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A Review of David Epstein's *Shaping Time: Music, the Brain, and Performance* (New York: Schirmer Books, 1995, 598 pp., $47.00. ISBN 0-02-873320-7)*

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This massive volume is the result of 15 years of theoretical thought, performance experience, and scientific study following the publication of the author's earlier book, *Beyond Orpheus* (Epstein, 1979), where some of the groundwork was laid. Epstein is a conductor and composer as well as professor of music at MIT, and his experience as a musician informs his approach to theoretical issues (and vice versa). As he says in the foreword, he has "long seen performance as the ultimate proving ground of musical verities" (p. xvi). To this fruitful interpenetration of theory and practice Epstein has now added a strong interest in the psychological and neurophysiological underpinnings of music performance, developed during several extended visits to research institutes in Germany. This interest has led him not only to peruse an impressive amount of relevant scientific literature but even to engage in some empirical research of his own. This rare confluence of musicianship, theoretical acumen, and hard science gives the book its unique flavor.

Shaping Time is divided into five parts containing 14 chapters ranging in length from 2 to 165 pages, followed by 83 (!) pages of notes, a bibliography, and an index. The introductory first part, entitled Time, *Motion, and Proportion,* defines some basic concepts and reveals the motivation behind Epstein's investigations. Epstein sees time as "*the* critical element in performance" (p. 3) and believes that shortcomings of performances are often temporal in nature. He says that "judgments about...the way a piece must move...demand extensive experience with the music" (p. 5) and refers to his own performance experience as a source of relevant insights. His theoretical and empirical approach to musical time thus can be seen to arise from a desire not only to communicate his experience to others but also to rationalize and systematize his musical intuitions. There is a certain danger of circularity in this enterprise: If Epstein's theoretical ideas have invaded his intuitions over the years, as they probably have, the latter cannot provide a neutral testing ground for the former.

For Epstein, the central concept in musical time is *motion*, which is the temporal unfolding of a musical structure, accompanied by an "internal sense of motion...a fact widely experienced and confirmed" (p. 487). Epstein discusses quantitative and qualitative (experiential, affective) aspects of musical motion and explains how it is controlled by hierarchic periodicities. He contrasts meter and rhythm, which give structural support, with tempo and its modulations, which pace the motion. Epstein's goal is to understand the *mechanisms* that govern musical motion, in contrast to many earlier authors who have dealt with this concept in a less rigorous or incomplete fashion. In the introductory chapter he provides some glimpses of things to come—a music example, a brief reference to *rubato*—and concludes with a disclaimer that seems appropriate and yet frustrating for the empirically oriented music scientist: "Replication and repeatability are not even desirable, much less applicable. Nothing would bore us faster than a musical system consistently and predictably used in exactly the same way, down to the smallest

detail" (p. 17). In other words, it will not be easy to test theories in a rigorous and objective fashion.

Part Two, *Rhythm, Meter, and Motion,* consists of a theoretical chapter that fleshes out some of the concepts mentioned in Part One, followed by a discussion of music examples. The theoretical chapter is entitled *Thoughts for an Ongoing Dialogue.* The partners in this dialogue seem to be mainly other music theorists. To this (psychologist) reader, at least, this part of the book seems relatively conventional and uncontroversial. Epstein distinguishes between chronometric time (meter) and integral or experienced time (rhythm), both of which he sees as parallel, periodic, segmented, hierarchically organized processes whose varying phase relationship creates conflicts in need of resolution, a cyclic process that propels music forward in time. The units of meter are beat, measure, and hypermeasure; those of rhythm are pulse, motive, and phrase. Accent, or structural prominence, is distinguished from stress, or surface prominence. Importantly, motion is described as "the ultimate goal of musical structure, possibly the ultimate goal of music" (p. 26). This is surely one of the topics of the dialogue referred to in the title of the chapter, addressed to those theorists who tend to survey musical structure by eye rather than by ear. Epstein's focus on the temporality of music provides a much-needed counterweight to the abstract analytic discourse that has dominated music theory for decades. By investing musical structures with communicative function through motion, Epstein reinstates performer and listener as essential participants in the musical transaction—one as the controller of motion, the other as its resonator and evaluator.

Epstein provides an apt analogy to structurally guided musical motion (leaving out the performer for the time being) in the form of a roller coaster. The various factors that control its motion—gravity, friction, the slopes of the tracks—need to be in balance, so that the car neither overshoots nor stops short of its final goal. Musical structures need to be similarly balanced in order to result in motion that is goal-directed and terminates smoothly at major structural boundaries. (At the end of the following chapter, Epstein presents an interesting example of a composition—a section of Scriabin's Piano Concerto—in which this balance seems to be absent.) The dualities of beat and pulse, measure and motive, and hypermeasure and phrase are discussed further in considerable detail. Epstein then expands on some broader issues arising from the preceding discussion, including the parallel processing of meter and rhythm, the role of stylistic experience in the perception of meter, and rhythmic ambiguity. At one point he criticizes psychological studies of meter induction because they ignore listeners' pre-experimental experience with musical conventions such as dance rhythms. His point is well taken, but his musical example (2.11, p. 44) rather seems to illustrate that notation (placement of bar lines) and/or the corresponding surface accentuation in performance can determine metrical interpretation, which few would want to dispute.

Epstein further makes the illuminating observation that ambiguity, far from being a problem, makes music interesting by allowing multiple interpretations. He credits Mozart with an especially high "ambiguity quotient" and cites the opening measures of the A-major Sonata, K. 331, as a well-known example. At one point he states that "[a]mbiguity of perception demands decision" (p. 51). This may be true only at the level of conscious analysis, however. In this reviewer's opinion, performers often make decisions for the listener by providing disambiguating surface cues (articulation, accents, agogics), but they can also refrain from resolving ambiguities, if they so choose. Listeners in turn may be unaware of ambiguities unless they are asked to reflect upon what they have heard. In other words, ambiguity resolution may be cognitive rather than perceptual. This chapter concludes with a discussion of phrase prefixes and extensions as devices for anticipating and prolonging the characteristic motion of a phrase.

The following chapter, as already indicated, provides a number of very instructive music examples that illustrate the concepts reviewed earlier. For example, Epstein points out how exaggeration of surface articulations (such as *crescendi* or *sforzandi*) can distort the flow of the music and change its character. By being overemphasized, such "nonstructural" articulations can "begin to feel like structural emphases" (p. 64). Other examples illustrate large-scale harmonic motion in Dvorák's music and compositionally controlled motion in Brahms's scores, among other things.

Part Three, *Tempo,* constitutes the core of the book. Here Epstein presents and justifies his theory of proportional tempo, familiar from his earlier publications and from various historical precedents, which are summarized briefly in the first chapter. The theory claims that most (all?) music—of the Classical and Romantic periods, at least—is structurally designed so that the tempos of successive movements or sections seem most appropriate when they are related by simple integer ratios, such as 1:1, 1:2, 2:3, or 3:4. The simple phase relationships between the periodicities underlying the tempos are said to give coherence to a multi-movement work. The reason why they do so, Epstein says, lies in human neurobiology.

Epstein elaborates on these biological bases in the following chapter. Here he discusses scientific evidence for oscillatory mechanisms in the brain, often drawing on the work of German researchers he has been in contact with. Much interesting literature on biological clocks and time perception is reviewed (often in extensive footnotes), but it all comes down to three crucial claims: (1) Musical behavior is subject to biological constraints, among which periodic oscillatory processes are especially important. (2) Multiple biological oscillators are drawn towards phase synchrony. (3) Phase synchrony is perceived as pleasant, whereas a disturbance of phase synchrony creates tension and displeasure. The first of these claims is hardly controversial if it is interpreted as meaning that humans can only do what they are biologically equipped to do. It is more debatable if it is interpreted as implying that humans will do only what seems easiest or most natural—a minimum effort principle applied to art. It seems to this reviewer that, in the realm of art, much training is devoted to overcoming certain natural proclivities. If phase synchrony were the overriding principle governing musical timing, then the tempos of most performances would be mechanically exact and in proportion. However, musical tempo choices are much more variable, as Epstein is well aware; thus there must be opposing tendencies or considerations that lead performers to deviate from proportionality and phase synchrony. Tension in music is often more pleasant or at least more interesting than resolution, and both composers and performers often delay resolution by prolonging tension. One is led to wonder whether a violation of tempo proportionality may not also create pleasurable tension or desirable contrast between movements. Although such a tension would be without resolution (and this may be the reason why Epstein does not consider it), it presumably would dissipate quickly as the performer or listener adapts to a new tempo.

Actually, it is not certain that deviations from tempo proportionality can generate tension at all. Epstein's theory rests on certain assumptions that can and should be tested experimentally. In order for phase relationship to play a role, two or more oscillators must be active simultaneously. However, it is doubtful whether listeners can (and want to) maintain a regular beat through a final *ritardando* and the pause that typically follows the end of a symphonic movement until the beginning of the next movement, and it is not known how accurate they would be in judging deviations from tempo proportionality under these conditions, especially for ratios other than 1:1. Collier and Collier (1994) found that jazz musicians, whose tempo sensitivity surely is at least equal to that of their classical colleagues, often deviate markedly from tempos intended to be in 1:2 relationship.

Another empirically testable implication of Epstein's theory is that, if an oscillatory process entrained to an ongoing tempo can indeed be maintained through a *ritardando* and a following pause, it should matter when exactly the next movement starts: Performers should want to start in phase with the ongoing oscillatory period, and listeners should prefer such an in-phase start to an out-of-phase start. However, this seems rather implausible: It could hardly make a difference whether the second movement of a symphony starts a fraction of a second earlier or later after a 20-second silence has elapsed. If so, this would imply that phase relationships are really unimportant and that tempo proportionality, if any, is based on *tempo memory*, a concept Epstein mentions only briefly in a later chapter (p. 412). Indeed, Ivry and Hazeltine (1995) found in a recent psychophysical study that interval duration discrimination is not diminished when the comparison interval is presented out of phase with the periodicity defined by a series of standard intervals, which led them to conclude that "timing is interval based rather than beat based" (p. 17). Memory for temporal intervals explains musicians' ability to reproduce the tempo of an earlier performance, and it may just as well operate across breaks between movements (and even

within movements) within the same performance. However, unlike the phase relationship of simultaneous oscillators, tempo memory does not offer any strong reason for why simple tempo ratios should be preferred by performers or listeners. Such a preference may be a matter of personal aesthetic choice, and Epstein seems to grant this (p. 155).

Even so, if Epstein is right about the neurobiological underpinnings and the coherence-lending function of proportional tempo, then most professional musicians should observe the principle, intuitively or deliberately. Therefore, it would be of great interest to examine the tempo choices of famous conductors, chamber ensembles, and soloists, which provide ample and easily obtainable data bearing on the theory of tempo proportionality. In his next chapter, Epstein indeed prepares the reader for such an investigation by discussing methods of empirical tempo measurement. This section is not quite state-of-the-art, as digital waveform editors, now widely available on microcomputers, are mentioned only in passing. Instead, Epstein describes a cumbersome and antiquated method of magnetic tape measurement which he used in his own studies. In order to arrive at a reasonable estimate of the region of uncertainty around observed tempo ratios (or ratios of average beat durations, his preferred measure), Epstein discusses the psychophysical temporal-order threshold (though its relevance is doubtful) and Weber's law. Based on psychophysical findings, he takes the confidence limit to be +/-5%, which seems a reasonable choice. Still, it is important to keep in mind the relatively high probability of finding evidence for tempo proportionality. Epstein permits four simple ratios: 0.5, 0.67, 0.75, and 1.0. Their respective confidence ranges are 0.475–0.525, 0.6333–0.70, 0.7125–0.7875, and 0.95–1.05. The probability that any randomly chosen tempo ratio between 0.5 and 1.0 will support the proportionality theory is (0.025 + 0.0667 + 0.075 + 0.05)/0.5 = 0.43. It also may be noted that Epstein does not deal here with the problem that expressive tempo modulation raises for tempo measurement; he advocates averaging over a number of beats (a procedure for which there is only limited empirical support at present; see Repp, 1994), but in later analyses he often seems satisfied with tempo estimates based on single beat durations.

Primed by Epstein's methodological discussion, this reader was eager to confront the empirical evidence in the following massive chapter of musical examples. He was quite disappointed, therefore, to find that the chapter does not contain any hard data at all. The reason for this is given by Epstein in a footnote, some 30 pages into the chapter:

> It would be methodologically neat...to compile examples of recorded performances and to offer their tempos as proof of the proportional tempo argument advocated here. It would also be unrealistic; for different tempos abound in performances.... To select such an approach would leave us with the fruitless (and unprovable) argument of advocating performer *x* as a "true" advocate of the music, and damning performer *y* as [a] musical infidel.
>
> We have chosen a different approach. Recognizing that most of us probably have a generalized sense of appropriate tempos for this literature, gained in part from our experience of hearing these works, we have designated these tempos as "commonly heard" in examples where such tempos are discrepant from composers' metronome markings. This places the burden of tempo judgment where it properly lies—upon our intuitions, our musical perceptions, our experience with the music (pp. 528–529).

Epstein thus puts the empirical question aside and instead indulges himself in showcasing "our" (i.e., his) scholarship and musicianly insight. This he does brilliantly, and this reviewer, having overcome his initial shock, learned much from reading the chapter. For each of the many works discussed, Epstein provides either the composer's metronome markings or his own estimates of "commonly heard" tempos, or both. (Instead of tempos, he sometimes gives beat durations in milliseconds, but they are derived from the tempos, not actual measurements.) Of course, without empirical data it is impossible to know how accurate the tempo estimates are. For Epstein, tempo proportionality clearly is not just an abstract idea but a recipe for making the "right" tempo choices in order to achieve temporal unification of large works, and for all we know he may have followed this practice for many years. His own preferred tempos surely influence,

and perhaps constitute, what he considers to be "commonly heard". Thus it is perhaps not too surprising that example after example yields impressive support for the proportionality theory.

Yet, as Epstein well realizes, great artists often deviate from convention. Famous composers followed individual paths that broke the stylistic rules of their time in one way or another. From that perspective, it seems surprising that all should have followed the principle of (intended) tempo proportionality in all their works. Why did great composers not *deviate* from this tendency in creative ways? Perhaps the answer is that overall coherence was their overriding aesthetic goal. Can performances be perceived as coherent if they violate tempo proportionality? Epstein suggests a negative answer, but this is again an empirical issue, to the extent that coherence can be judged reliably at all. To some extent, the structural coherence of a composition must be independent of the temporal coherence of its performance. Perhaps temporal coherence can be perceived and judged only if one espouses tempo proportionality as an aesthetic goal. In that case, however, the argument would be circular.

Another issue that calls for empirical tests is Epstein's contention that "[i]t is by tempo that the underlying structural shape is heard such that its pacing recalls, indeed identifies, similar elements elsewhere in the work" (p. 172). Indeed, Handel (1993) has found that rhythmical patterns are more difficult to recognize when their tempo is changed. It is unclear, however, whether this is also true for melodic or harmonic patterns, especially when the tempo change is very slight but sufficient to violate proportionality, say from 1:1 to 7:8. Nor is it obvious that a listener must be able to recognize motivic relationships across movements of a symphony in order to appreciate a performance; this may hold only for "musicological listeners" (Cook, 1990) whose aesthetic appreciation rests on analytic insights.

Despite all these reservations, however, it must be said that Epstein's musical examples seem convincing, especially those in which sections having different tempos but containing related motives immediately follow each other. Certainly Epstein makes a strong case for proportional tempos as one possible and even valuable strategy in performing these works. However, it will take a professional music theorist or musician to critically examine the rich and detailed observations in this chapter, which for this reviewer provided mainly an enjoyable educational experience.

The concluding chapter of Part Three finally does contain some empirical data, though not from Western music. Here Epstein summarizes findings (already reported in earlier publications) on tempo changes in the music of non-Western peoples, which he measured from anthropologist's tapes during a research visit to the Max-Planck-Institut in Seewiesen, Germany. The data are reported in meticulous detail, so that readers can follow Epstein's calculations step by step and draw their own conclusions, if they wish. For example, one table and an accompanying graph present beat durations measured at various points during a ritual verbal exchange among Yamomami Indians, lasting some 36 minutes. The durations, apparently of single beats, were "measured by stopwatch, each at a point where a tempo change was detected" (p. 345). From the graph it seems that the tempo accelerated during the initial 18 minutes, though there are many irregularities in the function. From among these irregularities Epstein picked "plateaus" whose beat durations—lo and behold—turned out to be in simple proportional relationships. However, his criterion for what constitutes a plateau seems rather subjective. This reader sees plateaus (if any) in different places. Epstein also sees significance in the finding that an exponential curve fitted to the acceleration portion of the graph passes almost exactly through the chosen plateaus, though this could well have happened by chance. Moreover, the function does not fit the data very accurately; two straight line segments would have done just as well. Thus, while there is not enough space here to discuss every example in detail, it seems that considerable subjectivity was involved in Epstein's analyses of these ethnomusicological data. Even so, tempo proportionality was found in only about 80% of the cases examined. To account for the deviations, Epstein once again refers to the fact that humans are not machines. Returning to Western classical music at the close of the chapter, he points out, however, that "some of us are more gifted than others" (p. 362) in executing precise (proportional) tempo changes. Are these gifted individuals then more machine-like than less gifted ones?

There is indeed a paradox in Epstein's suggestion that the most sophisticated musicians are the ones whose musical behavior is (or should be) governed most strongly by elementary neurobiological principles, whereas the "less gifted" may deviate. Since elementary principles surely must govern elementary behavior, Epstein creates here a "Paradise Lost and Regained" scenario, whereby the experienced musician recovers through insight and conscious effort the innocent perfection he or she has lost along the path of musical training. Why and how that loss has occurred is not clear, however. If biological principles govern music performance, they should govern the activities of all performers, regardless of experience. In fact, the "less gifted" should be more constrained by their innate equipment. By voluntarily submitting to the putative control of biological mechanisms, the "gifted" musician gives up some degrees of artistic freedom. On the other hand, if the neurobiological mechanisms Epstein is envisioning are not innate but are assembled as a function of growing musical experience, then they become merely a scientific (and mechanistic!) metaphor for that experience—the "gift" of neurobiology.

The lost freedom in global tempo choice may be compensated for by exploiting tempo flexibility, which is the topic of Part Four of *Shaping Time*. This is the most empirical part of the book. In an introductory mini-chapter, Epstein announces his strategy: He is going to investigate tempo modulation in selected performances by great artists "that have appeared excellent to one experienced musician's intuitions" (p. 368). This seems a reasonable strategy, assuming that his judgment of excellence was made auditorily, in advance of any measurements. Even so, however, he may have been listening for the very properties that his measurements were expected to confirm, and in that case there is again a certain degree of circularity in the enterprise. A more objective strategy would have been to select a sample of performances at random, measure them, and then have several experienced listeners evaluate the quality of the rubato, to see whether their quality ratings correlate with certain objectively measured properties. But such a larger study was perhaps beyond Epstein's reach at this point, and he appropriately describes his observations as pilot studies. It is interesting to note that his qualms regarding the empirical analysis of artists' tempo choices (see quotation above) did not extend to the analysis of tempo modulation.

The first of the two main chapters in Part Four is on rubato. Epstein begins by distinguishing between classical rubato, where a flexible melodic line weaves around a rigidly timed accompaniment, and romantic rubato, which is totally flexible, yet controlled. This control, Epstein theorizes, derives from the simultaneous operation of two timing mechanisms, a rigid metrical beat and a flexible rhythmic pulse:

> These two time controls, really *systems* of time control, rapidly become dissynchronous and thus in conflict, thereby adding excitement to the performance...A large part of the gratification in good rubato playing lies in the eventual reconciliation of these two systems, their return to phase synchrony....[A]s a general rule this resynchronization of beat and pulse lies within the extreme bounds of the phrase itself. It is at the phrase end (which in its timing is simultaneous with the attack of the next phrase) that the two systems realign. (p. 373)

From this perspective, classical and romantic rubato are similar, except that the explicit ground beat of the former is only implicit in the latter. What Epstein does not say is how such a rigid internal beat in romantic rubato can actually be established and maintained precisely for a number of cycles while a contradictory rhythmic activity is going on. One might suppose that such a ground beat, however it is initiated, would quickly degrade and fade away under these circumstances. Epstein sees no such problem, although he permits some inaccuracy in the system, which he sets arbitrarily at +/-10%. It is important to note that his theory makes no predictions at all about the nature and magnitude of expressive tempo modulations within a phrase, which is what other researchers have been interested in (e.g., Repp, 1992, 1995; Todd, 1985, 1995). The only prediction of his theory is that "the ground beat fits integrally within the phrase" (p. 377), which he proceeds to test in a performance of Chopin's Mazurka in A minor, op. 17, No. 4, by Guiomar Novaes.

In order to determine whether there is an integral number of ground beats in a phrase, it is necessary to measure the duration of the ground beat independently. This leads Epstein to look for it in the performance, somewhere near the beginning of the phrase, *even though it is supposedly implicit.* To this reader, it is not at all clear why the hypothetical ground beat should be manifest anywhere on the musical surface. Moreover, Epstein admits that "it is not always clear where, or in what unit, the ground beat may be for each phrase" (p. 383), though it should be somewhere at the beginning. From several options (first beat, second beat, first bar, second bar, etc.) he chooses one that happens to fit integrally into the duration of the whole phrase, no matter whether the number of such units in a phrase is 11 or 19 or 23. As a result, he finds different sizes, numbers, and durations of ground beats in different phrases, without being unduly bothered by these inconsistencies. He does not take into account the common phenomenon of phrase-initial lengthening, which makes it unlikely that a ground beat is established in the first downbeat or measure of a phrase. For example, the lengthened initial beat at the beginning of the Mazurka melody (Example 11.1f) is a priori unlikely to be a ground beat; yet Epstein accepts its integral fit into the phrase duration as evidence supporting his theory. Later he does consider the possibility that the ground beat is completely hidden, but his discussion becomes confusing here. For example, he attributes the longer beat durations towards the end of the phrase to "an extended influence of the opening ground beat " (p. 388), despite intervening shorter beats. Yet, such a slowing down is commonly observed in the vicinity of phrase boundaries (see, e.g., Todd, 1985; Repp, 1992), and any resemblance to initial beat durations is likely to be purely coincidental.

Epstein's methods imply extremely high probabilities of finding an integrally fitting ground beat by chance. Take a phrase of duration D and a confidence limit of 0.1(±10%). Then the probability that any randomly chosen ground beat duration d will provide an acceptable integral fit to D is 0.2.[1] Now, if there are m possible candidate units for the ground beat, the probability that at least one will provide an integral fit is $1 - (1 - 2c)^m$. With two candidate units, the probability becomes 0.36, with three 0.49, with six 0.74. In the Chopin Mazurka (Example 11.1d), Epstein finds six different ground beat units in 15 phrases. Although he may not have considered all these units in every phrase, it is not clear what a priori constraints he imposed in each phrase. Thus it is difficult to determine whether his results differ significantly from chance expectations; on the (possibly incorrect) assumption that he considered six possible units in every phrase, they do not.

Several additional performances are analyzed in this chapter, though in less detail. Everywhere Epstein finds evidence for periodicity, though not necessarily exact periodicity. This reader remains unconvinced and frustrated by these analyses, which seem to be based on implausible theoretical assumptions and a disregard of conventional statistical procedures. Yet, the many detailed observations presented in this chapter deserve further scrutiny, and Epstein must be given credit for presenting his data with meticulous care and honesty.

The following chapter deals with *Acceleration and Ritard.* Some of the work presented here was published previously (Feldman, Epstein, and Richards, 1992). Epstein and his colleagues propose that the smooth transition between two different tempi is (or should be) effected via a smooth curve that describes successive beat durations as a function of beat number. The proposed shape of the curve is a cubic spline—that is, the central ∫-shaped (for ritards) or inverted-∫-shaped (for accelerations) portion of a cubic function. The cubic function was apparently chosen because of its mathematical simplicity (p. 422) and "[o]n grounds of neural efficiency, or sheer ease of function" (p. 554), a somewhat dubious rationale. Epstein proceeds to fit this function to timing data from performances of orchestral works by Dvorák and Stravinsky, respectively, chosen because they contain long *accelerandi* or *ritardandi.* His two examples of *ritardandi* are described reasonably well by cubic functions, but it must be noted that neither of the functions is ∫-shaped; rather, they are inverted. This is so because the two tempi in each of these instances are *not* smoothly joined; rather, the *ritardando* progresses to its maximum, whereupon the new tempo commences rather abruptly. In the first example, the new tempo actually represents a return to the original tempo preceding the ritard. Epstein thus uses only the concave half of the inverted ∫-shaped function, and he ignores the convex half which does not

fit the data at all. Nevertheless, he points to the symmetry of these functions, which "says something about shaping, finesse, eloquence in performance" (p. 424).

The two examples of *accelerandi* are similarly problematic. The first example (De Falla) exhibits stepwise changes in tempo with *accelerandi* in between, and the piecewise or global fits to cubic curves are not really convincing. The second example (Tchaikovsky) provides a somewhat better fit, to a symmetric cubic spline in this instance, but, in his zeal to capture the data, Epstein extends the curve beyond the flat asymptotes of the inverted *f*-shape, so that the smooth connection with the preceding tempo is lost. The accompanying discussion, which relates performance timing to the kinematics of limb movements, is interesting. Todd's (1992, 1995) work, some (but not all) of it too recent to be taken into account by Epstein, has moved in the same direction but has led to different procedures and conclusions. In a forthcoming paper, Todd (submitted) will discuss Epstein's cubic model in relation to his own theory of linear tempo change.

In another analysis, Epstein examines the final *ritardando* in several performances of Schumann's "Träumerei", unaware (at the time) that Repp (1992) had used the very same music in his detailed studies of expressive timing. Repp found that one portion of this final *ritardando* was generally described well by a quadratic function. Epstein, naturally, prefers to fit cubic functions to his data, but his procedure is questionable: He includes the duration of the final chord as a data point, even though this duration is delimited by key releases, events of uncertain rhythmic significance. He also ignores the motivic structure of the final phrase, which typically results in a segmented *ritardando*, as seen in Repp's (1992, 1995) extensive data. Furthermore, Epstein claims to have found a better curve fit for a professional pianist (Jörg Demus) than for several amateurs, but the differences are small and suggestive at best. This reader's shaken confidence in the data was not restored by a final grand cubic curve fit to the 35-minute *ritardando* observed in the Yamomami data, discussed in an earlier chapter.

In a concluding mini-chapter, Epstein looks back at the premises of his approach to flexible tempo. He says that the nonlinear tempos captured by the cubic functions "embody proportionality, for they set in proportional relationship the tempos that they join" (p. 449). This is a *non sequitur* because tempo proportionality is quite independent of the shape of the tempo transition. Epstein also asks (finally!) whether "gifted performance" is characterized by strict adherence to some "innately determined" model of timing, or whether it is rather the deviation from such a model that marks "giftedness". He suggests that the first statement may apply to *accelerando / ritardando,* the second to rubato. However, this raises additional questions: Do less gifted performers play with less pronounced or less controlled rubato than do gifted performers? (Repp's studies suggest they do not.) Are these deviations from the model not themselves governed by biological constraints on timing? (Todd's recent work suggest they are.) Epstein's conviction that some model is needed to explain performers' exquisite control over tempo and timing is shared by most researchers in the field, but it remains to be seen whether his specific proposals will survive.

The book concludes with Part Five, an epilogue on *Affect and Musical Motion.* To illustrate that "[i]t is motion, with its correlated affect, that makes ultimate sense of the music" (p. 457), Epstein discusses a small number of musical examples, especially the first movement of Mozart's Piano Concerto in D minor, K. 466, a piece of "absolute" music that nevertheless seems to have an affective agenda of struggle and entrapment. In his concluding pages, Epstein stresses the importance of shaping musical motion "in the service of controlled affective statement" (p. 481). Particularly apt is his remark in a footnote that a "neutral" or "literal" performance of a score is itself an interpretation, though one that ignores the affective potential of the music.

A final critical comment is in order regarding the total absence from the book of any attempt to trace the fate of motion and affect in 20th century music and aesthetics. Epstein confines himself, without apology, to the masterworks of the standard repertoire that best illustrate his concerns. However, can one ignore one century of radical change in compositional technique and performance aesthetics? Are Epstein's theories confined to a repertoire that by many is considered part of a museum culture? On the other hand, it is important to ask why the standard repertoire still means so much to contemporary audiences, and Epstein is certainly not alone in

restricting his focus to the most beloved music of the past. The fate of musical motion and affect in 20th century music still awaits a detailed scholarly discussion.

Despite its shortcomings as an empirical contribution, *Shaping Time* is required reading for anyone interested in music performance. It is an important milestone in interdisciplinary communication and is likely to stimulate vigorous research and constructive criticism from both psychologists and music theorists. It is richly rewarding as a source of musical insights, which are presented in elegant prose and supported by imaginatively laid out music examples. It is virtually free of technical jargon and readily accessible to readers of various backgrounds. The book is well edited—this reader encountered only a few minor errors along the way—and affordable. Its unusually wide format leaves broad margins that invite the reader's notes and comments. Order your copy today.[2]

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FOOTNOTES

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[1]There must be an integer number n such that n <= D/d < n + 1. Within this range of 1, values between n and n + 0.1 and between n + 0.9 and n + 1 provide acceptable fits, whereas other values are unacceptable; the probability of finding an acceptable fit thus is 0.2.

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