without cutting any notes.

It is theoretically possible to find the rhythm of the superimposed pulse stream by

abstractly knowing that on the third chorus it will begin as it did in the original melody (i.e. with an eighth note upbeat). Again though, this explanation seems unsatisfying, because its applicability is so narrow, as though synchronizing requires knowledge only about very particular points in the form. Another possibility draws upon the fact that each of these examples is preceded by a full measure rest in the piano before the bridge begins. Perhaps that "breath" between phrases is strategic and allows Mehldau a moment to find the snare drum pattern, like the distracted musician looking for a conductor's gesture to help. In that case, finding the other pulse rate does not involve a process of entrainment and projection with the snare drum. If a musician already knows the rate at which the drum strokes occur, they need hear only one drum stroke to know when the next will occur. (Later, I will explore additional strategies, drawing upon Ari Hoenig's pedagogical method book.)

In the fourth chorus of the piano solo, the bass synchronizes with the snare drum's three-beat groupings (again in "double time" dotted quarters). Removing the consistent foundation of a "walking bass" destabilizes the underlying 4/4 dramatically, more than just the soloist's departure did. The entire chorus is transcribed in Example 3.9.



Example 3.9, fourth chorus solo section of "Anthropology"

In the first and last A sections, the bass gives up "walking" to align with the snare drum strokes, but the shift is not as seamless as in the previous example of Mehldau's piano playing. In measures 130-131 and 150-151, Mario Rossy first shifts to dotted rhythms which do *not* align with the snare drum hits. After one (m. 151) or two (mm. 130-131) adjustments, the bass and snare do line up and they then continue together until the bridge. These quick adjustments are revealing, as they indicate that the bassist may not have been precisely aware of the superimposed drum strokes before attempting the transition. If he were, we would expect him to have latched on right away. This supports the attending model's constraints on attentional entrainment. The bass player does, however, shift immediately to the correct *rate*, albeit not synchronized with the snare drum. Presumably, he already knew the *relationship* between the two periodicities that were occurring, even if he was not attending to the other one.

The fleeting moment is admittedly very difficult to catch. I found it only with the aid of audio software to slow down the passage. Nonetheless, it shows that a process of entrainment with a superimposed cycle is possible. It is a "process" because there is evidently some trial and error involved. This may reflect the difference between the roles of piano and bass. Mehldau plays phrases separated by breaks (or "breaths") on the piano, whereas Rossy provides a continuous texture. He does not stop playing for a measure before making the shift to synchronize with the snare drum pattern, as Mehldau had the luxury to do. On the other hand, both of Rossy's transitions back to "walking" basslines demonstrate a knowledge of the underlying form. Each of these transitions takes place on the downbeat of the final measure of the section (at the end of the bridge, in m. 155, and at the end of the form, in m. 163). That shift—without any trial and error adjustments—implies awareness of downbeats in 4/4 as well as

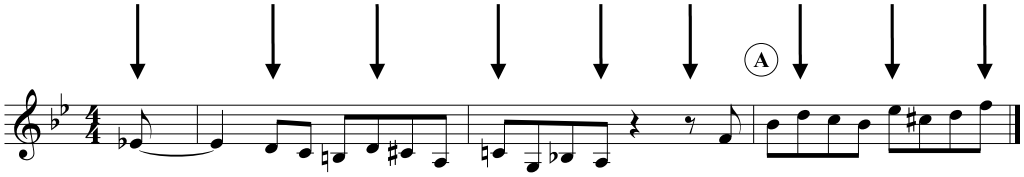
formal delineations around eight-measure phrases.

The entire solo builds to a climactic peak of tension at the end of the fourth chorus. In this final A section (mm. 150-157), the bass synchronizes with the snare drum's dotted-quarter "double time," to create tension with the "fast 4" of the song form. At the same time, the bass also builds tension harmonically with a dominant pedal for the entire duration of the final A section. This pedal point builds tension, because it occurs in relation to—and in this case in stubborn defiance of—the "changes," whether or not those harmonies are acoustically sounded. These two tensions (of pulse stream against underlying, global meter, and of an F pedal against harmonic expectations) form what what Stefan Love (2013) termed "subliminal dissonance," because the metric dissonance occurs against something you might not be actually hearing.[43] Add to this, the fact that the pedal is upon the *dominant*, and it all sets up a desire for resolution to tonic harmony. Multiple tensions find euphoric resolution at the start of the following chorus.

In this example, the musicians could off-load temporal information to each other. Piano and bass offer pitch cues about when the bridge occurs in the larger harmonic form, while they needn't always track the three-beat units, knowing that the snare drum will be articulating them. They could also use some abstract information about the mathematical relation between the two periodicities. It helps to know when the two rates align, or the fact that four groups of three will have the same duration as three groups of four. I also imagine this virtuosic group had experimented with this sort of temporal clash a lot before performing it here. Practice. Failure. Additional attempts. Perhaps they began with much shorter attempts that gradually grew more extended into what was recorded.

[43] The underlying form is technically sounded in the hi-hat, though that pattern is relatively quiet.

The recording fits into a larger set of rhythmically adventurous interpretations of standards. Certain standards lend themselves to this sort of treatment more than others. Performing such a superimposition in "Anthropology" brings out and develops syncopations in the "head" melody, which might not otherwise be such an obvious feature of it. At the end of the bridge, for example, the melody's rhythm and peaks in contour offer a faint outline of a dotted quarter rhythm.



Example 3.10, dotted-quarter syncopations in Brad Mehldau's interpretation of "Anthropology"

Other tunes also have this sort of syncopation built into their melody, and have received similar sorts of treatment in improvisations. The tunes "Oleo" and "Billie's Bounce" for example, have an even more striking dotted-quarter syncopation built into their melodies, and likewise have inspired this sort of metric modulation in their interpretation. Curiously, "Oleo" is also another "rhythm changes" tune lending itself to *rhythmic changes*. (Bill Evans's recording from the album *Everybody Digs Bill Evans* offers an excellent example in this regard.) Developing ideas upon dotted quarter-note rhythms may also reflect the rhythm of the original "I Got Rhythm."

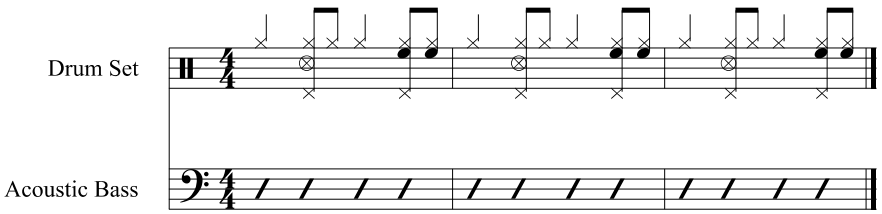
What is remarkable about the Mehldau and Rossy trio's version of "Anthropology" is the duration through which the alternate metric stream is sustained, and the virtuosic synchronization of piano, bass, and drums all around this alternate timeline. Snare and hi-hat provide cues about the locations of two different periodic cycles. Performing those patterns may constitute embodied awareness much like the foot stamps of Meredith Monk's "Panda Chant II." They also provide aural signifiers about the structure of those two cycles. This helps to off-load

information for other group members. Even if they are not constantly aware of the superimposed three-beat cycle—and the quick trial and error of the bass player's synchronization with the snare drum suggest he is not—the snare drum hits both construct and signify that cycle. Additionally, pitch content of the bass and piano reflects and signifies the form of the global harmonic changes based upon the fast 4/4, particularly at the bridge. In order to multi-task as the musicians do, it helps to have extensive practice with these resources and strategies, both individually and in a group context.

3.3 Not-so-standard Time: Inconsistent Frameworks

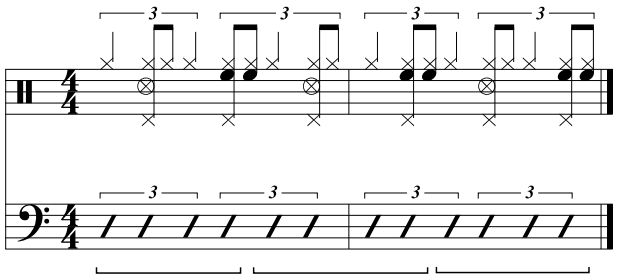
Wynton Marsalis' *Standard Time Vol. 1* is a tour de force exploration of standards from the great American songbook, full of imaginative arrangements and improvisations. The album title refers firstly to the collection as a time for playing standards (it is the first in long series). However, there is also a bit of irony in the title, as the "time" of the arrangements is anything but standard. The group manipulates normative ("standard") timekeeping figures with virtuosity and refreshing variety. Generally, the rhythmic section's manipulations are based upon defaults of a "walking" bass and "swing" drum pattern. The walking bass is a standard timekeeping strategy in which each note the bass plays corresponds with a beat of the meter. Normative drum patterns have more variety, but often include hi-hat on beats "2" and "4" as well as a ride cymbal pattern. An important feature in establishing (or reinforcing) the underlying meter, is not just that these patterns occur on the beat, but also that they occur *together*.

Throughout the album drummer Jeff "Tain" Watts and bassist Robert Hurst often perform these patterns in synchrony together, not in synchrony with the beat of the song form upon which they improvise. For example, in "April in Paris," they shift patterns to match the quarter-note triplet of the main melody. In this case, the drum pattern on which the interpretation is based is four beats long. It includes a "swing" ride cymbal pattern along with hi-hat backbeat, and alternation of snare drum and tom, as shown in example 3.11.



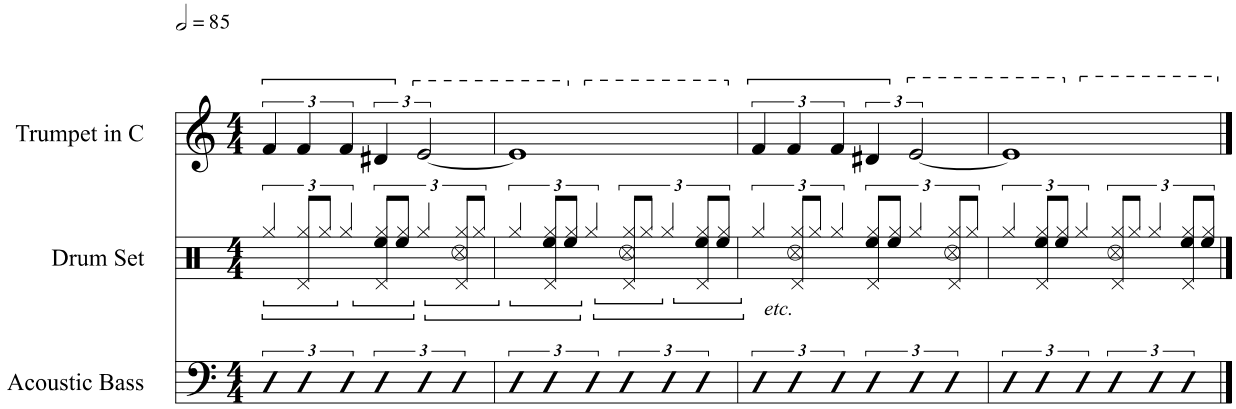
Example 3.11, a common "swing" drum and bass pattern

Bass and drums together modulate this pattern so that three beats of example 3.11 fit into two quarter-notes of the notated 4/4 meter, as shown in Example 3.12.



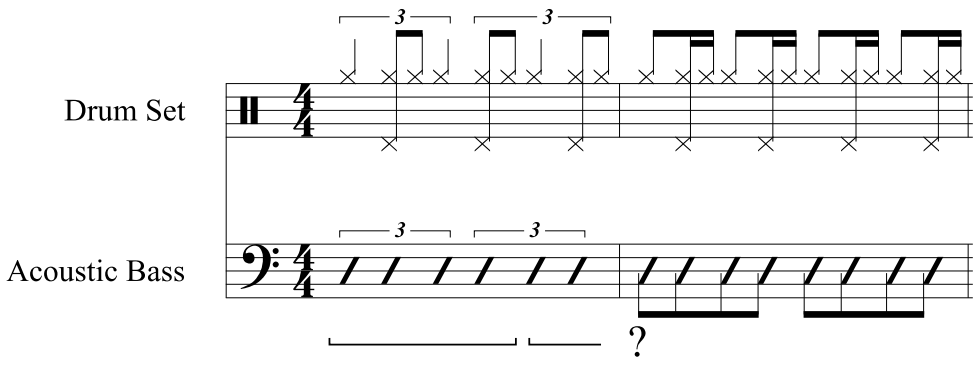
Example 3.12, superimposed 6:4 version of "swing" drum and bass patterns as performed by Watts and Hurst in "April in Paris" from *Standard Time, Vol. 1*

The idea to do something like this was no doubt inspired by the prominent quarter-note triplet of the main melody. The normative interpretation of the composition will have a sounded non-alignment between the melody and the rhythm section. This arrangement shifts the rhythm section to align with that moment in the melody, creating "subliminal dissonance" by eliminating a sounding one.



Example 3.13, rhythm section 6:4 superimposition as designed to align with the "head" melody's triplet

Given the rhythm of the melody and the patterns of bass and drums, one could easily slip into a sense of phrase involving three groupings of four, as annotated with brackets in example 18. Until subsequent changes in feel, I am always surprised at how natural the alternate rate feels. The resolution of the lower chromatic neighbor figure (D#-E) lands on the beginning of a new grouping, and there is no large-scale conflict with the (notated) meter of the changes. The temporal relationship is simpler than in previous examples, because the 6:4 alteration aligns with every other measure of the song form's 4/4 (and the hypermeter of the song form is duple). However, this interpretation cannot comfortably continue for the duration of their arrangement. The bridge and solo sections move to the 4/4 feel as reflected in my notated time signature, and the out-chorus alternates between the superimposed 6:4 and 8:4 "double-time," as shown in example 3.14.



Example 3.14, rhythm section feel for the A-sections in out-chorus (following solos)

This change of feel is aligned with the underlying notated measure, but not with the groupings marked by brackets in Example 3.14. To feel only the superimposed pulse stream without *any* awareness of the form's temporal structure would be easy, but the experience would feel insecure. There would not be a single unifying metric framework for the piece. Changes of feel would occur midway through phrase groups, and tempos would shift. Moreover, changes to and from 6:4 would not have the same sense of tension to be released with the arrival of the bridge.

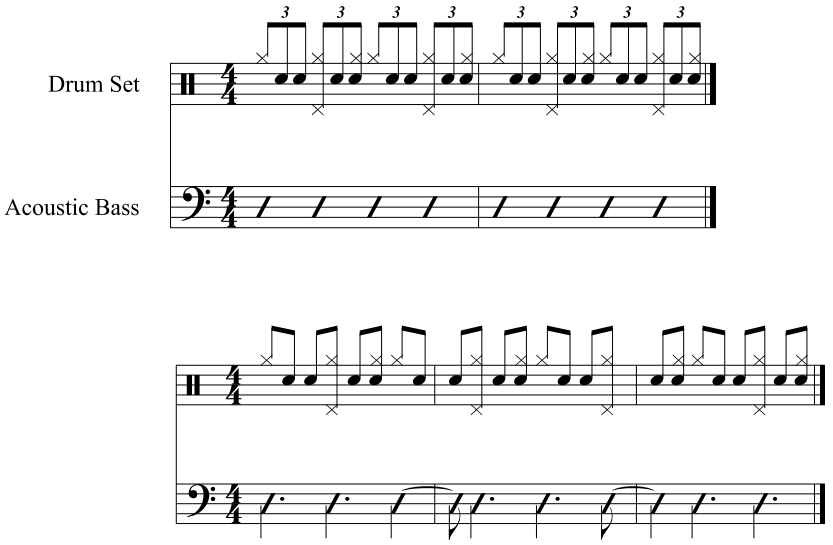
These temporal feints can engender other (better, I think) sorts of experience. One might grasp that there is another framework in operation, but not precisely be able to follow it. To understand the numeric relationships in previous examples but not follow them on the recording would be an experience of this type. The goal, however, which stems from an awareness of both frameworks, would be to follow the structure of the changes with precision without ignoring other periodicities as "noise." Toward that end, it helps to know what's going to happen next, and get to know this specific recording. Information I've gone over thus far ought to help, might further information, such as the fact that Marsalis later displaces the melody one quarter-note triplet later, as transcribed in the appendix.

Other examples on *Standard Time Vol. 1* manipulate the default patterns with less

consistency. Their arrangement of "Autumn Leaves" for example, begins by increasing the ratio of superimposed beats in each measure from 1:8, to 2:8, to 3:8, to 4:8, to 5:8, to 6:8 to 7:8 until it comes into alignment with the beats of the song form (i.e. 8:8). The final eight measures similarly decrease the ratio of superimposed beats, from 6:8 to 4:8 to 3:8 to 2:8. Here the critical point is that the underlying form is revealed primarily through *changes* of rate. Every change in rate corresponds with a new pair of 4/4 measures. The result may sound like an accelerando and ritardando over a songform whose tempo does not change. There is a tension between the melody with its harmonic rhythm (which sounds consistent) and the bass and drum note rates (which seem to speed up and slow down). Here, it helps to employ some theoretical knowledge, particularly around the "odd" groupings of 5-over-8 and 7-over-8. This might entail knowing the relationship between measures and these superimposed rates, or simply counting along with the knowledge that after five (or seven) events, two measures of the form have passed.

The arrangement of "The Song is You" (composed by Jerome Kern and Oscar Hammerstein) involves more sorts of temporal inconsistency and presents an extraordinary temporal challenge which summarizes many of the resources in previous sections. Before explaining what occurs, I want to point out just how difficult it is to figure out what occurs without analytical guidance. In fact, I'm not sure if I would have been able to follow what occurred only by listening. I recall first reading about some of the recording's features in John Riley's *Beyond Bop Drumming* (1997) when I was a teenager. As in "April in Paris," the band enters with a version of default "swing" patterns stretched out of alignment with the changes. However, in "The Song is You" the alterations deny various normative expectations. I recommend listening to the first chorus of the piece again each time new information, or new strategies for approaching it, are introduced.

The manipulated feel takes a typical jazz pattern and stretches the eighth-note triplets into duple eighth notes, as shown in example 3.15.

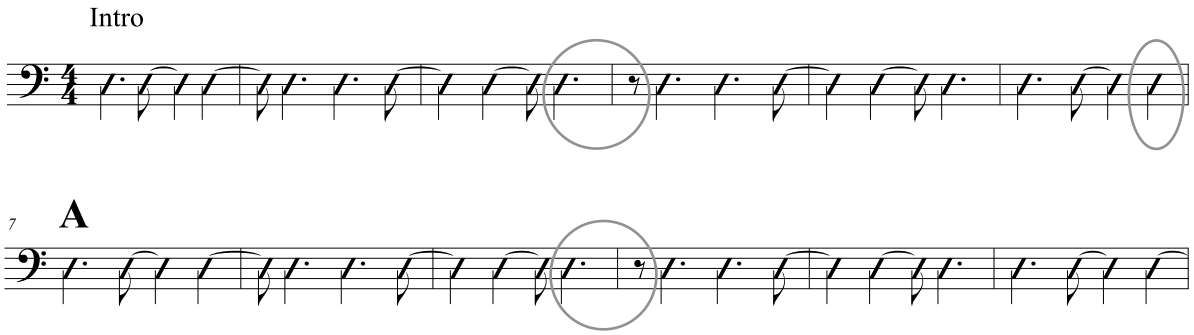


Example 3.15, a typical "swing" drum pattern aligned with a walking bass line and version stretched to articulate dotted quarter-note pulses

The idea is mathematically similar to the texture found in the Mehldau and Rossy Trio's "Anthropology," but Marsalis' group texture fully commits to this superimposed rate of the dotted quarter, with the drums (including hi-hat), bass, and piano all articulating a dotted quarter pattern. Here, the metric dissonance is entirely subliminal, in contrast to the dissonance sounded in various ways in "Anthropology." (Mehldau's group had another sort of commitment to the alternate feel though, in that his trio sticks with the three-beat units far longer than Marsalis' group does.)

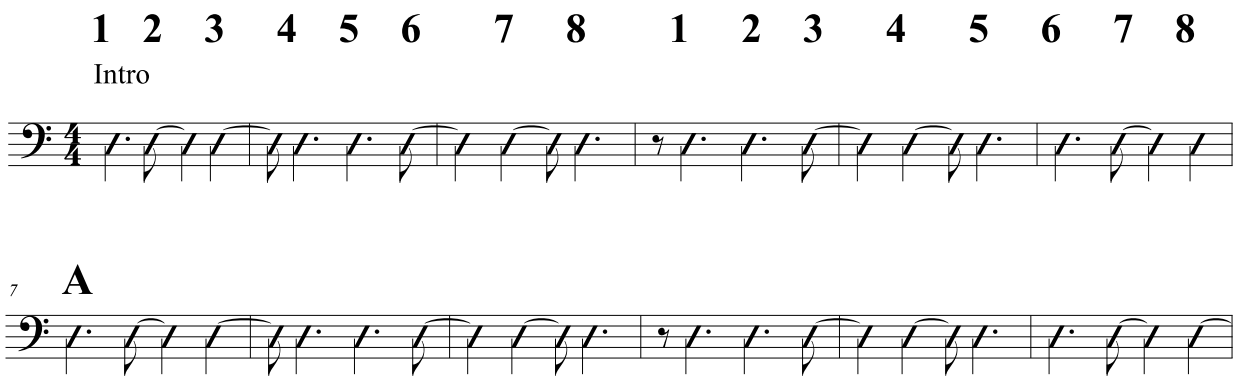
The piece begins with an intro vamp expressing the tempo that we will later come to understand as a superimposed one, with almost no evidence of the global meter of the song form. There is no song tune to offer outline phrase length. Still, there may be signs that the group is

doing something unusual. The fact that everyone is so synchronized might be a subtle red flag. Keyboard chords on every beat is quite odd indeed. Rhythmic tension might also be manifest through subtle timing nuances as well. Eventually the disruption of the pattern by "hiccups" (by which I refer to moments in which the duration of hits is not consistent with previous material) is a clue that the "hits" are not the beats (of the song) As shown in example 3.16, the stream of dotted quarter notes is not continuous.



Example 3.16, superimposed hits in the intro vamp and beginning of melody for Wynton Marsalis' arrangement of "The Song is You," with circles indicating deviations from a pure "dotted quarter" superimposed rate

Perhaps these perturbations work to provide a sense of tension, to destabilize a superimposed pattern that might otherwise be too easy to latch onto. The intro vamp is only *six* measures of the song form, but it is comprised of two groups of *eight* hits.



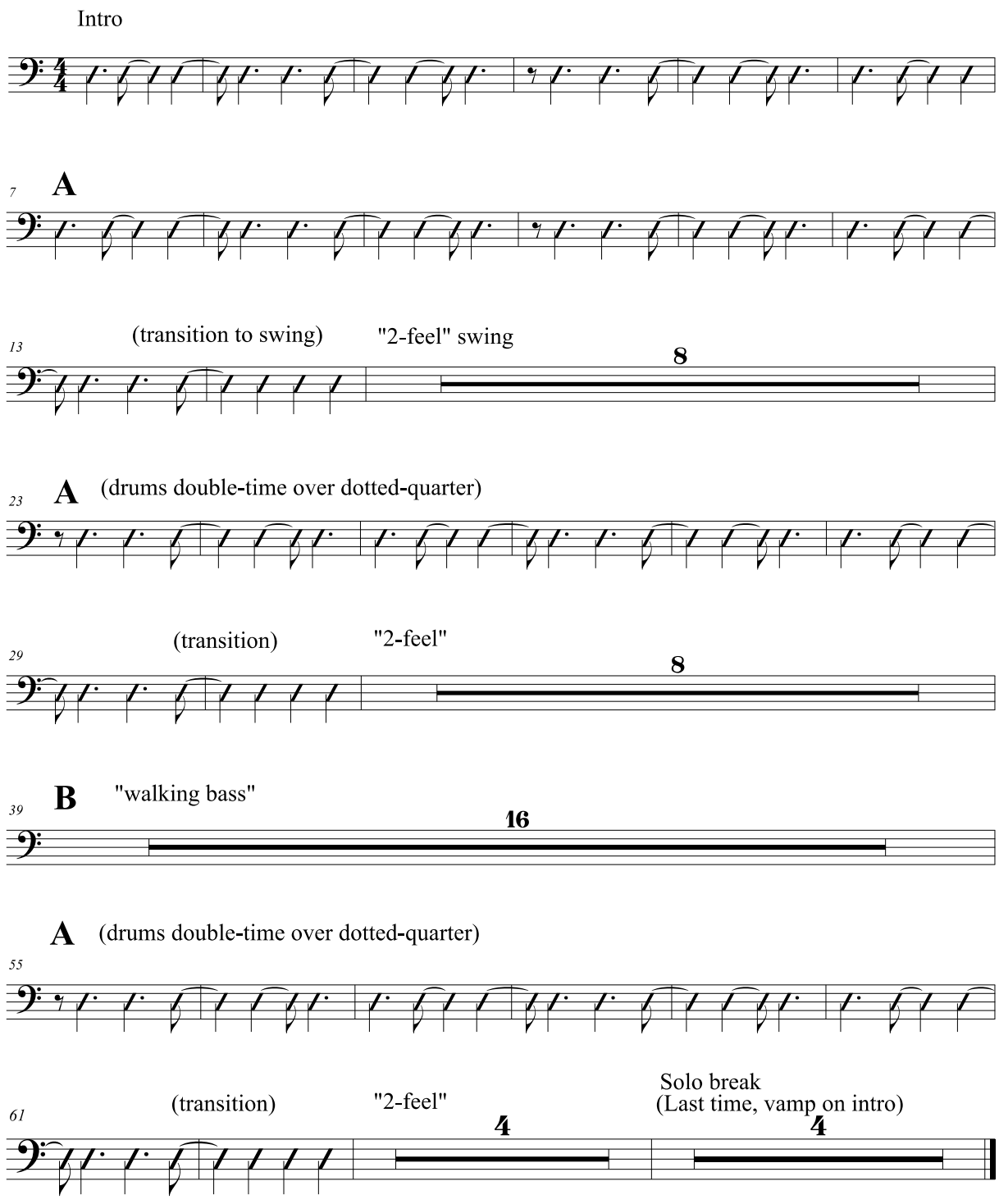
Example 3.17, intro vamp to "The Song is You" as two sets of eight hits

Without any perturbations to the flow of dotted quarter, there might be insufficient evidence of any "subliminal dissonance" at the outset. And without any reason to believe something's the matter, it might come off as awfully square, perhaps even amateurish. The perturbation also destabilizes the underlying (notated) meter, avoiding the first hit which would otherwise fall on a downbeat.

I stated earlier that to hear the beginning without being specifically prepared for what occurs (such as by reading through my description and notation), there's almost no way to realize the tempo of the song form until Marsalis enters with the melody. However, the track includes the musicians' count-off to the tune, albeit quietly. If you turn the track up, you can faintly hear "1 … 2 … 1 . 2 . 1 2 3 4" with fingers snapping on "two" and "four." Given what is to come, this is very useful, if you know how to find it. It provides a clear indication of the song's meter and enough time to entrain to it. It's also remarkable that the decision was made to include the count-off for this track, and not others. Clearly, someone was aware that it adds something valuable to the recording. I like that they left it rather quiet, as an Easter egg for listeners who were listening very closely, intent on figuring out what was going on.

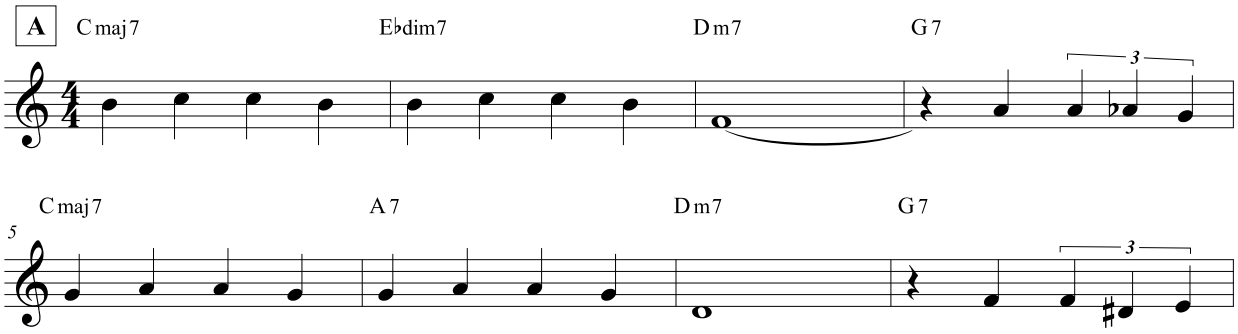
The arrangement includes other subtle alterations and inconsistencies as it moves through

the song form, beyond the "hiccup" of the opening vamp. Example 3.18 provides a lead sheet of the way the rhythm section hits lie against the song form. It is constructed to deny many possible expectations and maximize disorientation without altering phrase lengths of the song. The first A-section begins much like the opening vamp, with an analogous hiccup among the superimposed dotted quarter-notes. However, measures 10-13 continue the dotted quarter feel without the second hiccup. In the second A and the final A, the hits begin with an eighth note after the beginning of the section, allowing the hits to process as a continuous stream of dotted quarter notes without any hiccup. (Watts takes advantage of the continuity by playing a feel at double the rate of the dotted quarter note.)



Example 3.18, rhythmic hits in “The Song is You”

In a way, these subtle changes and adjustments are in keeping with general aspects of the form. The song form, a 64-measure AABA structure, does not have identical A-sections. Each A section begins the same way, however, with those identical beginnings reproduced in Example 3.19.



Example 3.19, The beginning measures of "The Song is You," as notated in *The Real Book*

The difference between the A-sections is in the latter half. In the first A-section, the harmony and melody do not resolve to C major, but they do in subsequent A-sections. I might argue that altering the hits in the second A-section and final A-section to be a continuous series of dotted quarters constitutes a sort of resolution to a more continuous periodicity and that this parallels the harmonic and melodic resolution in those subsequent A-sections.

Unlike the melody to "April in Paris," the melody of "The Song Is You" is not particularly distinct in its rhythm. The arrangement adds rhythmic interest to an otherwise rhythmically boring melody. When Marsalis enters with the melody after six measures of introductory vamp, his is the only rhythm which aligns with meter of the changes, and this constitutes a reversal of roles. As the rhythm section performs the inconsistent superimposed hits, only the melody provides a clear indication of "the beat." It is not a stable enough indication of the beat to take a timekeeping role, however. It includes phrases separated by rests as well as

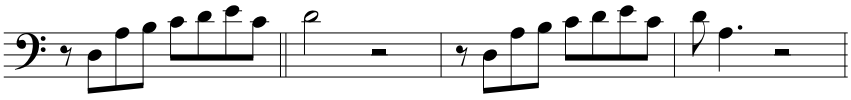
ideas which do not perfectly align with every beat. At the bridge, there is another reversal of roles, back to something more conventional. When the rhythm section resolves to plays the song's "time," the trumpet plays syncopated figures in new groupings of five eighth notes.

What I consider a satisfying experience of this piece—or, to be specific, of the intro and "head" of the piece—may use all of the preceding information in order to navigate the temporal framework. Presuming my chart accurate, it provides a lot of usable information, about when changes of feel happen in the form. My suggestion is that you start by listening for the quiet count-off and tapping (or moving) along in some meaningful way. Drawing upon the relationship to walking, I suggest alternating right and left foot taps, because they also provide some information about the duple hypermeter of the form. Whatever mechanism is chosen, the taps outline the meter of the song, even when it is unsounded, as is the case at the start of the piece. If you know ahead of time how the band hits lie within the meter (i.e. having read through example 23), this is actionable information to aid in tapping along. It is helpful to know that your tapping will align with the rhythm section hits in measures 6 and 7, but not in measure 4. While tapping is likely the most secure way of following the changes, especially as a performer, it is not necessary to follow the structure. An easier, yet perhaps less secure possibility afforded to listeners is to simply allow oneself to entrain to the different pulse rates, while following along in the score. This may be a first step *en route* to preserving the underlying meter, but on the other hand, it might take away from the sense of resolution when the rhythm section moves to ideas which align with the meter. Regardless, following along in the score gives theoretical information about the current location, and can offer preparation for upcoming changes of feel.

3.4 Ari Hoenig and Jean-Michel Pilc's "Sinister" Temporal Games

Ari Hoenig and Jean-Michel Pilc are frequent collaborators finding and pushing the limits of temporal capacity in improvised jazz. Their original compositions—such as Hoenig's "Birdless" discussed previously—toy with creative temporal relationships, and their interpretations of standards often include a barrage of conflicting signals and superimposed feels. I still recall from my personal drum lessons with Hoenig, that he referred to his bands as being "sinister." They were "sinister" not only because their ideas might throw off listeners, but because musicians would go so far as trying to mislead each other! The goal was likely not to truly lose fellow bandmates, but to test each other's limits. The two examples discussed in this section highlight these "sinister" traps in which musicians play around with sonic symbols of the form as well as false flags. And a meaningful aspect of experience here involves identifying which markers are false and which are true. Among these markers are not only stretched and manipulated default patterns, but also rhythmic and melodic symbols of form and meter.

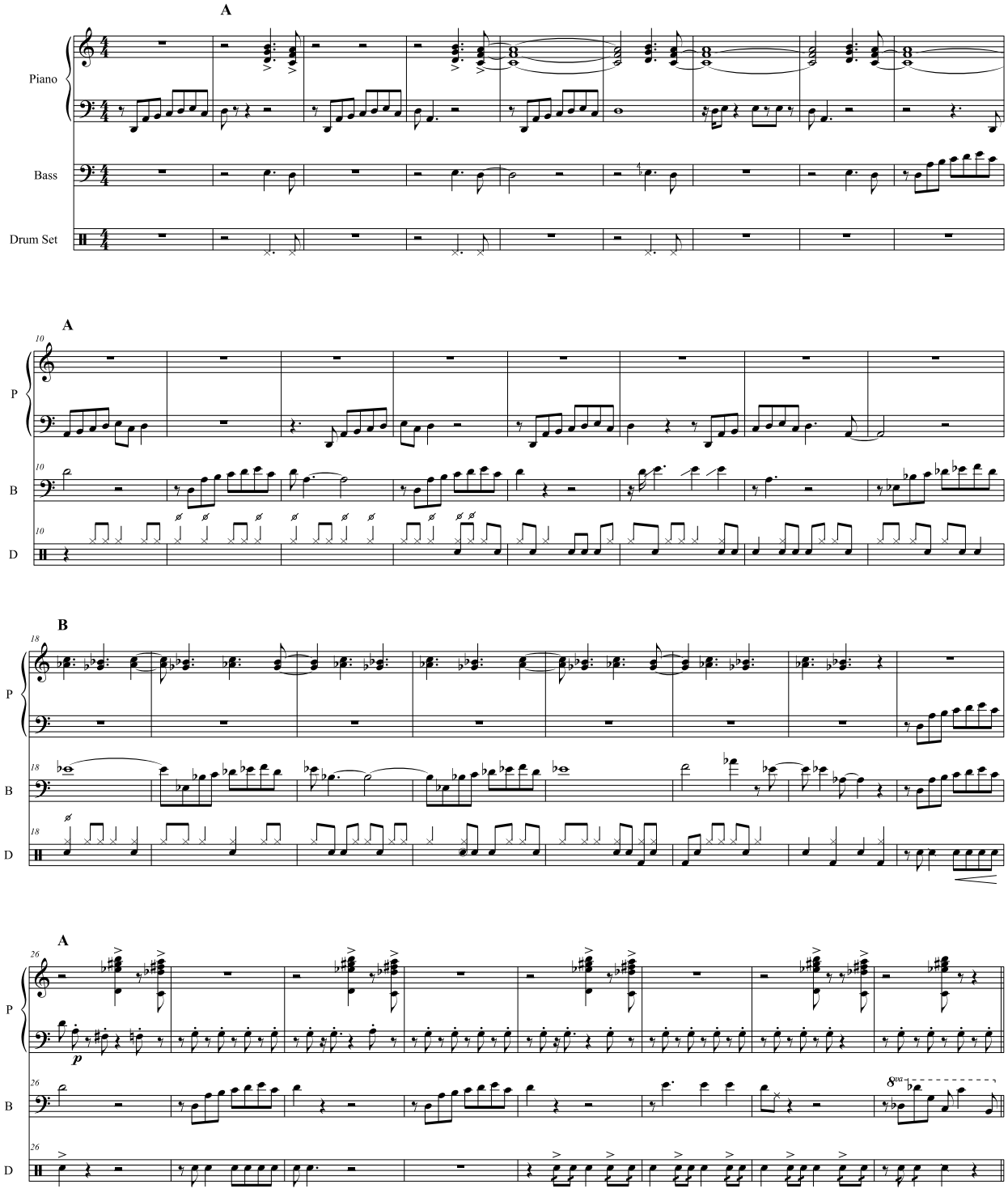
Before exploring the Jean-Michel Pilc trio's interpretation of "So What," it is worth noting that in Miles Davis's original recording on *Kind of Blue*, the upright bass takes the melody. The more typically "melodic" instruments follow each of the bass's ideas with a pair of hits. The melody begins during a pick-up measure (a hypermetrically weak measure) such that the arrival of the tonic pitch falls on the downbeat of a strong measure (sometimes immediately followed by the fifth, A), and the hypermetrically weak measures emphasize diatonic neighbors (C and E) to that tonic.



Example 3.20, the melody of "So What"

Given its well-known status, we may also consider that this melody provides metric information when it occurs. That temporal information involves two phases. First, the scalar portion signifies "here comes the downbeat," and the arrival of the root (D and later Eb) signifies "here is the downbeat."

In the Jean-Michel Pilc Trio's version (from the album *Welcome Home*, with François Moutin on bass and Ari Hoenig on drums) the piano begins with the melody in its low register (or "bass") for the first A-section. Then, in the subsequent A-section, the bass takes the melody, while the piano interleaves rhythmically displaced versions of it. As shown in measures 10 to 17 of the transcription in Example 3.21, the piano's interjections land the tonic everywhere *except* the downbeat of strong measure. In so doing, they could imply "false" downbeats, or at the very least destabilize the meter. They generally fall between the melodic ideas of the bass, but also ratchet up intensity by reducing the space between each subsequent idea. Pilc is in a particularly good position to lay down these false signals in the second A-section, having just played the melody in its "true" form, aligned with the changes as expected. The play between piano and bass seems to continue an important thread in the composition, the question of who has the melody, or at least whose melody aligns with the meter in the original temporal context. It was an important moment to have the bass take the melody in Miles Davis' original. Here the piano's displacements are all more magnetic, having presented the melody in the first A-section.



Example 3.21, first chorus of the Jean-Michel Pilc trio's interpretation of "So What"

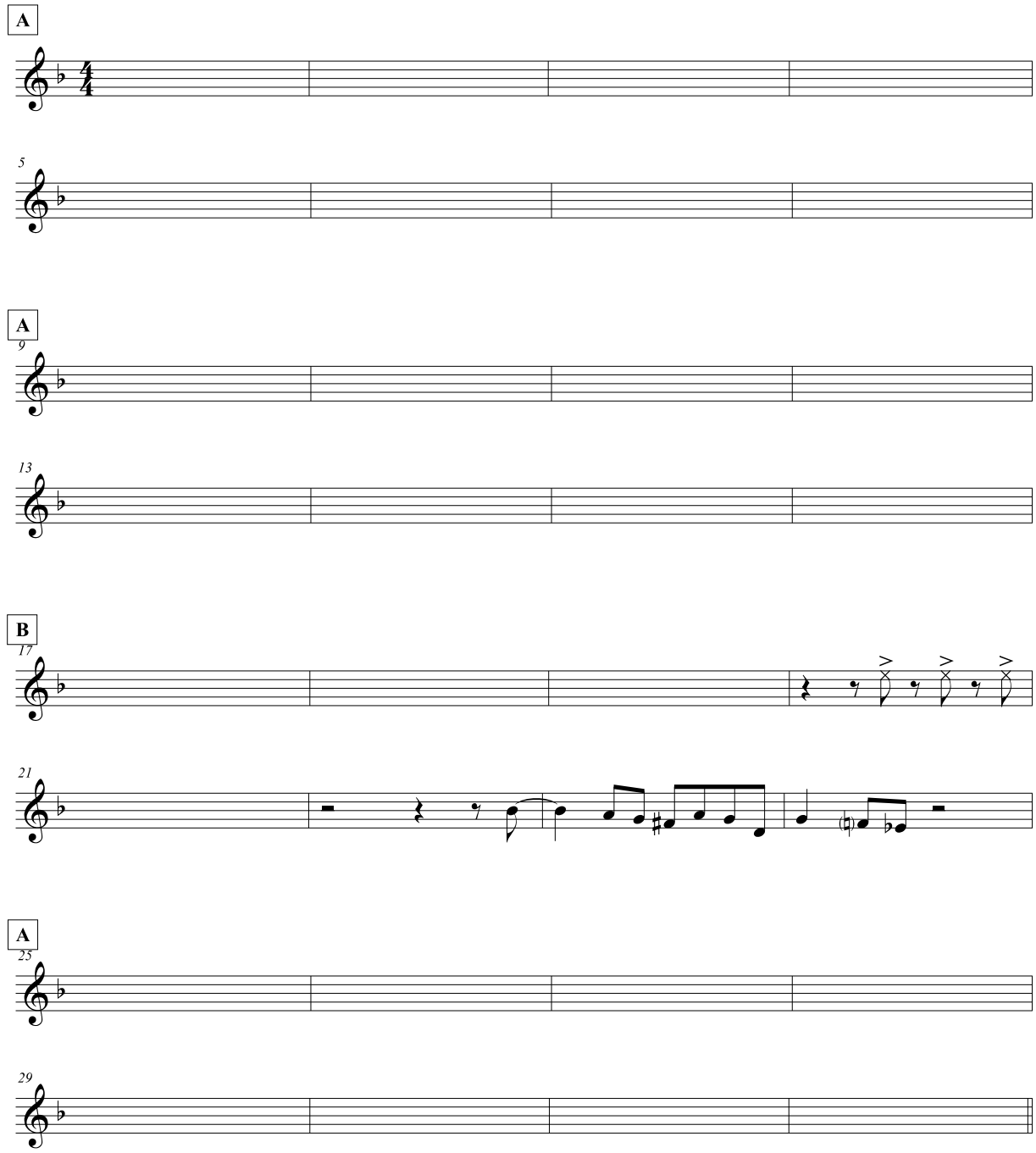
The other defining aspect of "So What" besides the melody are the pairs of chordal hits which follow each phrase. These hits occur in their original form (that is, like the Miles Davis version) in the first A-section. Each pair begins on the third beat of the measure, with the upper voice stepping down in pitch, with upper voice moving from B to A. Each also includes a tame syncopation. In each pair, the first hit is a sustained dotted quarter-note, whereas the second hit is attacked staccato, on an offbeat. Pilc plays with this idea of "dotted-quarter moving down a step" as he accompanies the bridge. There he constructs a pulse stream built around the rate of a dotted-quarter using pairs of notes moving down a whole step and then back (in the local mode of Eb Dorian). At a local level, these sustained "floating" dotted-quarters mask the beats and downbeats of the 4/4 meter, but at a larger level they highligh larger scale formal boundaries. They begin precisely at the start of the bridge and end just before the return of the A-section leaving time for the pickup measure that returns to D dorian. (The beginning of the solo section includes additional play with the chordal pairs placing them in still other metric locations.)

Hoenig and Pilc's collaborations often use melodies to lead or mislead listeners (and fellow musicians) about the temporal framework. In their interpretations of "So What" and "Giant Steps," the melodic symbols are sourced from the composition being interpreted, but this is not always the case. Melodic and rhythmic devices which indicate (as opposed to obscure) the form are not merely aids. Although of course they can help listeners in metric position-finding, they also provide aesthetically powerful evidence that—despite embarking on extraordinary tangents—the group is not lost (even if the audience is). This an important distinction: a perceiver need not follow the form to be aware that the group has done so. Of course, individual musicians may sometimes get lost, especially given the sinister brinkmanship which occurs. The Hoenig trio's version of "Anthropology" from the album *Inversations* plays with its material in

this way during the latter half of the solo section.

About three minutes into the recording, the group moves through a remarkable variety of superimposed frameworks, while highlighting the form using a rhythmic and melodic figure drawn from the bridge of the tune. Not only is this quotation a useful resource, its presence just when the form might seem lost adds to the awe of the piece. The formal marker has two components, both derived from the main tune. First, there is a trio of staccato notes on eighth-note off-beats in the fourth measure of the bridge. Second, there is a quote of the melody in the sixth through eighth measures of the bridge. Example 3.22 situates the two ideas in the context of the rhythm changes form.

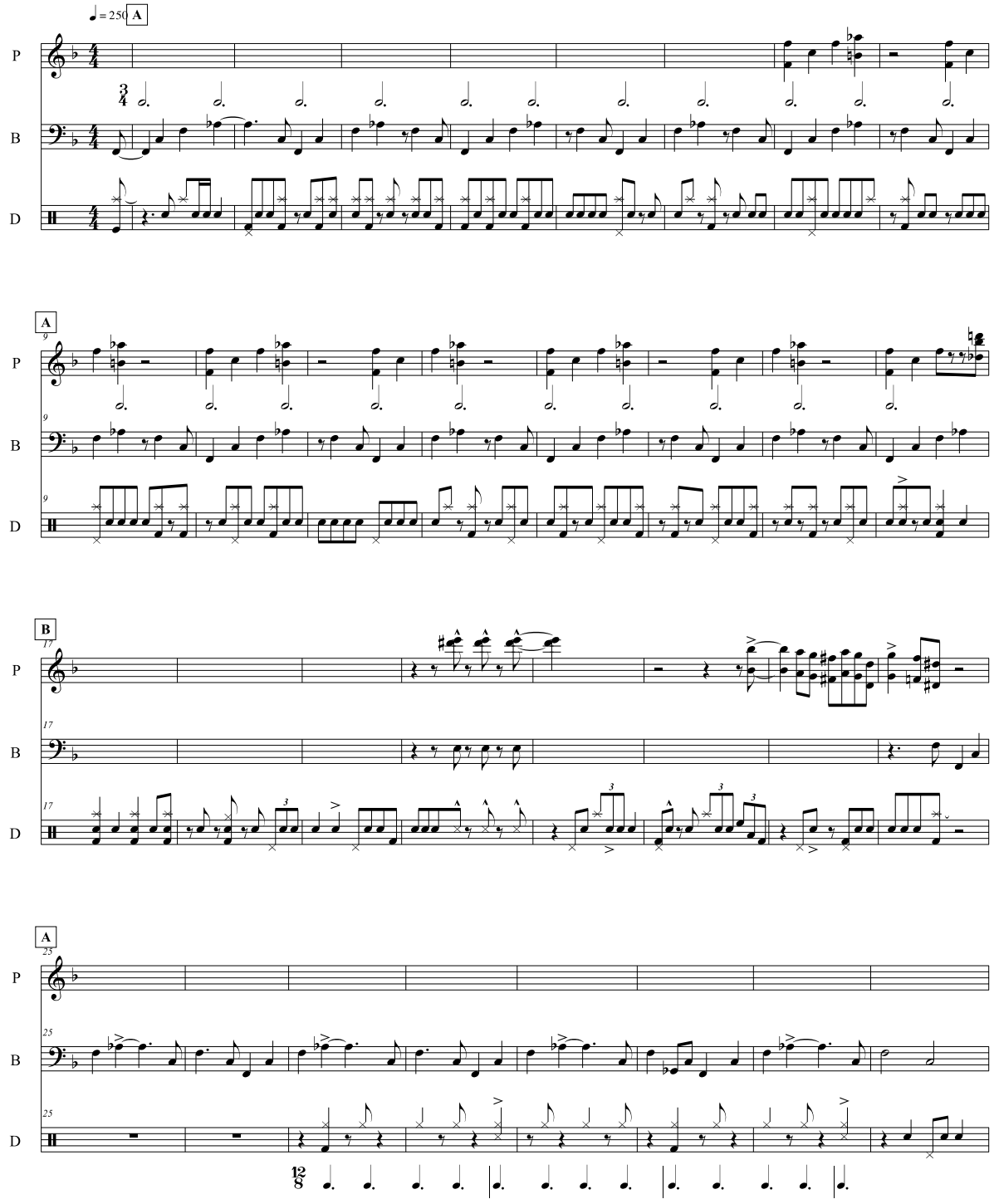
To hear these figures without abstract theoretical knowledge to go with them is not very informative. They do not occur in a temporally "strong location" in the form, and the group does not play them on every chorus. At a local level, they do not align with the meter. The three staccato hits occur in metrically weak locations, and the melodic contour seems to emphasize the rate of a dotted quarter-note, as shown previously in Example 3.10. However, with the knowledge of their derivation, and hence their signification, they become a powerful resource about temporal structure at both a local and larger scale. In a general sense, the two figures signify "this is the middle of the bridge" and "this is the end of the bridge" respectively. To know in advance that the three staccato hits end just before the local downbeat also allows a moment to entrain with the local meter, if it had it been lost or weakened.



Example 3.22, recurring “hits” and quotation during solo section of the Ari Hoenig Trio’s interpretation(s) of “Anthropology”

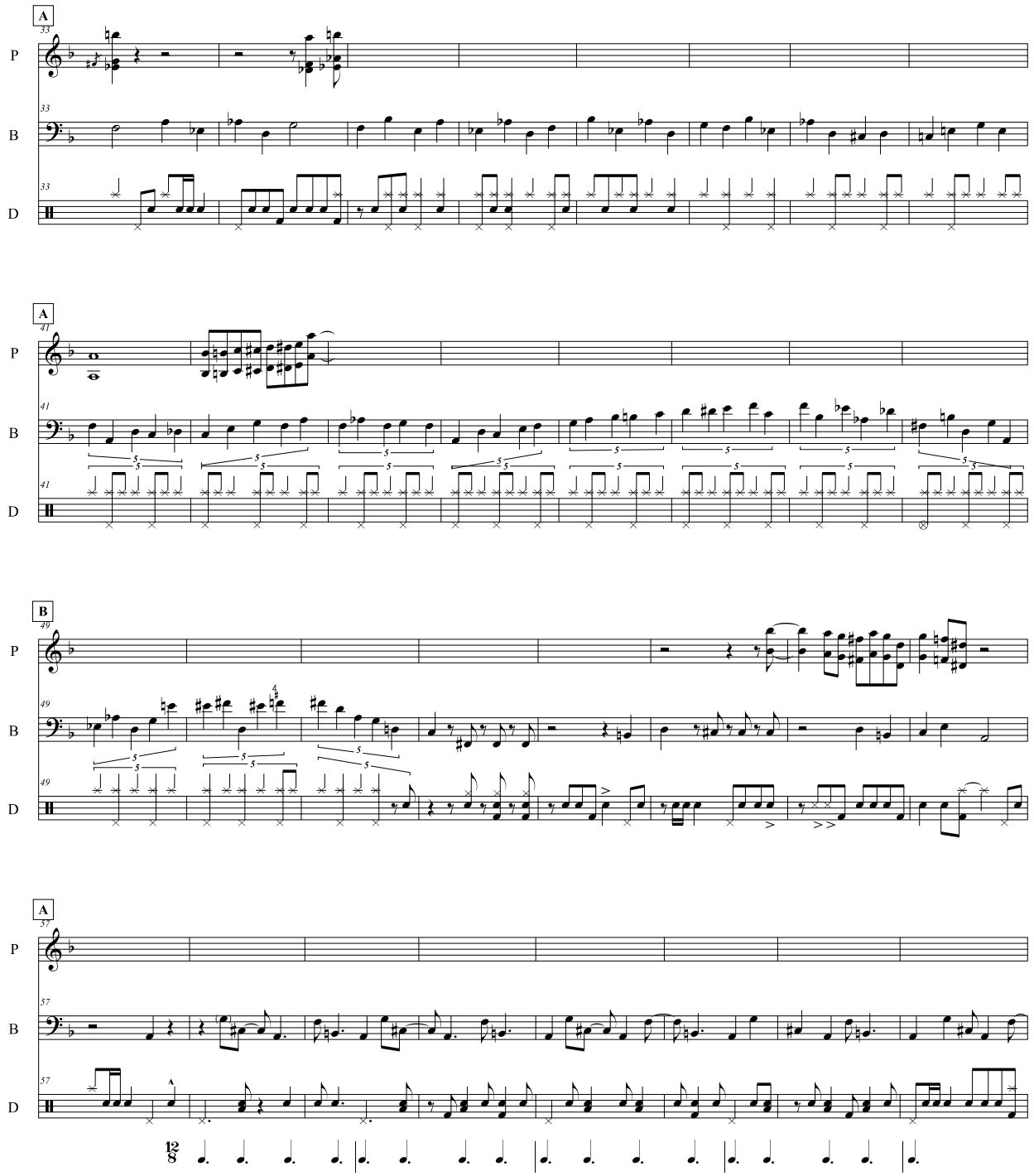
This type of information is very useful in contexts such as the final few choruses of the performance. These are extraordinary for the variety and complexity of superimposed pulse streams, but those superposed ideas still show links to the song form, based upon where they begin, end, or change structure. Figures of this sort could emerge over the course of a single recording, but in this case, the figure is part of their other versions of "Anthropology." It is part of their arrangement, whether written down or simply developed through regular gigging.

Following the piano solo (3'04" on the recording), bassist Johannes Weidenmuller (who collaborated with Hoenig on a pair of books about metric manipulation) superimposes a pulse stream in groupings of 3/4, quoting the famous bassline of the song "Footprints," by Wayne Shorter. Example 3.23 transcribes this chorus, annotated between staves with indications of superimposed meters. In this case, the familiar melodic contour adds to the subterfuge, and the piano doubling adds to the strength of its metric pull. The beginnings and ends of the line correspond with larger-scale formal locations: the bass line begins with the start of a new chorus, and stops during the bridge (perhaps also due to harmonic considerations), returning for the last A-section and ending with the chorus. This procedure is similar to those of Marsalis's arrangements on *Standard Time Vol. 1*. While the superimposed pulses do not align with the local beats of the form, *changes* of feel do correspond with the boundaries of large-scale sections. This moment carries significant tension, despite the fact that *sounded* stimuli are in synchrony, pedaling F minor harmony in 3/4. The bass and piano are only "subliminally dissonant" with the unsounded 4/4 meter. (They are also subliminally dissonant with the unsounded harmonic changes, which the ostinato pedals over.)



Example 3.23, the first chorus after piano solo in “Anthropology” as performed by the Ari Hoenig Trio (beginning at 3’05” on recording)

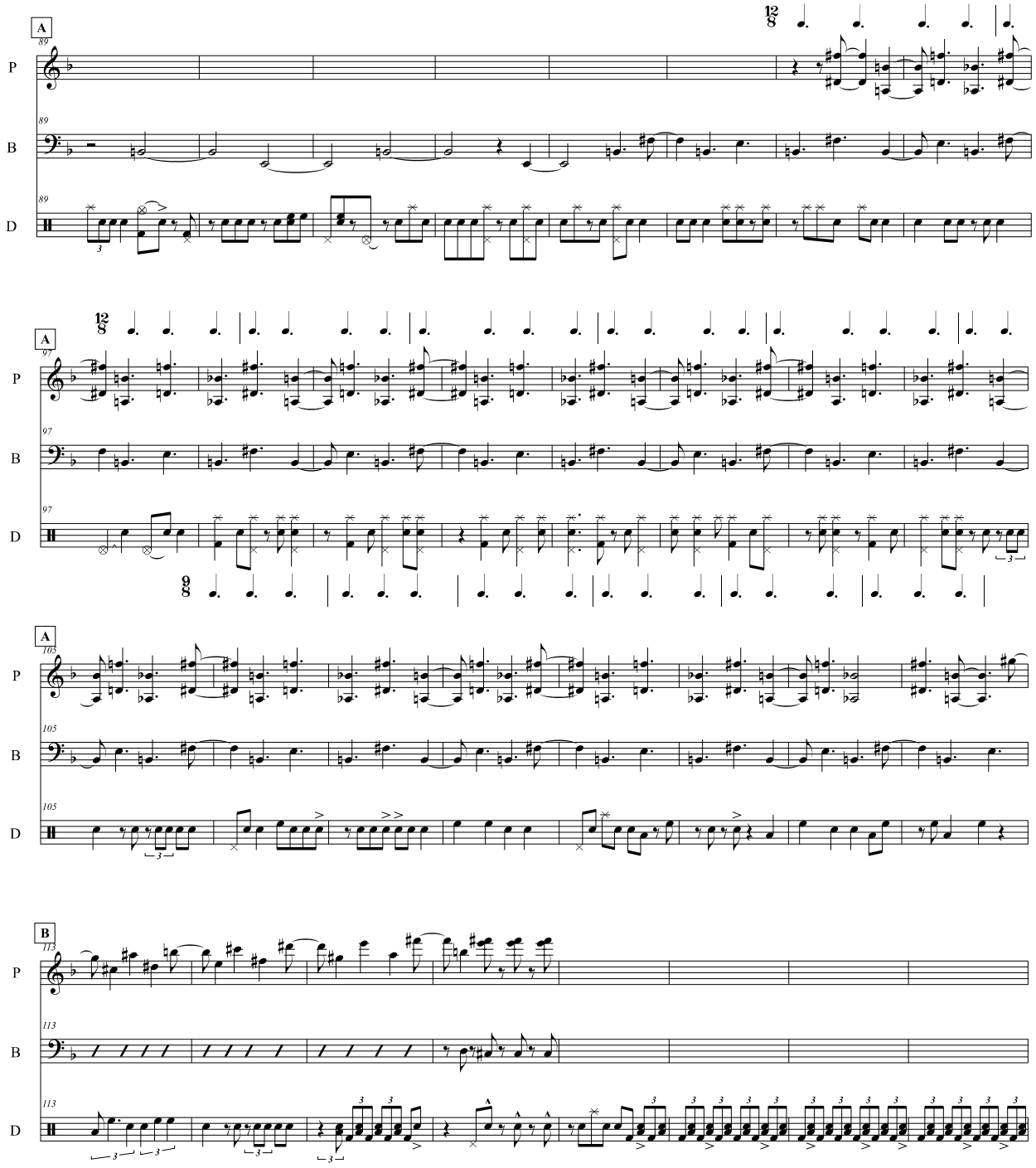
The following chorus presents another temporal shift whose point of change corresponds with boundaries of the form. As shown in Example 3.24, Hoenig and Weidenmuller shift the rate of their "walking" and "swing" patterns with a ratio of 5:4. Although the shifted rate does not lay easily across the meter of the tune, the moment of change to this feel reflects the form. It occurs precisely with the start of the second A-section.



Example 3.24, the second chorus after piano solo in “Anthropology” as performed by the Ari Hoenig Trio (begins at 3’35” on recording)

Navigating the changes with this quintuplet shift is difficult without some preparation and a strategy for following along. With a score in hand (or equivalent knowledge), it is possible to know in advance when the shift will occur (i.e. at the second A section) and what sort of shift it will be (to five-over-four). This sort of preparation can help to avoid the (incorrect) feeling that the group sloppily increased in tempo. Part of the ease in simply sliding into a new tempo, is that the shift to five-over-four does not involve such a dramatic change of rate as does, say, three-over-two. There is also little sounded material that might highlight groupings of five here. The hi-hat and bass both continue to construct ideas with *duple* groupings. However, if you know in advance when this shift will occur, you can allow attentional entrainment to slip into the new rate, while applying a symbolic or embodied counting strategy to track the groupings of five. This might mean vocally counting "1, 2, 3, 4, 5, 1, 2, 3, 4, 5,…" or coding the same information as a set of actions. (One could tap on every beat, but cycle through all five fingers to generate a cycle of five events, for example.) As if to offset the difficulty of the material, the quintuplet passage leads directly into articulation of the bridge hits described earlier, before moving on to other material.

The extraordinary climax leading to the drum solo (transcribed in example 3.24) simultaneously brings together many different pulse streams to ultimately release not at the top of the chorus, but at those same staccato hits which signify the fourth measure of the bridge. The multi-layered tension begins out of an idea in the bass: four-note groupings oscillating up and down a step at the rate of a dotted quarter-note. As with the "Footprints" quotation, the piano then latches on and synchronizes with the subliminally dissonant, superimposed 12/8. The drums also participate in the superimposed dotted quarter-note, but Hoenig's pattern groups those units into groups of *three* (i.e. into 9/8).



Example 3.25, climactic buildup to drum solo in “Anthropology”

In keeping with previous discussion, the rhythmic figures do not align with low-level meter, but significant *changes* to those figures align with and demonstrate awareness of larger-level form.

In this case, the dotted quarter feel ends at the start of the bridge. There, the melodic ideas gain momentum with an increase in rate and register. Brilliantly, this final lead-up occurs on off-beats to seamlessly connect with the offbeat hits which quote and signify the fourth measure of the bridge. The hits represent a release of tension by offering a clear indication of the form. The fact that the drum solo begins there, in the fifth measure of the bridge, is unusual yet revealing. More typically, transfers from one solo to the next occur at the beginning of the form, perhaps because it is a temporally strong and stable location. In this case, given the sinister traps laid out by the group, one could see this mid-bridge location, along with these hits, as the most stable location in the form. The hits provide information about both the local meter and large-scale structure, as long as you know how to read them!

In this analysis, I have taken the perspective of both performer as well as an omniscient listener (with a score and a specific recording to work with). Some resources, such as the ability to know precisely when a shift will occur, are not available in improvised contexts. The performers may have managed to navigate the examples without needing the very resources I bring up. If that is the case, there are other resources and techniques at their disposal, which future research might aim to explore. Or perhaps they do utilize these resources in some sense. Knowing what's coming next *is* still possible from the perspective of a performer in group improvisation. Performers can choose what to play next and also clue in bandmates about what is coming using any number of symbols, whether quoting a meaningful melody, making eye contact, or literally shouting out directives.

Another possibility is that these performers do not need the expanded set of resources I discuss at all, or that they need them to a much more limited extent. Perhaps this reflects the idea that these resources serve as a stopgap for difficult tasks, not a permanent necessity. The tasks

for which they are required depend on the skill of the person in question. It likely takes me a good deal more focus (and perhaps "attention") to track a form while performing ideas at another rate than it does for Jeff "Tain" Watts or Ari Hoenig. Rhythmic virtuosi may not need to slowly dissect a score or count beats with hand gestures in order to navigate a complex passage. At the other end of the spectrum, these sorts of strategies may also be beneficial for a middle schooler learning a comparatively easy task, like clapping on "2" and "4." The point, and segue to the next section, is that these resources may serve a pedagogical function because they are purposed for situations that are difficult for the person experiencing the music at hand. And learning something new is difficult.

CHAPTER 4: TEMPORAL RESOURCES IN PEDAGOGY

Needing to consider score information, numeric calculations, and encoded gestures as an additional (or "expanded") set of resources may be a peculiarity of perspectives rooted in mainstream music theory and psychology. Some omissions in these disciplines were framed in Chapter 1 as byproducts of a listener-centric perspective at the expense of other possibilities. Pedagogy's focal point, on the other hand, is not so listener-centric, nor is it so restrictive about the contexts and permissible resources involved in musical experience. The idea of music as something you *do* as well as perceive is central in pedagogy, as is the multi-modal perspective of performers. In the introduction to *Rhythmic Training* (1969), Richard Starer explains the priority he places upon developing musical literacy,[44] and Suzanne Bloch's foreword to his book praises his approach for its concern with music as "either read, performed or heard" (Starer 1969, 2). Several of the sources discussed previously as counterexamples to the mainstream trends in music psychology were also drawn from pedagogical journals. Persellin's (1992) study discussing the effectiveness of visual, auditory, and kinesthetic strategies for rhythm was published for the National Association for Music Education, and McCoy and Ellis' (1992) findings that large muscle movements provide the best aid in meter discrimination tasks was published for the Council for Research in Music Education.

I associate pedagogy with two notions of "practice": one, in the sense of doing something (i.e. *praxis*), the other, in the everyday sense of practicing, i.e. practicing a skill to improve it. Music theory does sometimes explore the former, by attempting description of performers'

[44] More specifically, "the ability to transform visual symbols of rhythmic notation in to time-dividing sounds" (Starer 1969, 3).

experience. This is quite different from analyzing nuances of a particular performance, which is more common, but may erase the role of the musician playing it.[45] The other category, what it is like to *learn* to perform such-and-such a piece, remains more or less the exclusive domain of pedagogy. With priority on learning and progress, pedagogical methods do *not* prioritize describing someone's current abilities, or some status quo, as psychology generally does. Relatedly, notions about cognitive limits are not very productive topics either. After all (as Diana Deutsch explains in her introduction to the first issue of *Music Perception* (2004, 286)), it will remain unclear which mechanisms are shaped by experience and to what extent. In sum, pedagogy can avoid some foci and assumptions of mainstream music theory and psychology described at the outset of this project, because it highlights performers' perspectives and values specific practice.

In this section, I consider how an expanded set of temporal resources and strategies is already more present in pedagogy, as well as how it might be incorporated into pedagogy. The starting point here is that exceptional cases of metric multi-tasking motivate the extra techniques not only because traditionally conceived attentional entrainment is insufficient, but because the tasks are *difficult*. *Anything* challenging involving navigation between some events and their temporal framework may benefit from use of scores, transcriptions, mathematical calculations,

[45] Nicholas Cook's "Analysing Performance and Performing Analysis" (1999), points out this erasure of the musicians in Lerdahl and Jackendoff's conception of music, and also criticizes theorists (Wallace Berry and Eugene Narmour in particular) for setting up a relationship in which "good" performances are supposed to reflect particular structural analytic points. In other words, the direction of ideas is too often from analysis to performance, leading to a general "authoritarian" tone of music-theoretical writing about performance (Cook 1999, 239-240).

Suzanne Cusick's (1994) discussion of what it feels like to play the chorale prelude on "Aus tiefer Not" from Bach's *Clavierübung* is a prime example for attempting description of performers' activities. She frames the analysis as something theorists should do more of (as part of what would constitute feminist music theory). And indeed, since her publication, that direction of inquiry has grown considerably.

embodied actions, and symbolic off-loading. Additionally, the usefulness of the resources depends on context including the person who uses them. I chose virtuosic temporal tasks to make the difficulties apparent for the expected readership of professional musicians. For a child, the same strategies will be needed for far easier tasks. To say that they are relevant to simpler musical tasks may require a reworking of concepts of meter, perception, and attention, a point I return to in the conclusion of this dissertation.

The "expanded" set of temporal resources and techniques are not very unified beyond their omission from mainstream discussions, and the distinction between static and dynamic temporal resources is not one which pedagogues generally make. Similarly, pedagogy's openness to more sorts of experience does not translate to an *equal* use of the many resources I have acknowledge. The use of scores and abstract theoretical knowledge, for example, comes with a greater degree of caution than the use of physical actions does. Score-based musical literacy is often considered critically incomplete without aural training, leading to "sound before symbol" approaches. The reverse is often true for physical actions, which often provide help for perceiving during early stages of learning.

4.1 Actions First

Practical texts on rhythm often involve exercises in which a rhythm is given with a metric context, along with instruction on how to articulate the meter. It is quite remarkable how closely some pedagogical designs mirror the patterns of the alto singers in Monk's "Panda Chant II" discussed previously. (And vice versa.) Starer's *Rhythmic Training* includes the beat of meter as a notated stream of quarter notes against a rhythm above it. As he explains, "the upper line may be sung, hummed or spoken on a neutral syllable; the lower line should be tapped by hand or foot, or it may be conducted" (Starer 1969, 4). As in "Panda Chant II," one stream of activity is vocalized, and another embodied through other physical actions. However, the metric actions of tapping or conducting are only a first stage of learning. "Eventually the lower line should only be 'felt,' that is, it should be done in silence" (Starer 1969, 4). The implication here is that physically embodying meter is *easier* than simply "feeling" meter internally, or at least developmentally prior.[46] Learning to feel meter internally emerges after having physically performed it. Starer's method, along with others, presents the experience of metric cycles as an action which is eventually "internalized."

Anne C. Hall's *Studying Rhythm* (1989) takes a similar approach with more explicitness about conducting patterns' potential for off-loading.

[46] The pedagogical preference for active, physical strategies to develop metric capacity seems to be inversely related to age (see Persellin 1992). This may be in part a practical solution to issues maintaining interest in younger children. Moving around simulates play, but having children learn about meter through visual symbols may be seem more like reading a book. Perhaps the point is not that younger-aged children are better at learning through movement, but that they are simply worse at learning through other mediums. (College-aged students also show improvement learning metric types through physical motions. See for example, McCoy and Ellis 1992.)

> Conducting the meter both helps keep the beat steady and lets the hand take care of counting beats. We should conduct while singing…so that conducting becomes natural. Only when we can perform the beat patterns without thinking about them does conducting become a help. If beating time seems a hindrance rather than a help—one more thing to think about—then it should be practiced assiduously, for it is an essential tool for musicians. However, we must not grow dependent on our hands to keep the beat because they will, in many musical situations, be otherwise occupied we should therefore also practice the studies without conducting. (Hall 1989, 3)

The idea that the hand takes care of counting beats without thinking about them gives the hand its own agency and suggests that information is encoded in the gestures. To say that they should be performed "without thinking" further supports an idea that it is involved in off-loading, that the lack of attention needed is an important facet of that conducting. Specific ("assiduous") practice is also critical, as it reduces the attentional demands on these gestures. But if you have to think about them too much, they become a hindrance. Hall's caution not to grow dependent on our hands for beat-keeping also underscores the productiveness of the gestures in counting beats. If they were not so helpful, there would not be a risk of becoming dependent on them. The progression from performing gestures to feeling meter without acting it out again suggests a notion of meter and beat (much like Starer's) as an internalization of real actions. Hall's and Starer's books are typical in this regard. Other texts reflect the same method. Paul Hindemith's *Elementary Training for Musicians* (1949) begins with exercises in which a beat is tapped, clapped, or walked. Those beats are subsequently grouped into measures by replacing taps with counting out loud. Then that counting out loud is replaced by counting "mentally."[47] Kazez (1989), for example, puts forth the option to "count the beat silently" as the last means of

[47] Hindemith's first chapter provides exercises given only a beat, which is tapped. The concept of measure is introduced in the second chapter by simply replacing tapped beats with verbally *counted* beats (and a certain cardinality at which to repeat). Then the instruction is given to "count mentally" (Hindemith 1949, 10).

tracking beats following "external" techniques such as tapping, conducting, and counting out loud (Kazez 1989, xxii). And Krueger (2011) sets up the goal of developing "an internal feeling of the pulse" by walking in place, shifting weight, or tapping the beat silently with large arm movements (Kruger 2011, 3).

The idea that silently counting or feeling a beat without moving is typically the last stage in a progression of exercises suggests that it is also the most advanced. In some ways, of course, it might be easier than doing it by moving. *Not* executing a physical motion is, after all, one less thing to keep track of. But, assuming gestures are properly practiced, why might taking them away make the task more difficult? One answer is that the motions, an *observable* counting activity are replaced by an *imagined* activity. It remains neurologically and experientially real, but takes away the advantages afforded by larger motions. The other difficulty of silently counting might have to do not so much with feeling a meter, but feeling it *well* (i.e. securely and steadily). Hall's point that conducting "helps keep the beat steady" underscores that physical constraints on motions (as opposed to neuronal oscillations) may be a productive feature. The tempo of beats may be steadier when associated with physical actions, because durations depend on distinct properties of the action, such as speed of muscular contraction, acceleration of bones, etc. It becomes steadier still if a physical motion's comfortable temporal range fits the periodicity it represents. A pattern of expectancies (i.e. "attentional entrainment"), by contrast, lacks such physical limits and is not steadied by consistency in physical exertion. Confronted by an odd stimulus, our expectancies can quickly shift and cut beats short. The inertia of embodied swinging and swaying resists rapid changes. This helps explain advice given in Carol Krueger's *Progressive Sight Singing* (2011), in which she cautions that "clapping will not internalize beat because it doesn't involve changing/shifting body weight" (Krueger 2011, 3). I take this

statement to mean that techniques that do involve shifting body weight are *better* at internalizing a beat, not that clapping is worthless in such a regard. (And it *does* involve changing body weight, after all, but not very much.)

Robert Abramson's *Feel It! Rhythm Games for All* (1998) also relies on a notion of temporal training as an internalization of real movements and aligns tempos with different types of action, using clock metaphors to describe the function of those actions. As is typical of texts aimed especially at younger learners, *Feel It!* offers more variety beyond conducting with the hand. For example, to "experience 3-beat movement," Abramson suggests a modified marching pattern, involving (1) a bend at the knee, (2) a step onto the same foot, and (3) motion up onto the ball of that foot. Another exercise—one of the first ones in the book—involves turning oneself into a "pendulum clock."[48] Participants mimic a pendulum by swinging their arms across the body and up to shoulder height on one side, before similarly swinging to the other side. A teacher leads the group by speaking the word "Swing… swing" as he performs the motion, and all students synchronize with his accompanying words as well as his motions. The addition of the words spoken by the teacher takes advantage of the fact that aural stimuli provide easier cues for entrainment than visual ones.[49] To adjust the tempo of the game, the teacher adjusts the construction of the human pendulum. For slower tempos, Abramson recommends a "grandfather clock," which incorporates the torso and knee-bends. At faster tempos, the clocks become smaller. "Tiny clocks" use only wrists and hands, and "tiny-tiny clocks" use just four fingers (Abramson 1998, 7).

[48] For Abramson, it is also important that these are not be exercises but *games*, in order to engage the participants.

[49] See, for example, Cameron and Grahn (2014, 114)

Dalcroze Eurhythmics is a more well-known embodied system of rhythmic pedagogy. Elsa Findlay constructs practical applications in her book *Rhythm and Movement* (1971) and similarly links physical actions to a more robust, steady feeling of meter. For Findlay, rhythmic experiences are made more reliable by the addition of physical movement. She charges that notational symbols bear "no relation to a real feeling for time" (Findlay 1971, 16). Her notion of "real" feeling of time likely critiques the static nature of scores and symbols of duration. Findlay also raises a worthwhile point regarding counting. For her, "time, however, cannot be measured by counting. At best counting can only mark the beat, not the time lapse" (Findlay 1971, 16). I have previously considered various methods of counting as ways of marking off time, but Findlay underscores that counting tracks a *quantity* of events which have passed and not necessarily the "space between." However, counting strategies with more significant associated motions, such as the "grandfather clock" described in Abramson (1998, 7) do have activity *between* beat events (or as she calls it, the "time lapse"). I would not consider this a critique of time-marking strategies such as counting out loud or tapping, but a rationale for why physical activities can make time-keeping more robust. All these methods have a modest (though endlessly refinable) goal of feeling a consistent (notated) meter against which rhythmic ideas occur.

4.2 Sound before Symbol

Visual notation's lack of actual acoustic sound is both its asset and point for critique. In introductory pedagogy, where musical literacy is the goal itself, authors stress the importance of incorporating sounds in the process of learning the notational system. The goal of this move is to stress a sound experience, not just a fractional set of relationships. In texts where literacy is assumed (i.e. where notational literacy is not the goal itself), notation is nonetheless approached with care that its aural associations not be omitted. Peter Schubert's (2008) book on Renaissance counterpoint (admittedly not a "rhythm" book), introduces printed scores as essentially incomplete—and boring—without the sounding music they represent (Schubert 2008, xii). His method is to focus training upon the "outer ear" over the "inner ear." By this he means to stress activities with actual sounds such as composing at the piano or singing with colleagues, as opposed to only reading and writing at a desk (Schubert 2008, xvi). This type of recommendation seeks to solidify visual notation's relationship with aural experience. Notation should not only represent a configuration of sounds, but also the *experience* of those sounds. That is Schubert's goal, at least.

The prioritization of aural training when teaching notational literacy often links with "sound before symbol" approaches. That sounds are "first" can be taken to mean aural training literally precedes abstract explanations of mathematical relationships in pedagogical progressions and also that it is given more weight overall either in class time or graded work. Micheál Houlahan and Philip Tacka's *From Sound to Symbol* (2009, drawing upon the Kodály method) and Maureen A. Carr's article "The Importance of Sound Before Symbol in Developing Intuitive College Musicians" (1989) are two good examples of this approach. Gary Karpinski's

four sequential phases of melodic dictation from "hearing" to "memory" to "understanding" to "writing" offers as a more nuanced progression from sound to symbol. And Joshua Palkki (2010) explores the productiveness of rhythm syllables in those intermediary phases, referring to some general psychology of mnemonic devices.

Rhythm syllable usage has not caught on to the degree that *solfege* has, but there are nonetheless many systems available, and Palkki offers a good survey. Some systems use existing words, some use numbers, and other use original syllables.[50] The application of syllables may also be "beat-based" or "symbol-based." Beat-based systems depend upon metric location (e.g. on a downbeat or not) whereas symbol-based systems depend on the type of note (e.g. quarter-note, eighth note, etc.). Palkki's preferred system is the "Takadimi" method, which is a beat-based method constructed by Hoffman, Pelto and White (1996). It is closely related to the Kodaly method, but also "influenced by the authors' extensive study of Indian music" (Hoffman, Pelto, and White, 1996, 14).

In their advanced rhythmic pedagogy, Hoenig and Weidenmueller treat notation as a tool, but also a last resort.

> The text and book examples should be referred to if necessary, only after listening to and trying to absorb the musical examples by ear. The idea is that these musical examples should be learned primarily aurally, in an organic way. This will aid you in making musical decisions that are dictated by emotion and not mathematics. (Hoenig and Weidenmuller 2011, 4)

I've previously considered scores as a useful resource which provides information about temporal relationships. The fact that they recommend using it *only if necessary* might reflect a

[50] Cynthia Crump Taggart (1989) explains that rhythm syllables' connection to vocabulary for audiation can make them more effective than numbers. Presumably this includes both systems with real words and ones with original syllables.

sound before symbol approach. Or it could intentionally construct a desirable difficulty. To withhold scores and examples forces work and engagement on the part of the reader-perceiver. Like a student forced to take dictation before seeing the solution, it solidifies an experience of sound, rather than providing abstract knowledge. It might also attempt to avoid the pitfall of an "artificial" sounding execution in real performance. Figuring out temporal relationships in a score and performing them can require abstract thinking which destabilizes the consistency of beats. As material becomes more difficult, the tempo may drag, for example.

At the same time, Hoenig and Weidenmueller's recommendations also seem like a preemptive defense of their aesthetic style. It allows the claim that they, although their book is quite mathematical, make musical decisions through "emotions." It also set up an odd relationship to theoretical resources. They seem to be in the paradoxical position of wanting to students to learn odd temporal relationships, but not be seen as overly math-y. The book itself is organized by mathematical relationships. Perhaps the hope is to avoid excessive counting. To make decisions "dictated by emotions," may be a bit romantic, but I think the ideas is that—during musical improvisations—one ought not be thinking about mathematical relationships. With adequate practice their usage ought not require conscious calculation in the moment, just as a singer thoroughly prepared for an aria ought not be thinking about *solfège* syllables. It is one thing to know how a 5:4 rhythm will fall against beats of 4/4. But it is quite another to *do* it, to do it evenly, and to feel the tension between the two pulse streams.

It's easy to come away from sound-before-symbol approaches with the idea that notation is a problem. Hoenig and Weidenmueller imply that learning from notation is not "organic," and that decisions based upon it may "lack emotion" or be "dictated by mathematics." They do not actually say this, however. Instead, they minimize score reliance, because there are substantial

benefits to avoiding it. The reliance on scores may be a product of my own position as a theorist whose *modus operandi* involves and immediate jump to scores for information.

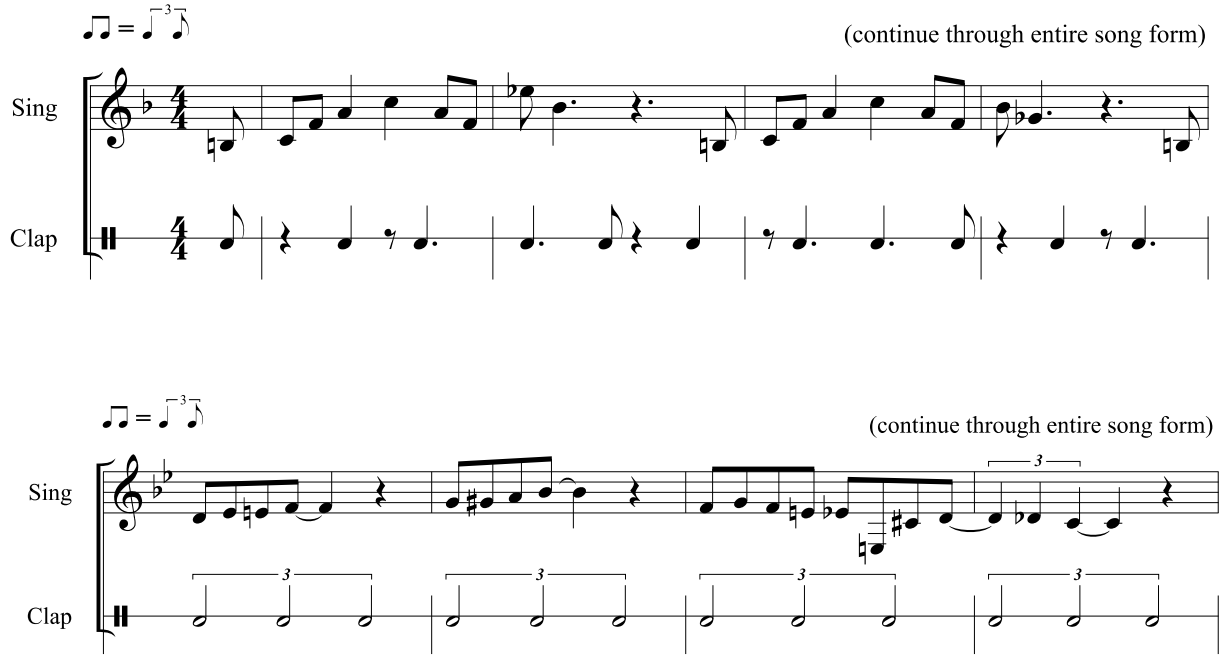
4.3 Learning to Multi-Task

Hoenig and Weidenmuller incorporate both action-first and sound-before-symbol approaches into their two-volume series (2009, 2011) on "contracting and expanding time within form," along with stipulations which overwhelm attention. They begin from an idea that learning to feel a framework stems from an actual articulation of meter. However, they design exercises for advanced metric multi-tasking of the sort described in Chapters 2 and 3 (which they call "superimposed metric modulation"), and they begin with an expectation of musical literacy. Their system is designed to cover a very wide range of temporal relationships, so it is fitting that the actions are essentially claps and foot taps. These actions do not mark time-lapse as well as Findlay proposes, but their quickness facilitates versatility of tempo. And that quickness would be impeded by choices to use larger muscle motions. Those large-muscle movements could be enlisted, but Hoenig and Weidenmueller do not make such a suggestion. The other substantial difference between this and previous texts is the insistence on developing various actions which do *not* align with the form in straightforward ways. However, I will argue that the non-alignment of actions prepares the learner for situations in which meter is only indirectly referred to, or for times when attention spreads thin across many stimuli.

In preparation for "real" improvisations, Hoenig and Weidenmueller's exercises occur over actual song forms, rather than only a meter. Importantly, they often require that the tunes be sung. This starting point—the ability to accurately sing a melody without needing to tap out beats—is more or less the *endpoint* of the methods discussed earlier. To sing the form involves performing whatever syncopations are built into the song and takes for granted that the performer has a robust enough concept of the meter to "count silently" or "feel without tapping." The

rhythms in most jazz tunes are not as complex as the final rhythms found in Hall's and Starer's methods. On the other hand, to take an entire song as a large-scale form goes beyond notions of temporal structure found in previous methods, which stop after grouping beats into measures. Hoenig and Weidenmueller use entire forms, because they provide "an opportunity to raise the intensity of your expectations for resolution" and "without a form over which to apply the new groove, you won't achieve the same amount of tension nor the effect of any subsequent release." (Hoenig and Weidenmueller 2011, 5). To play a superimposed three-beat pattern will align with a downbeat every three measures of 4/4, but only aligns every three *choruses* of a "rhythm changes" form, for example.

The centerpiece of their strategy involves repeating patterns called "core rhythms" which are clapped over the song form. Core rhythms are designed to later constitute the a superimposed beats of a core *groove*. Core rhythms could be, among many possibilities, half notes displaced by an eighth-note triplet or claps every fifth eighth note. Example 4.1 offers two realizations, one for the tune "Well You Needn't" with a core rhythm occurring every third eighth note, and another for "Blue Monk" with a core rhythm of half-note triplets.



Example 4.1, two possible realizations of exercises as proposed under "general practice tips" in *Metric Modulations* (Hoenig and Weidenmueller 2011, 6)

As difficult as this may appear, it represents only the first stage of Hoenig and Weidenmueller's method. The next step involves adding metronome clicks to fall on various metrical locations *or at any other regular pulse rate*.[51] The metronome may be heard on off-beats, triplets, dotted quarter notes, etc. Figure 4.2 offers versions of the same exercises with the addition of one possible hearing of metronome clicks.

[51] Hoenig and Weidenmuller also suggest performing foot taps as an intermediary stage before the metronome. I will focus on the metronome possibility, though, because the foot taps are essentially equivalent to clapping. The only difference is the body part doing the performing and some distinct rate associated with them

Example 4.2, two possible realizations of exercises as proposed under "general practice tips" in *Metric Modulations* (Hoenig and Weidenmueller 2011, 6) with added metronome clicks

Each of these requires entrainment with a pulse that is not sounded. Actually, it's difficult to say whether this ought to constitute entrainment, because there is not direct synchronization. The exercise requires—and helps develop—a great deal of self-conscious control over one's own attention as well as theoretical knowledge of how the different pulse rates align with each other and with the meter. It puts also increased strain on attention, by increasing the numbers of musical balls to be juggled. Perhaps part of the point is to find some threshold of attention and push it to its limit.

As a whole, the exercises here combine (and hence help summarize) several pedagogical methods. (1) Given that they are designed to strengthen one's ability to *superimpose* a pulse rate

on another, the claps could represent an "action first" approach. Each superimposed pulse is physically performed and practiced until it needs less concentration or attention, in order to be "felt." In terms of pedagogy this is an obvious move: a regular action, through practice, becomes internalized, just as metric cycles are taught. In mainstream metric perception theory, however, this is a more radical move. It implies that some second pulse stream might possibly be felt, i.e. tracked without any external off-loading. (2) The requests from the authors to engage with recordings and videos before looking through book notation represents a "sound before symbol" approach. This may be an attempt to force more engagement, or allay fears that superimposed metric modulations are overly mathematical. (3) The idea of using a metronome to be heard in weak and odd locations helps make temporal navigation more robust. Considering the musical end goal, this addition would likely be good preparation for group improvisation of the sorts analyzed in Chapter 3, because the metronome is an external source of information for synchronization. However, the clicks themselves are not for direct synchronization. Given the common purpose of a metronome, the clicks convey a "false" sense of beat to be resisted. And that false sense of beat, and tension with the form, is one of the most defining characteristics of group improvisation in Hoenig's bands.

CONCLUSION: METER, PERCEPTION, AND WHERE TO DIRECT OUR ATTENTION

I have done my best to avoid the baggage associated with the term meter and perception by presenting the scope of this project with other terms: temporal "navigation" and "knowledge". "Meter" nonetheless has been a part of the discussion throughout, especially through my use of the term "metric multi-tasking." At the outset, I stated a preference for an "objective" definition of meter, where a particular sort of engagement is not required to count as meter. If I've done something dramatic with meter here, it is not in the definition. It is in the contexts relevant to discussion and strategies for perceiving, experiencing, or knowing about it. One of the most important points is that following periodicity and finding metric structure need not mean finding periodic events! Events may be periodic, but features other than that periodicity provide information (a symbolic melody, for example). I also made a point not to require that all strategies be "perceptual." However, the idea of meter perception should be opened somewhat, to include active and multi-modal engagement with music, even if certain metric strategies are considered as more general forms of knowledge (and not perception).

Talking about perception generally (i.e. outside of music) involves sensory engagement with an object separate from the perceiver. I *perceive* an egg by *seeing* it, or *feeling* its shape, texture, and weight in my hand. I could also perceive an egg—and hopefully this hypothetical egg is cooked—by *smelling* it or *tasting* it. However, you do not always need direct sensory information to know about the egg. In a supermarket, I can identify eggs by reading the word "eggs" on a carton, but I probably would not consider that as "perceptual." (It does involve sensory information to *see* the written words, but the important information is presented as

linguistic symbols). I can also read about structural or biological properties of eggs—about how they have a rough shell and ovoidal shape—without being anywhere near them. This too can provide useful information, but—without a direct sensory encounter—I would be unlikely to claim it as *perception*.

Talking about *music* perception often involves an added limitation which stems from the notion of music as sound (i.e. its "primary medium") and the assumption that sensory encounter means *listening*. On the other hand, recent work in embodied cognition (Godøy 2003, Noë 2004, Goldin-Meadow and Beilock 2010) offers an avenue of challenging this notion by also including actions as constituting perception, and that notion works particularly well in describing temporal perception in music. It also aligns with the recurring idea put forth in this dissertation that navigating periodicity begins with real actions that eventually become "internalized" (as opposed to some "internal" processor which is somehow prior to, and facilitates, the actions). As long as actions may constitute perception, active strategies (e.g. automating foot stamps, *tala* gestures) can too. By discussing active, gestural strategies that symbolically encode and off-load metric information, I hope to add a sense of what we can literally *do* to make notions "embodied cognition" and "active perception"—which are often presented metaphorically in music theory—more concrete.

Other resources and strategies for tracking periodicity—extensive specific practice yielding a memory of the piece, score-like knowledge, abstract calculations, and other symbolic indicators—also constitute forms of temporal knowledge, but they fail to fit the notion of perception. And they do so in different ways. One difficulty in subsuming all these possibilities under a broad concept of perception is the "indirectness" of the strategies. For example, akin to *reading* the word "egg" in the opening example, the ascending fourth C# F# *signifies* the end of

the song form to the Jean-Michel Pilc Trio's interpretation of "Giant Steps" discussed previously (example 2.1). And the three staccato hits *signify* the fourth measure of the bridge in Ari Hoenig's interpretation of "Anthropology" (example 3.22). In these cases, information about temporal cycles of a musical object is transmitted, without actually being a patterned cycle. The signifiers do not need to be periodic themselves to provide that information so long as *when they do occur*, they occur in their significant location. That might be a roundabout way of getting at temporal structure. On the other hand, the information is part of the musical sound object, making it more perceptual than other options.

When looking to a conductor or seeing someone else's *tala* hand gestures, the same sort of signifiers are transmitted through a medium other than sound (in this case, *visually* through gestures). Literally looking for information would constitute a problem for the approach found in London's early work (2009) in which listening to music's primary medium (sound) was a requirement for perception. His more recent work, on the other hand, explores music perception without limiting stimuli to sounds.[52] If we allow perception to involve *any* form of sensory information—and I think we should—another sort of indirectness remains at issue, in addition to the fact that information is presented symbolically. Do those gestures constitute a part of the musical object? And, does that really matter? In other words, does it count as perception if the information comes from a source other than the percept? In Western contexts, we might not want to include the conductor's gestures as a part of the musical object. In South Indian music the gestures seem more easily subsumed as part of "the piece." Either way, to exclude resources from "perception" on this basis still seems rather arbitrary. Better perhaps, would be to expand

[52] London et al 2016 explores the way visual stimuli of a dancer affect judgements of music, for example.

the notion of the piece based on resources which come into play. If seeing a conductor's gestures helps, then it should constitute part of "the music."

The idea that we come to know something about a temporal object's structure through scores and abstract calculations is the most difficult to subsume within a category of "meter perception," and I advocate against doing so. Even if we expand the notion of music beyond sound and open modalities through which perception occurs, this knowledge is abstract and static. It is, however, useful knowledge which is actionable in time, and perhaps it is best to describe it as just that: useful knowledge. Constructing a category for knowledge (or "knowing") might be the best way to expand discussion without inflating perception beyond its meaningful capacity. I would like to lay out a conceptual landscape in which temporal *knowledge* forms the broadest category with no stipulation other than usefulness. Various modes of perception form a subset of that knowledge, but I remain unsure of where to draw the line around what constitutes perception. I am also unsure, if doing so is very productive. After all, excessive focus upon conceptual bounds may translate to restrictions or the sort outlined in the first chapter of this dissertation.

Another reason why the expanded set of temporal resources might not sit very well in "perceptual" terms—or, conversely why a perceptual starting point obfuscates those resources' existence—is the performer's perspective I often invoke. Perception generally involves a perceiver and some external percept. *Performers*, by contrast, do not have such a simple separation from the object. They do not simply discern properties of their musical objects. They *create* them! However, I would like to argue that, just as performers are often listeners, so too can listeners be performative. For example, in Meredith Monk's "Panda Chant II" I described strategies a performer could use in order to coordinate stamps, claps, and vocalizations. I avoided

the listener's perspective, because it does not require following both the notated 6/8 and 11/8 with the same urgency as the performer's perspective does. Yet the performer's strategies remain available to listeners. If you want to follow "Panda Chant II," it may help to have extensive practice automating the foot stamps and to actually do them along with the piece as it occurs. This does not constitute listening in any conventional sense, but listeners need not limit themselves to only listening! To be a resourceful listener means employing modes of perception beyond the listening-and-attending paradigm. It means seeing and moving and abstractly calculating.

How should future research continue with the paradigm of metrically-modulated "attention" for navigating periodicity? Instances of metric multi-tasking highlight some awkwardness in "attentional" theory. If we have only one "attention" for periodic events, what do we do with instances in which actions outline an additional temporal hierarchy for which attention is not available? When do periodic physical actions such as tapping reflect "attending," and when do they not? And, can we have periodic actions which substitute for peaks in attention? By considering many possible temporal resources and strategies, the concept of "attention" is likely more difficult to pin down now than at the outset of this project. I have been admittedly loose with "attention" throughout, using it in both the colloquial sense and its psychological definition involving periodic peaks in expectation. I could attempt more precision in using the term—or attempt to avoid the concept entirely—but perhaps being a bit loose and disorganized with "attention" is a move in the right direction. Attention is messy and constitutes substantially different sorts of awareness.

In this project, I described trends and attempted in order to break free of them. I did this by focusing on multi-modal active experiences and experiential possibilities rather than existing

norms. I also linked notions of embodied cognition to real actions in an attempt to make those ideas concrete and executable, rather than metaphorical. Because this project is about possibility, I hope readers take away new ideas for approaching music, including the freedom to *look* for information, to physically *act* with music. It is important not to let "cognitive limits" stifle potential. We must realize that those very limits are only limits given a specific context and a particular strategy. And I hope the analyses presented here provide reason enough to seek out those extra strategies and more.

Active strategies may also help artificially construct hearings of music. If a writer proposes that a piece should be heard "in 3"—and I had not been approaching that way already—counting "1, 2, 3" and tapping associated downbeats help the desired hearing. In other cases, a downbeat (for example) may be difficult to hear, because it lacks any associated sound. To help emphasize it, we can create an event in our body by swaying or tapping. Feeling that structure *begins* with the actions in order to manipulate how it is experienced.

One attractive avenue for future research could be to explore active perception, symbolic encoding, and abstract calculations as strategies applicable for dealing with pitch. When I first hear a note, I generally do not have an immediate idea of its pitch, because I do not have absolute pitch. However, I learn something by singing it (by embodying it). I *feel* generally where it fits in my range by the degree of tension in my chest and throat. I know theoretically where the limits of my range are. I can sing up or down to find how close the pitch is to those limits. I am not particularly good at this, but I get better the more I have been singing. More capable singers are much better at this. The point is that actively embodying a note provides information, and practice improves the quality of that information.

Expanded theoretical resources are also productive in dealing with melodic-harmonic

material. I recall as an undergraduate, I excelled at part-writing exercises yet struggled with ear training and dictation exercises. (I would argue that this related to my trouble singing. Since I struggled to *do* it—by singing—I struggled to not *hear* it.) One of the most difficult tasks I was given involved taking down a passage in four-part harmony. At the time, I could hear the melody rather well, but could not "hear" the inner voices. However, I often succeeded at correctly notating them, by knowing that the part-writing followed established norms of Western common practice. With only a few clues, such as the spacing of a starting and ending chord, or hearing a close vs. open position, I could make educated guesses about those voices. It is difficult to say whether that should constitute hearing and perception, but I want to make room for this (abstract theoretical) strategy to be legitimate. Consider another case. A pianist plays something, but there is an unusual interval which is hard to place. Or, perhaps you want to identify the tonic pitch-class. Presuming you don't have perfect pitch, literally looking at which keys were depressed can help. If you know the relation of piano keys to the sounds they usually produce, *seeing* which keys constitutes a symbolic resource.

Incorporating these expanded techniques and resources for temporal periodicity into psychological experiments may be challenging. It requires finding participants who are professional musicians, giving them access to scores, and providing long-term specific practice with stimulus and task. Finding virtuosic professional musicians as participants is more difficult than using a class of undergraduates. And engaging those professionals in a long endeavor requiring specific practice is even tougher. It is also very difficult to set up controls for an experiment which allows participants a full palette of strategies. I would also worry that running laboratory tests may simply come to the banal conclusion that the various resources and strategies discussed here improve performance. I think the more important information is what

sorts of resources and strategies help in temporal navigation, and that would be an experimental input. A more productive route should find new temporal resources and strategies as its *output*. Case studies involving individual the development of temporal strategies for difficult tasks will likely yield more intriguing results. Studying particular people, rather than groups, is also in keeping with the goals of this project, to seek out methods on the basis of usefulness rather than universality.

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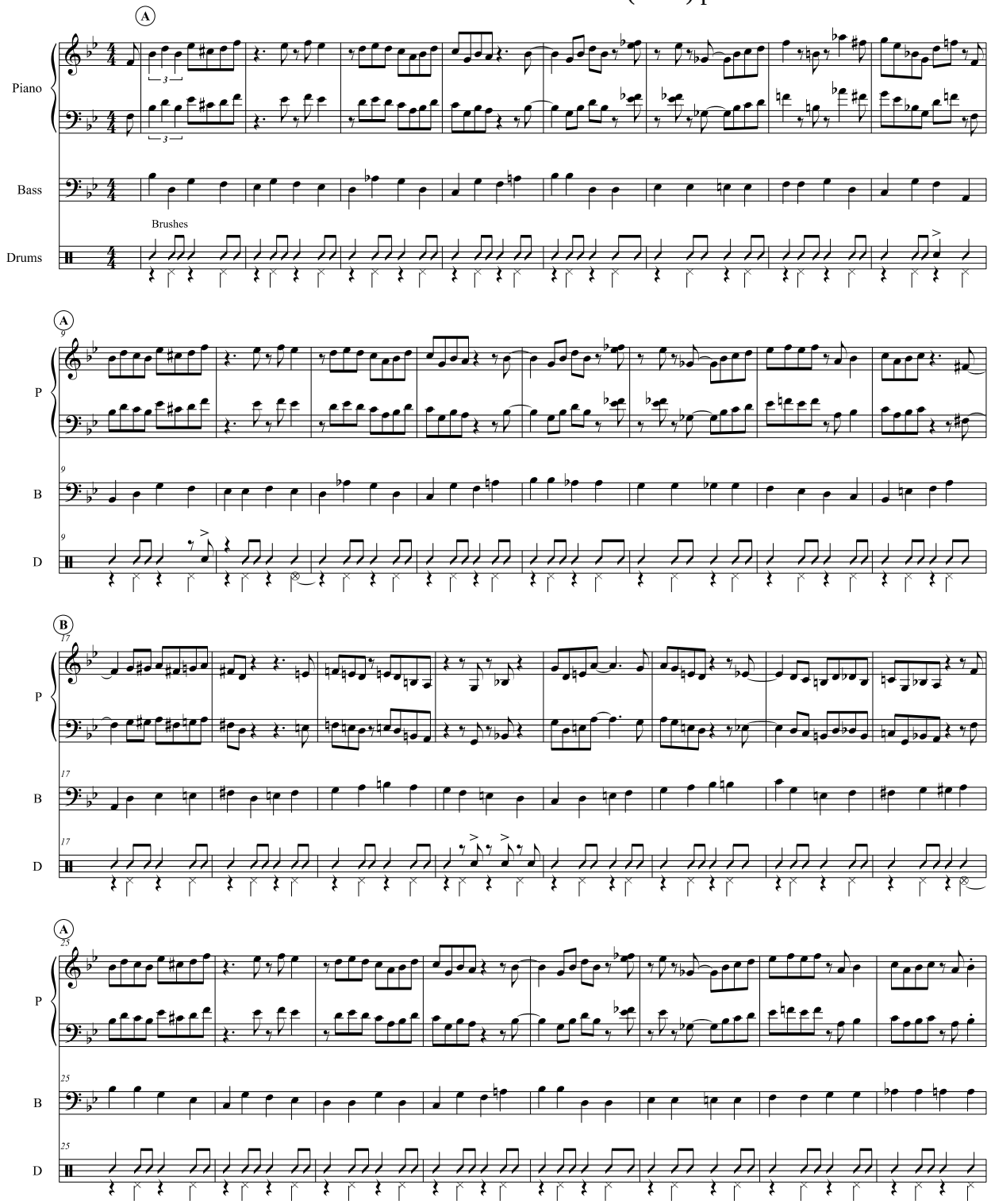
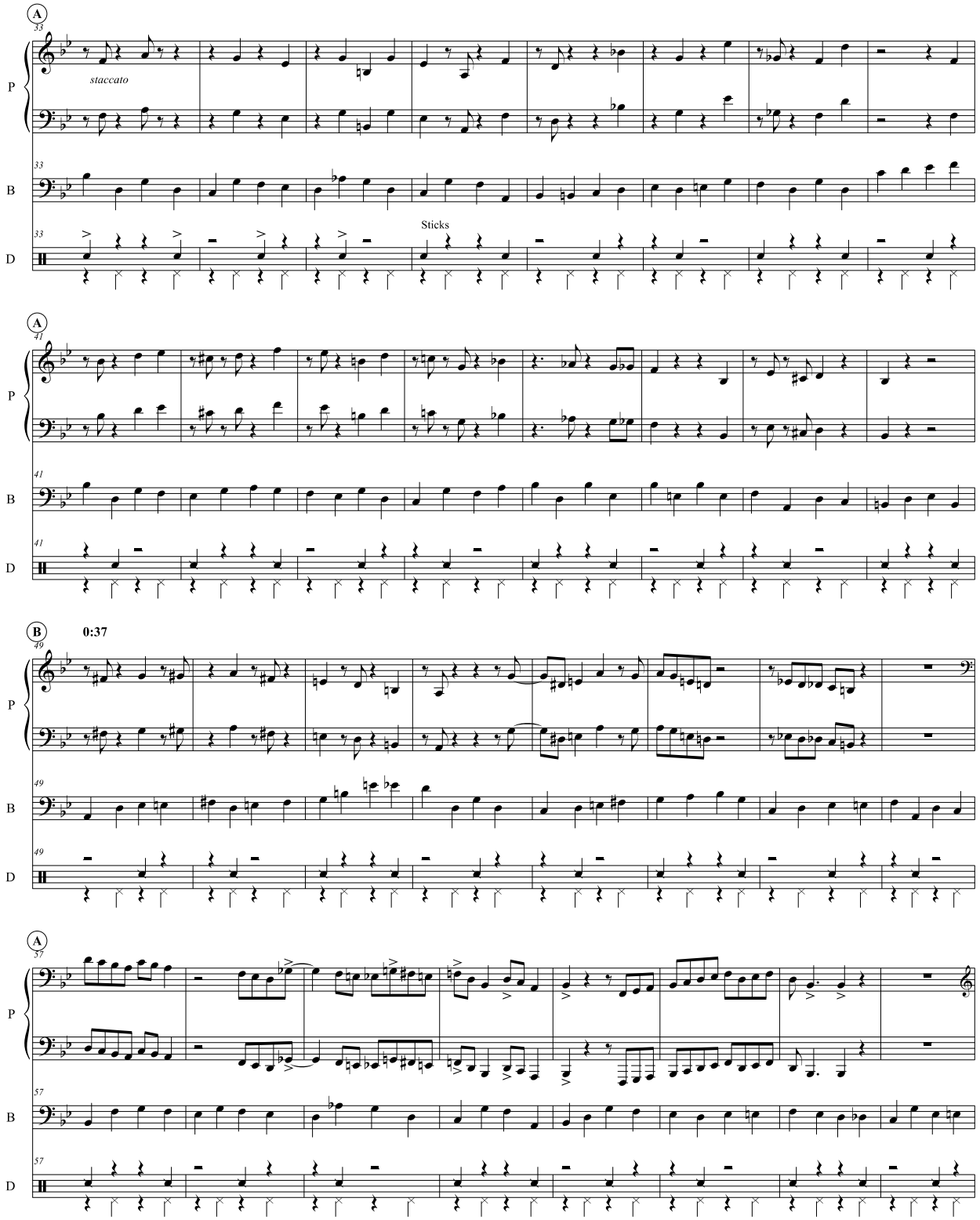
APPENDIX: TRANSCRIPTIONS

Mehldau and Rossy Trio, “Anthropology”
from the album *When I Fall in Love* (1993) p. 1



Mehldau and Rossy Trio, “Anthropology”
from the album *When I Fall in Love* (1993) p. 2



Mehldau and Rossy Trio, “Anthropology”
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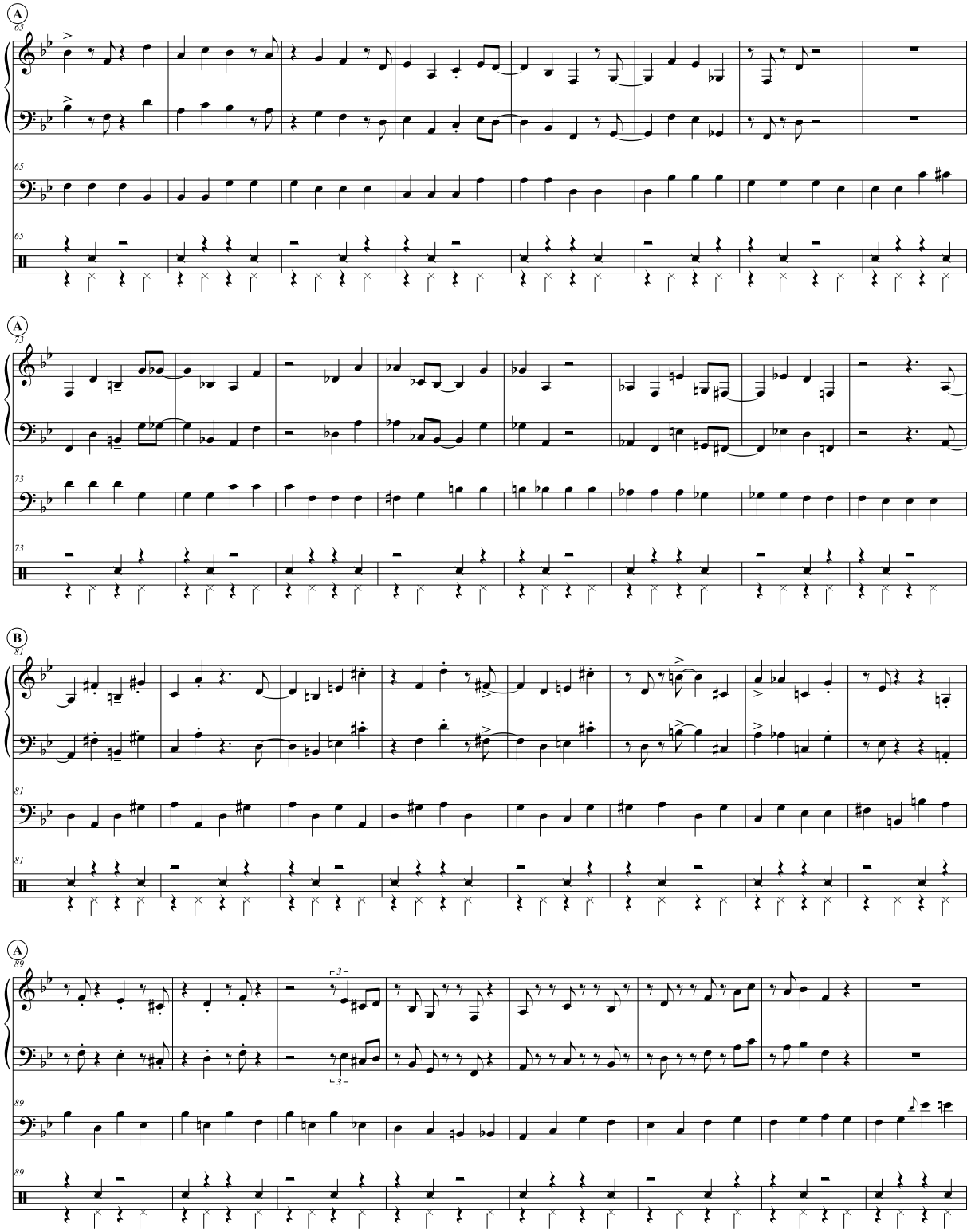

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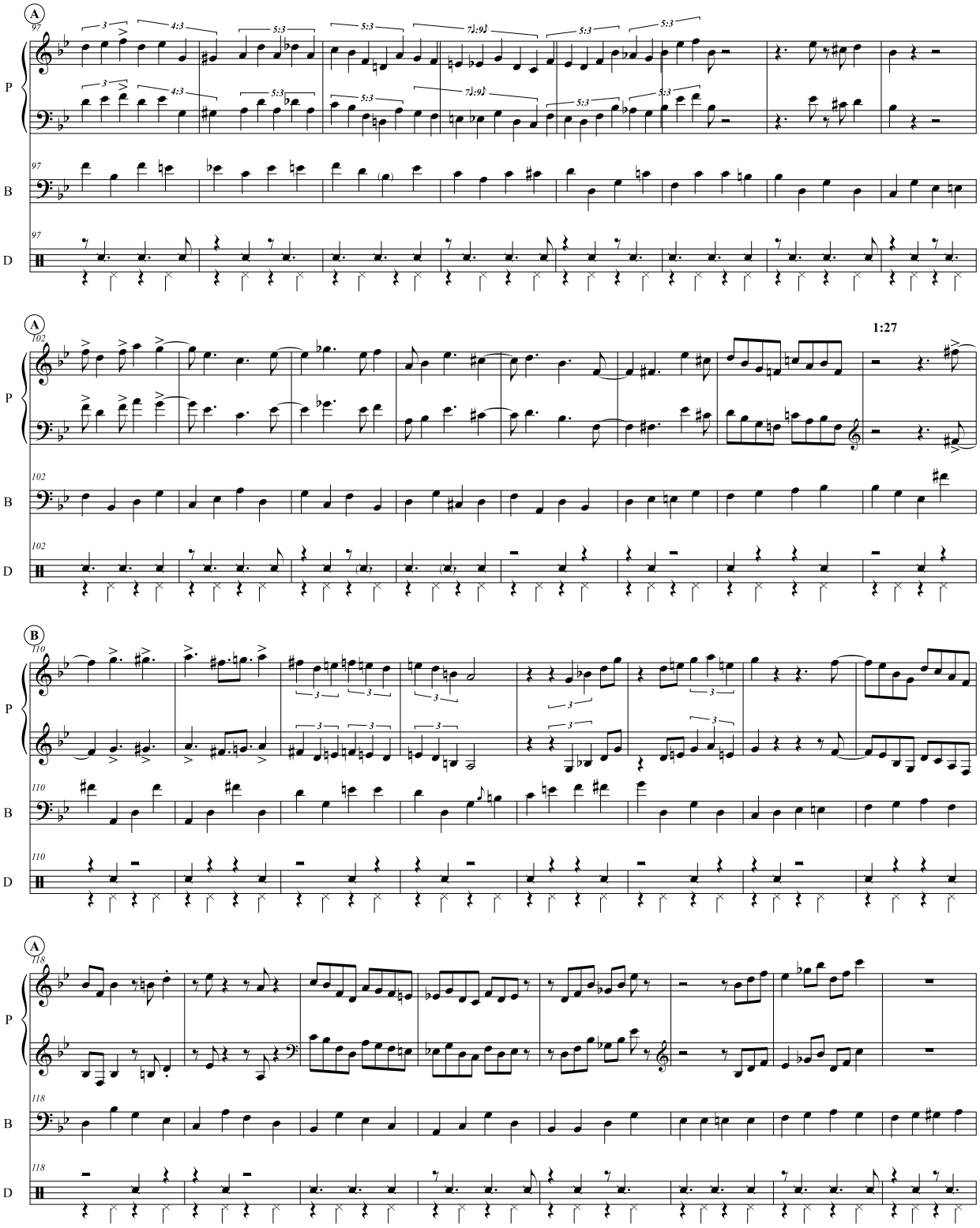
from the album *When I Fall in Love* (1993) p. 4



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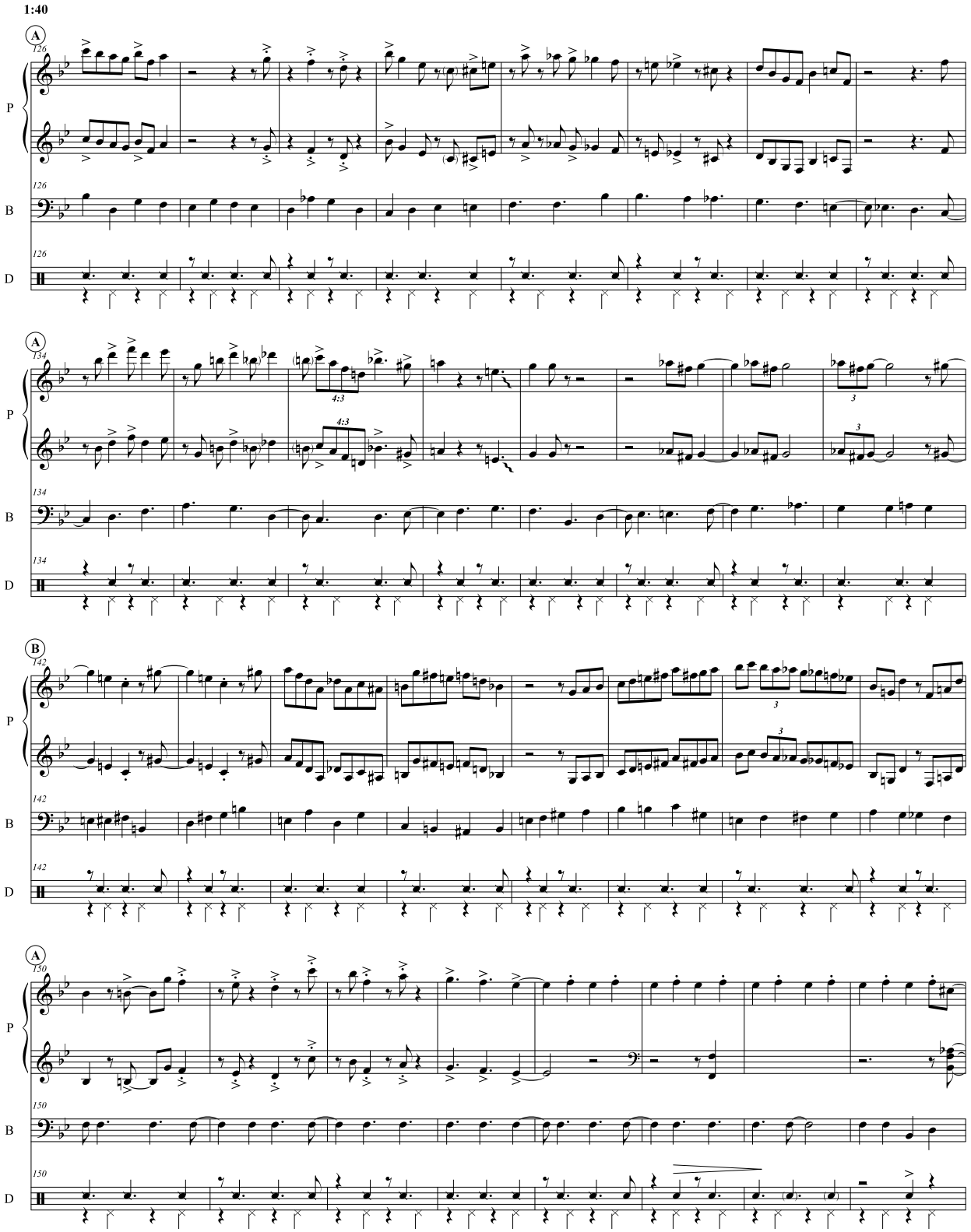
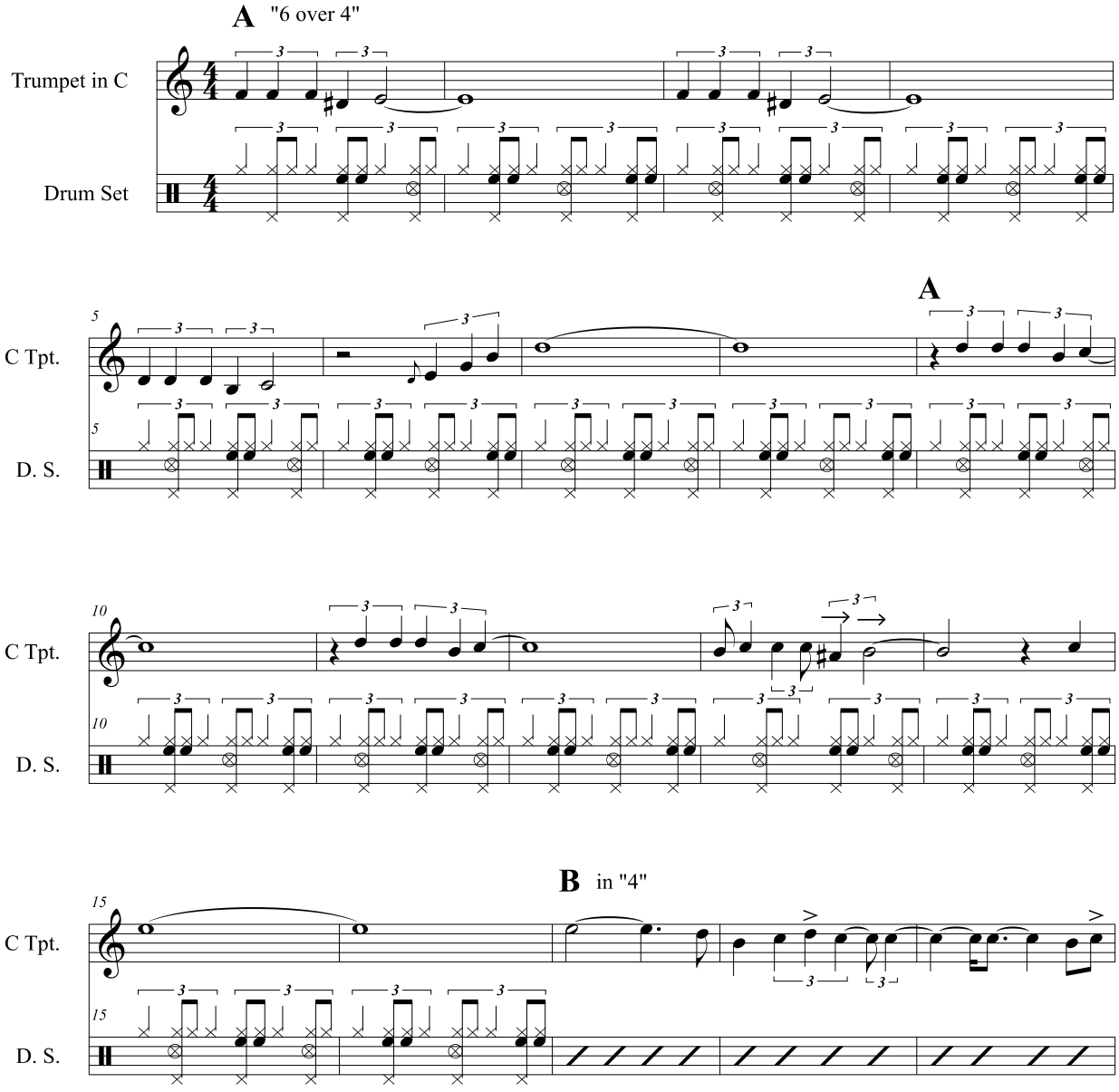
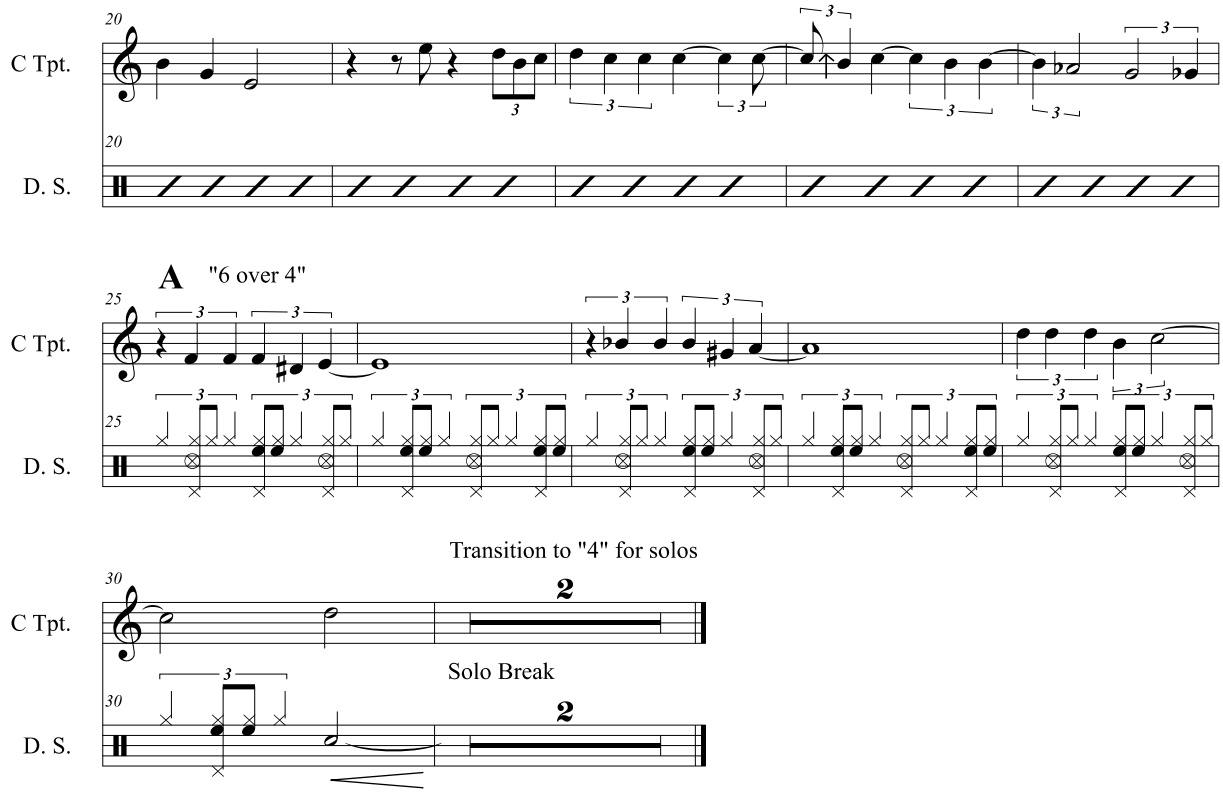
from the album *When I Fall in Love* (1993) p. 5



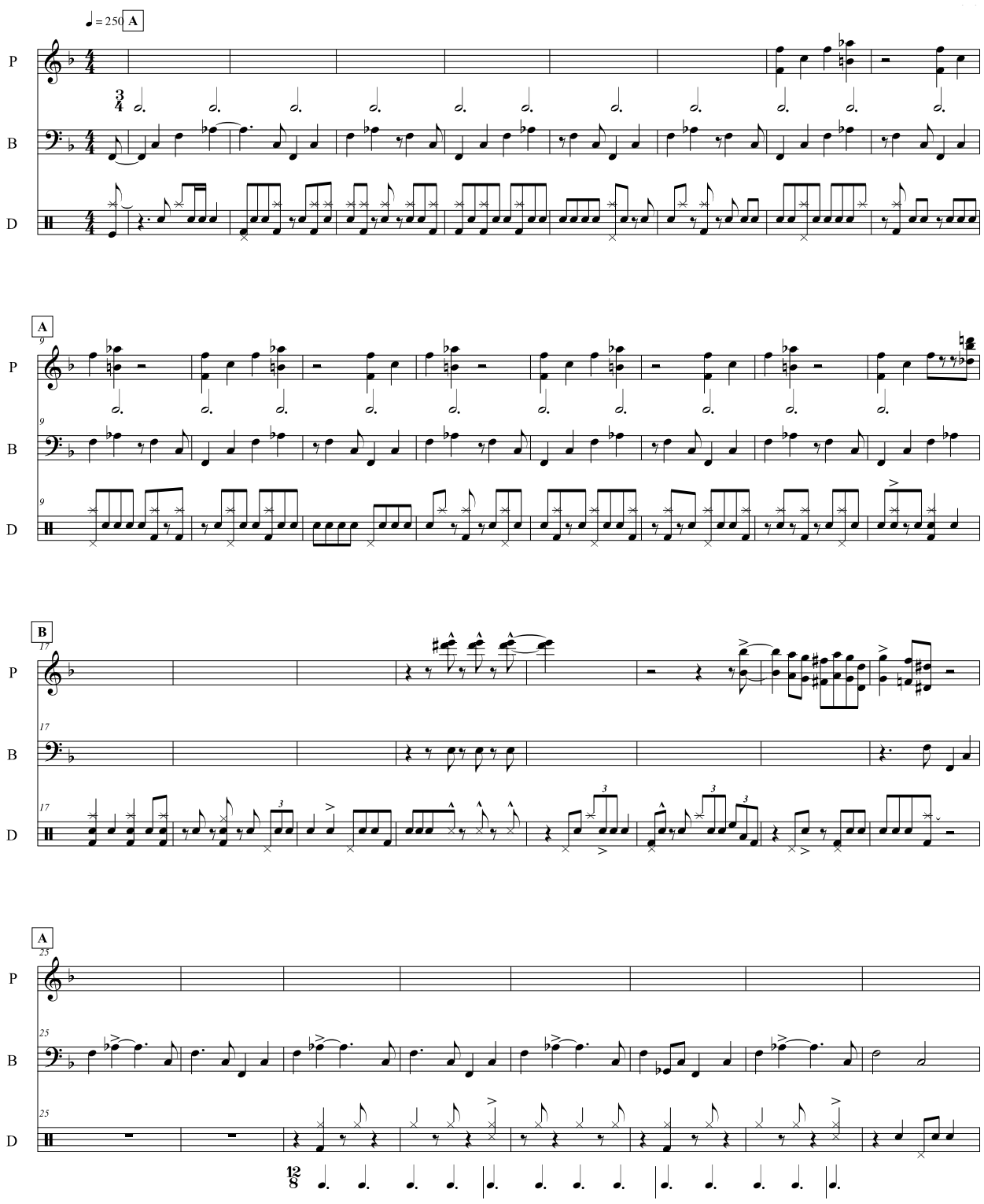
Wynton Marsalis and Jeff “Tain” Watts, “April in Paris”
From the album *Standard Time Vol. 1* (1986)
(not shown: Robert Hurst, bass, and Marcus Roberts, piano)
page 1



Wynton Marsalis and Jeff “Tain” Watts, “April in Paris”
From the album *Standard Time Vol. 1* (1986)
(not shown: Robert Hurst, bass, and Marcus Roberts, piano)
page 2



Ari Hoenig Trio "Anthropology" from the album *Inversations* (2006) p. 1



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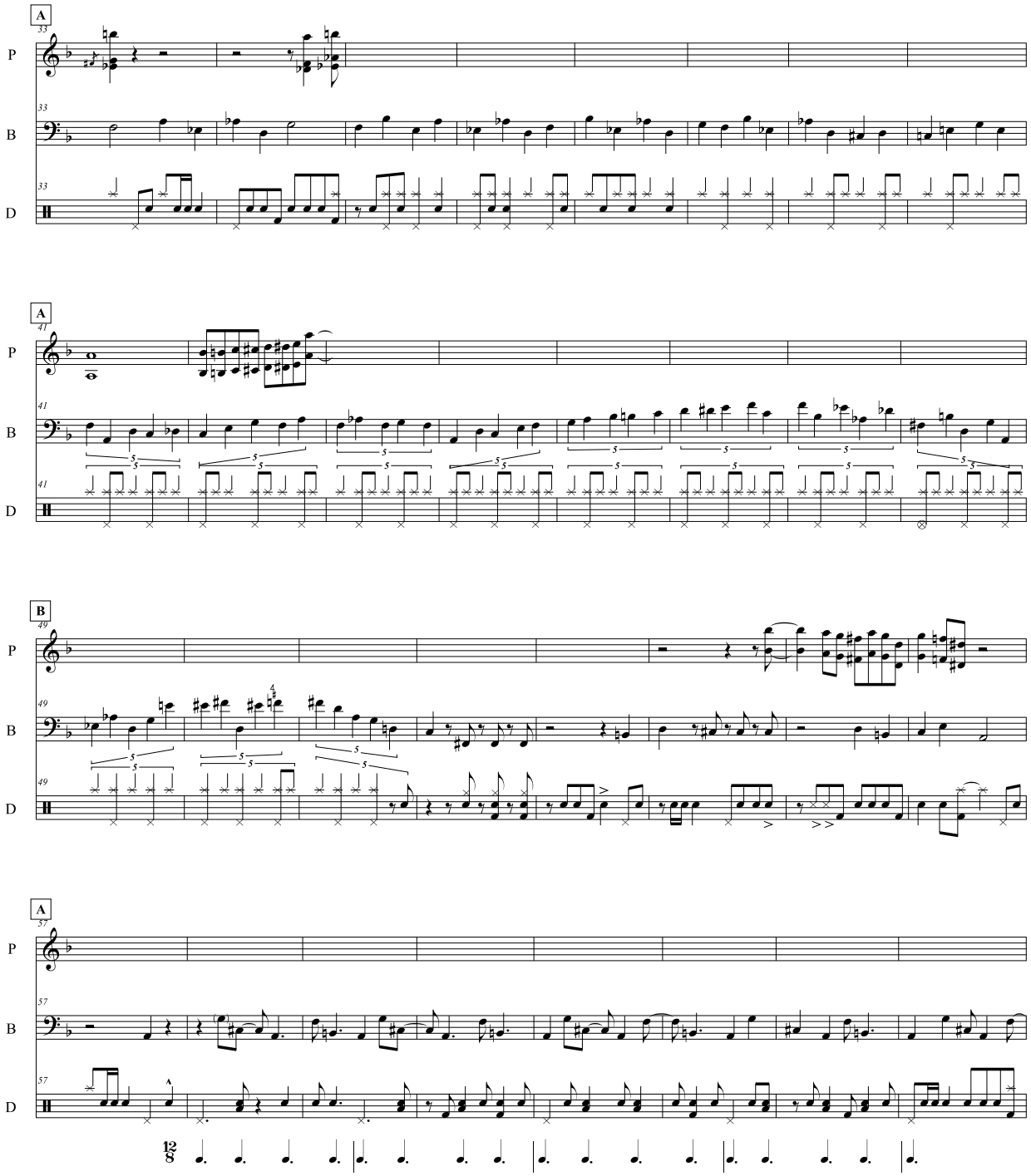

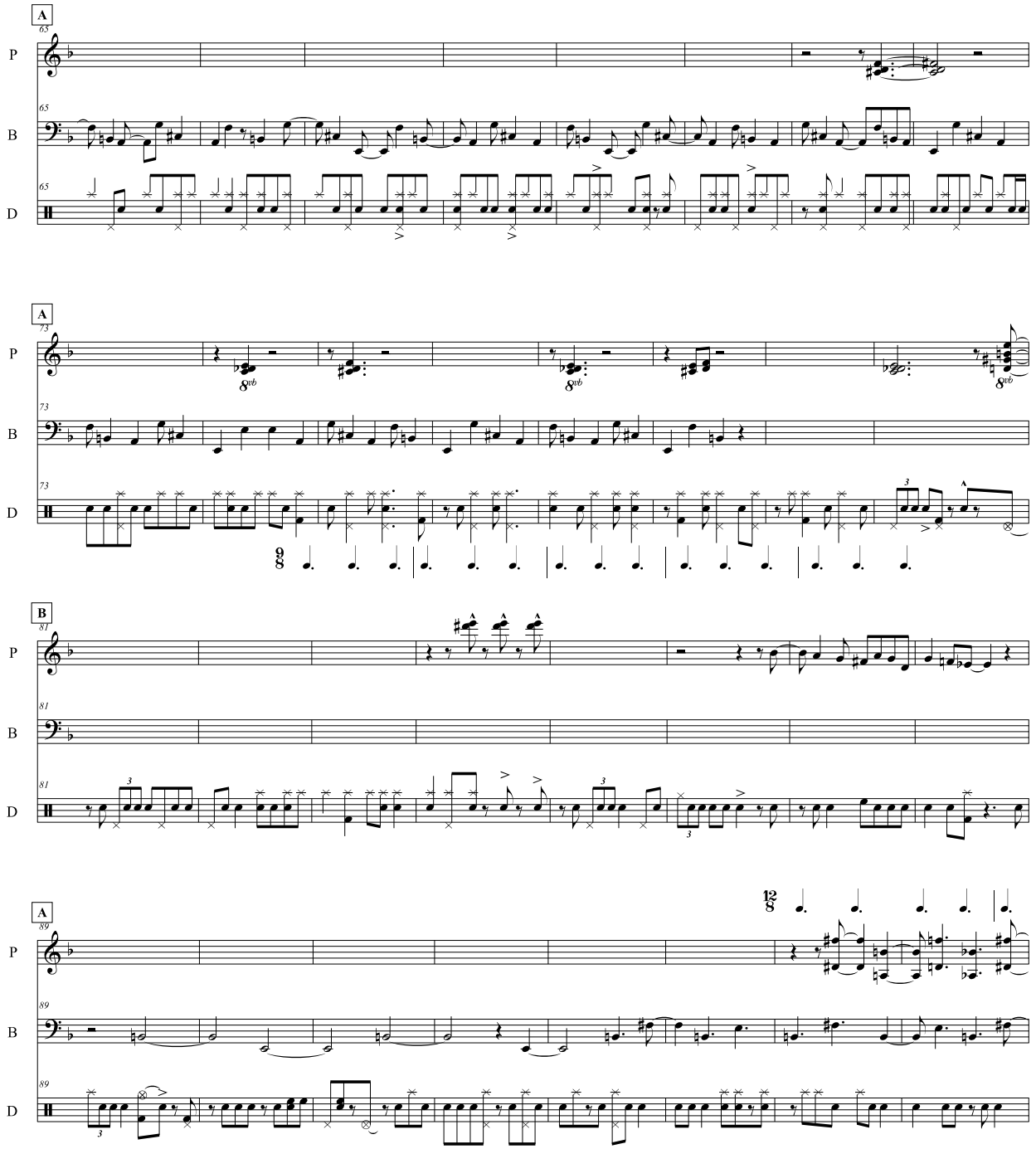
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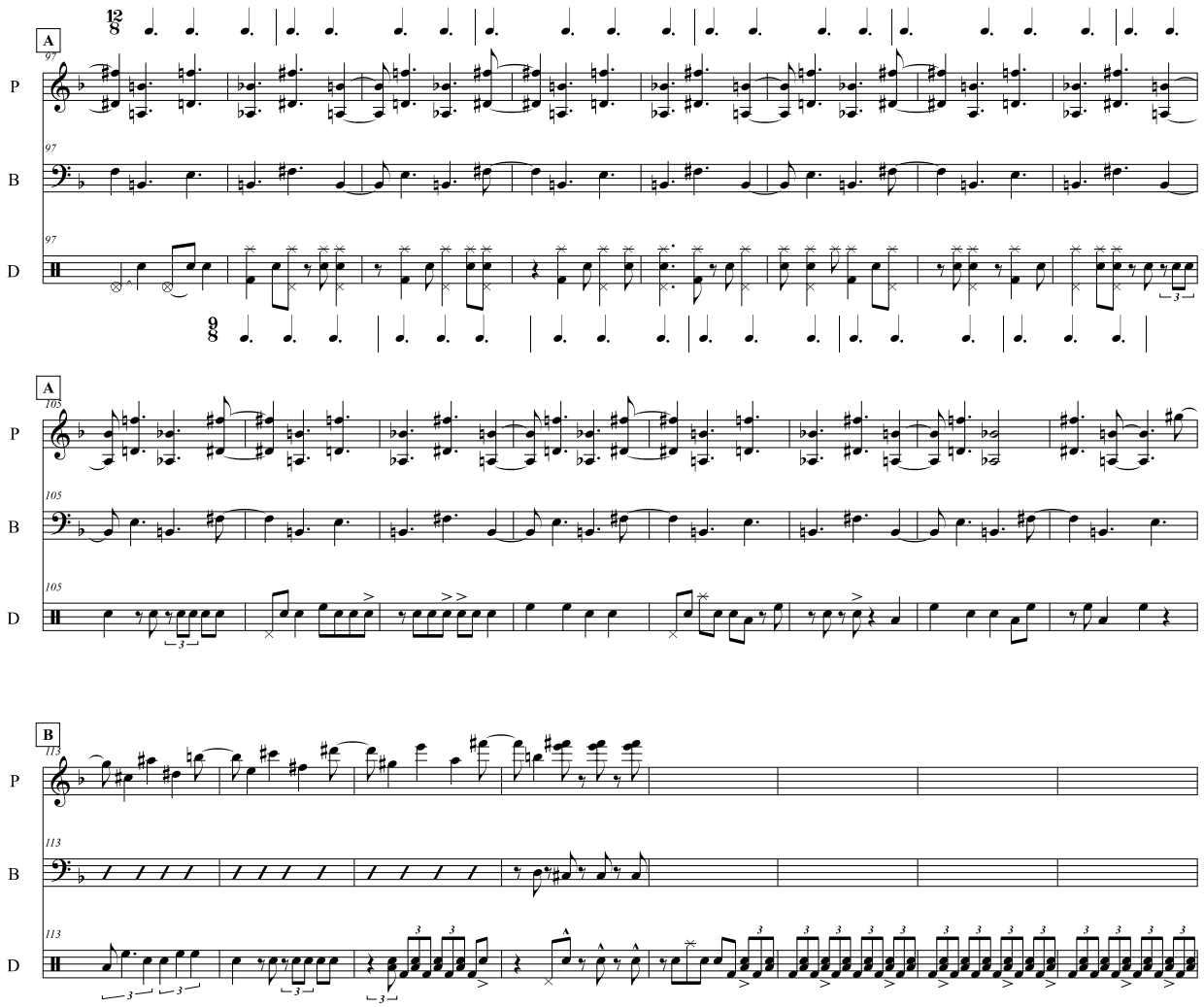
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Jean-Michel Pilc Trio “So What” from the album *Welcome Home* (2002)