one's own structural changeability." Lachenmann's music, then, can be understood as a kind of phenomenology, "deliberately incorporating, provoking and revealing perception."

The rest of the chapter shows how this can be achieved through altered instruments. With an altered instrument, realizing the simplest tune may become confusing: I no longer know what notes I am playing.

Retuned Instruments: Kurt Rosenwinkel, "Zhivago"

The jazz guitarist Kurt Rosenwinkel (b. 1970) describes creative development as a cycle of stability and instability, learning and unlearning. "You start off not knowing what you're doing," he says, "then you organize things so they become ordered. When that order becomes static, you have to break it up to create another state of instability, which, in turn, throws you back into chaos. That's what continuing on to the next step is all about" (Rosenwinkel 2007). On his 2001 album, *The Next Step*, this dynamic process is driven largely by instrumental modification: he uses alternate tunings for four of the record's eight tracks.[6]

Rosenwinkel had found success in the mid-1990s with a Composer's Award from the National Endowment for the Arts and a recording contract with the prominent jazz label Verve. But at the point when he started work on *The Next Step*, Rosenwinkel was dissatisfied with his playing. "My knowledge of the guitar was hindering my relationship to the music," he explains. "I felt like I knew too much about what I was doing and not hearing the music directly." This is not simply about practiced hands falling into predictable patterns. Rather, Rosenwinkel frames this as an inability to *hear* the music properly. It involves *perceptual or conceptual habits* as much as performative ones. In cognitive terms, Rosenwinkel is describing particularly tight auditory-motor connections. If he already knows what his actions will sound like, he may come to hear his playing as unsurprising, overly schematic. A description by Rosenwinkel's colleague Christian Rover (2006) evokes the instrumentalized simulations discussed in Chapter 1: "To have a certain collection of voicings for every harmony, and a sound you already internally hear before you actually play it, would eventually make it redundant to still play it."

Rosenwinkel's solution was to retune his guitar in a form of "voluntary self-sabotage." "Anyone who has ever tried this," Rover comments, "knows that one twist of a tuning peg can turn you into a beginner in an instant. Just like the first time you touched a guitar all you have is your ears to rely on—and that's exactly what Kurt's intention was." There is some sense to this metaphor. Beginners rely more on visual feedback and pay more attention to motor patterns than do expert performers (see Palmer and Meyer 2000, discussed in Chapter 1). Since their

6. While alternate tunings are uncommon in jazz, they are often used in other guitar traditions, from the widespread drop-D tuning (that lowers the lowest string a whole step) to various open tunings of folk and slide blues guitar.

mapping between hand and ear is still being formed, they lack the perceptual habits that Rosenwinkel found frustrating.

In other ways, though, this professional musician was quite different from a beginner. Rosenwinkel was able to adapt various motor skills to the altered instrument. His right-hand picking, for example, would be unaffected. This reflects a general principle: *retuned instruments change place-to-pitch mapping, while preserving the instrumental interface*. The experiments by Pfordresher and colleagues, cited in the preceding section, imply that new mappings might be most challenging when they preserve aspects of a familiar tuning too.

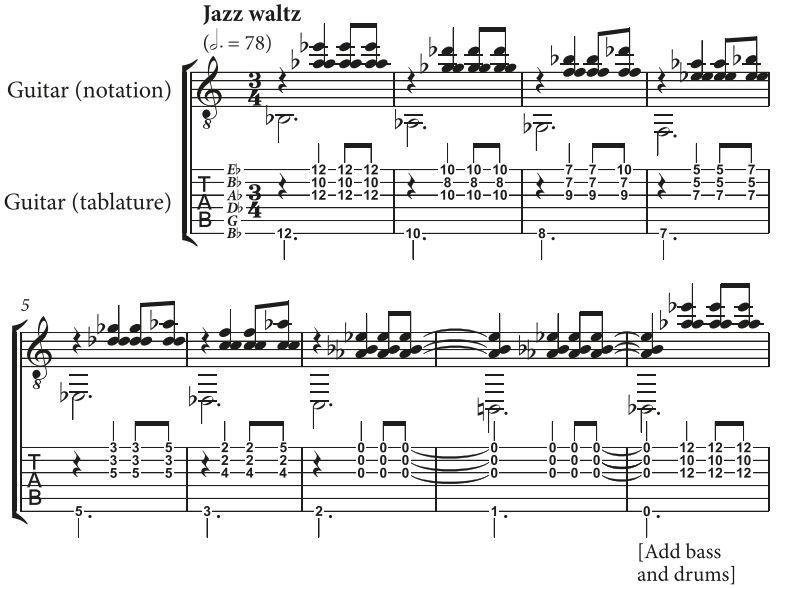
I analyze relationships between standard and altered tunings through transformational voice leading theory, an application suggested by a speculative "scordatura fantasy" by David Lewin (1998, 38–41). Figure 4.4 represents alternate tunings as mappings between two pitch sets. This shows each string's movement in pitch space and sums up the mapping as a whole with two metrics of transformational voice leading, "consistency" and "displacement." "Consistency" measures the mapping's uniformity: it counts the number of voices that move by the same pitch interval (Straus 2003, 315). Higher consistency values mean that the mapping is closer to transposition—and that it preserves more inter-string intervals from standard tuning. Rosenwinkel's favored retuning takes three strings down a semitone; it is semiconsistent. By comparison, the scordatura for Toru Takemitsu's "Equinox" keeps four strings consistent. "Displacement"—the total number of semitones traversed (Straus 2003, 320)—further quantifies distance from standard tuning. Where Takemitsu's tuning moves only two semitones overall, Rosenwinkel's tuning moves twelve.

Rosenwinkel's scordatura is further from standard tuning than Takemitsu's. Every string moves, and the tuning does not repeat pitch intervals between adjacent strings. Yet Rosenwinkel also maintains some familiar features. Because three strings transpose together, he can play standard fretboard patterns involving those strings. This is particularly notable with the perfect fourth between the highest

Figure 4.4 Tuning transformations for guitar scordatura by Kurt Rosenwinkel and Toru Takemitsu. "Consistency" counts the number of voices that move the same distance; "displacement," the total number of semitones shifted.

	Kurt Rosenwinkel "Zhivago" (2001)	Toru Takemitsu "Equinox" (1993)
	E4 $\xrightarrow{-1}$ E♭4	E4 $\xrightarrow{0}$ E4
	B4 $\xrightarrow{-1}$ B♭4	B4 $\xrightarrow{-1}$ B♭4
	G3 $\xrightarrow{+1}$ A♭3	G3 $\xrightarrow{0}$ G3
	D3 $\xrightarrow{-1}$ D♭3	D3 $\xrightarrow{0}$ D3
	A2 $\xrightarrow{-2}$ G2	A2 $\xrightarrow{0}$ A2
	E2 $\xrightarrow{-6}$ B♭1	E2 $\xrightarrow{-1}$ E♭2
Consistency:	3	4
Displacement:	12	2

Figure 4.5 Kurt Rosenwinkel, "Zhivago," mm. 1–9. (This follows an improvised solo-guitar introduction.)



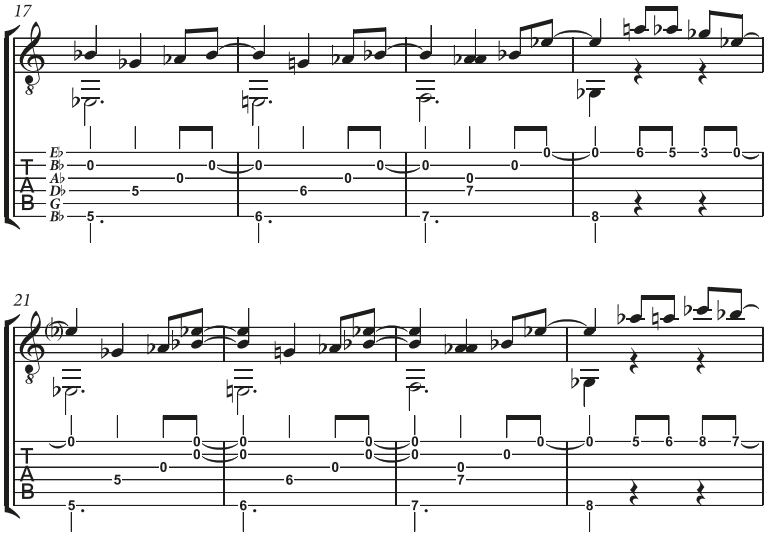
two strings. Such zones engage established performance habits. They allow the player to forget temporarily about the retuning, making other areas on the instrument more surprising by comparison. All of this involves cross-string intervals, of course; relative pitch relations along the strings, which are determined by acoustics, remain constant. It is perhaps unsurprising, then, that Rosenwinkel privileges motion along the strings in the opening track from *The Next Step*, "Zhivago."

"Zhivago" is a contemporary jazz waltz. After a free solo lead-in, Rosenwinkel establishes the driving triple-time feel of the composition proper. The guitar descends for eight measures, then repeats the progression with bass and drums (see transcription in Figure 4.5). Together they develop a new vamp, shown in Figure 4.6. At m. 33, the saxophone joins the guitar with a skipping theme that will return throughout the eighty-six-measure composition (see Figure 4.7).

The following analytical notes consider these opening sections, using the transformational model of guitar space introduced in the preceding chapter. As illustrated in my network for a riff by the Kinks in Figure 3.3, I represent fret/string positions as ordered pairs of the form (*f, s*). (Transformations in this space are represented by ordered pairs that show movement in these dimensions with integers marked by + or –.) This model makes it possible to show how "Zhivago" thematizes certain kinds of movement on the fretboard, even more than specific hand shapes or harmonic objects.[7]

7. For a similar approach, see Montague (2012) and Bungert (2015), who analyze thematic keyboard gestures in Chopin and Bach.

Figure 4.6 Kurt Rosenwinkel, "Zhivago," mm. 17–24.



In the first section's descent, the bass note begins at the twelfth fret of the bottom string (12, 6) and steadily works its way to the open string (0, 6). Here Rosenwinkel alternates between two basic hand positions, labeled α and β in Figure 4.8. I add subscript numbers to distinguish different instances of these chord shapes: the number refers to the position of the sixth-string fret (that is, the bass note). The move from α_{12} to α_{10} is a straightforward along-the-string transposition, (–2, 0). The shift between α and β, however, is also an along-the-string move. The two shapes hold frets on the same strings, and my fingers slide along the fretboard as I shift from one to the other.

Defining two contextual transformations will help us conceptualize the relationship between the two shapes. J formalizes a "pivoting" gesture. J holds the fret on the lowest string of the shape constant and moves the others up by one. A complementary perspective is provided by another transformation, K. K moves the lowest-string fret down one, while holding the others. This will prove to be a kind of "thematic move" throughout the piece. Figure 4.9 and Video 4.1 demonstrate these operations, applying each to α_{10}. These transformations, however, might apply to any fretboard shape and may appear in standard tuning. For example, K and J^{-1} can be used to toggle between two voicings in a common descending "ii–V" progression (see Figure 4.10 and Video 4.2).

Readers versed in transformational theory will note that J and K are operations (not simply transformations), since they are invertible. Their inverses—J^{-1} and K^{-1}—undo the move, taking β back to α. More specifically, I am describing groups of operations isomorphic to the integers under addition.[8] This means that

8. This means that the model incorporates negative fret numbers, which must be included for formal reasons (Rings 2011, 25–27; De Souza 2016b).

Figure 4.7 Kurt Rosenwinkel, "Zhivago," mm. 33–46.

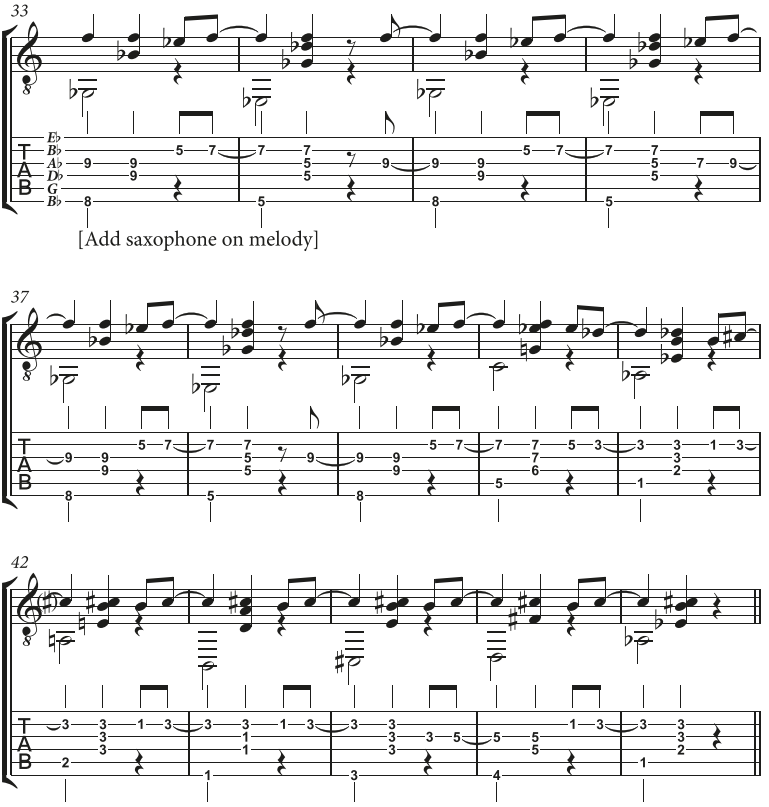


Figure 4.8 Kurt Rosenwinkel, "Zhivago," mm. 1–6, labeling basic hand positions. Subscript numbers refer to the fret on the lowest string. For these hand positions, I include only the lower anchor note on the highest string (excluding the added melodic neighbor note). This underlying schematic shape for α—with the highest two strings sharing a fret—emerges clearly in mm. 4–5. Here the higher note on the first string is added at the end of the bar, whereas throughout mm. 1–2 this highest note covers the basic shape.

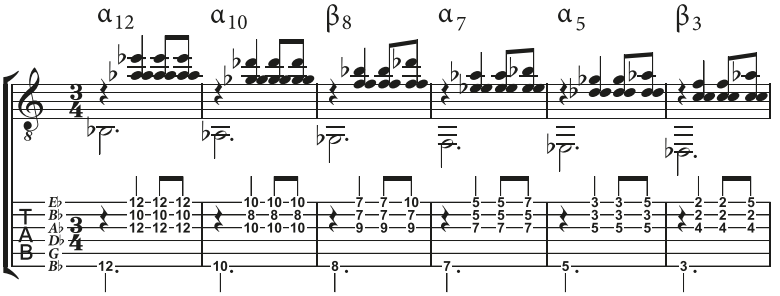


Figure 4.9 Two contextual operations for fretboard shapes in Rosenwinkel, "Zhivago." Both connect α and β. J holds the bottom-string fret and moves the others up one; K moves the bottom-string fret down one, holding the others. The inverses of these operations (J^{-1} and K^{-1}) take β back to α.

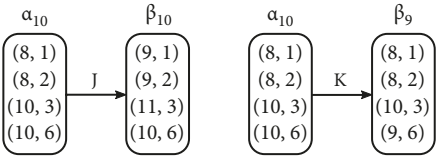
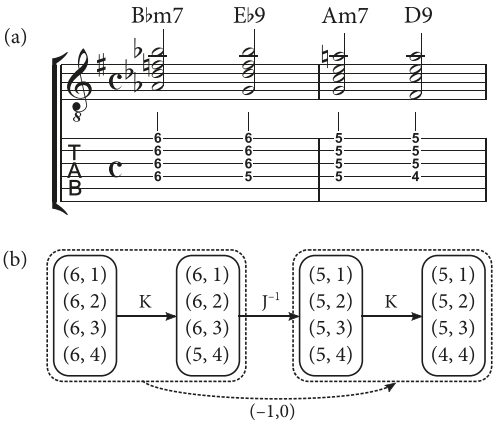


Figure 4.10 Contextual fretboard operations with a chromatically descending ii–V progression, which appears in many jazz standards (including Duke Ellington's "Satin Doll," Miles Davis's "Four," and John Coltrane's "Lazy Bird"): (a) an idiomatic voicing for this progression, using only the highest four strings on a guitar in standard tuning; (b) transformation network modeling these voicings via K and J^{-1} (the inverse of J).



the operations can also combine with themselves: for example, performing K twice in a row (K^2) moves the lowest-string position down two frets. Furthermore, these contextual operations commute with transpositions in fretboard space. The order in which these transformations are combined does not change their product: for example, (–2, 0)J = J(–2, 0). Figure 4.11 demonstrates the combination of pivoting and shifting along the fretboard with the middle section of the Beatles' "Blackbird" (see Video 4.3▶).

Figure 4.12 represents the opening section of "Zhivago" in networks that combine J and K with transpositions along the string. (This section is performed in Video 4.4▶.) The first two networks show that Rosenwinkel repeats a sequence of hand shapes as he moves down. The interpretation that uses J highlights the bass line, showing that it always drops two frets after α forms. Thinking in terms of K obscures this somewhat. Yet as Figure 4.12c shows, K also accounts for the descending motion in mm. 7–9 and 15–16. Though these measures introduce new

Figure 4.11 John Lennon and Paul McCartney, "Blackbird" (1968), mm. 13–14: (a) notation; (b) a network that combines the pivoting gestures J and K with along-the-string transpositions on a guitar in standard tuning. (The interested reader can pursue such gestures throughout the rest of "Blackbird," starting with the characteristic (+8, 0)J leap in the song's first two measures.)

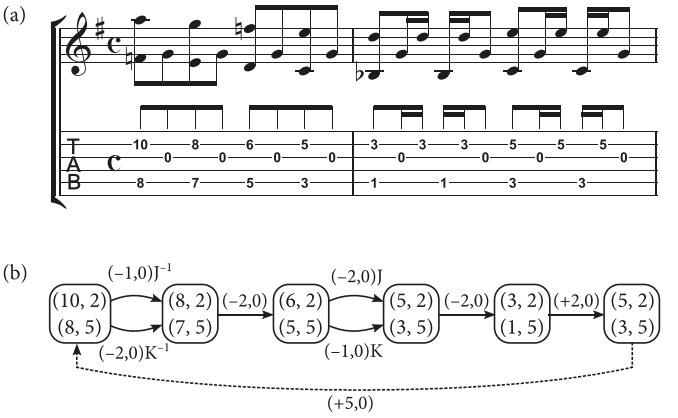


Figure 4.12 Transformation networks for Rosenwinkel, "Zhivago," mm. 1–16: (a) network for mm. 1–6, 9–14, using J to connect α and β; (b) network for mm. 1–6, 9–14, using K to connect α and β; (c) network for mm. 7–9, 15–16.

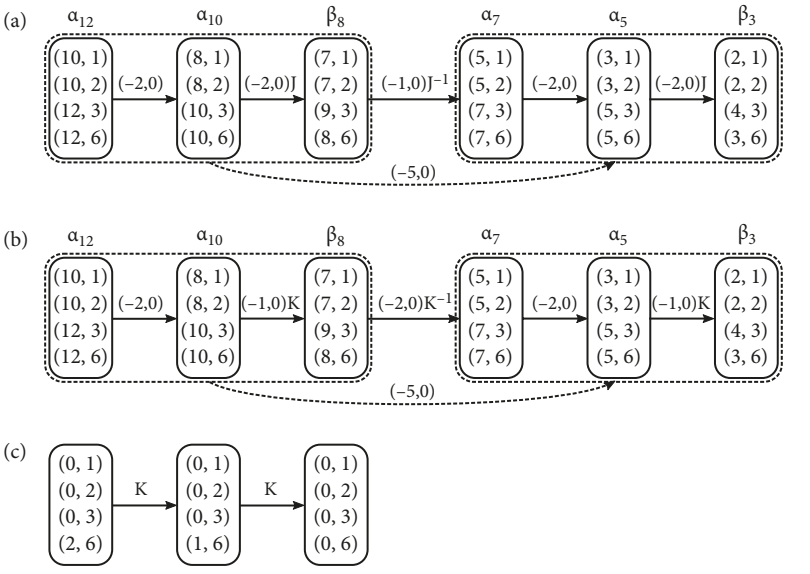
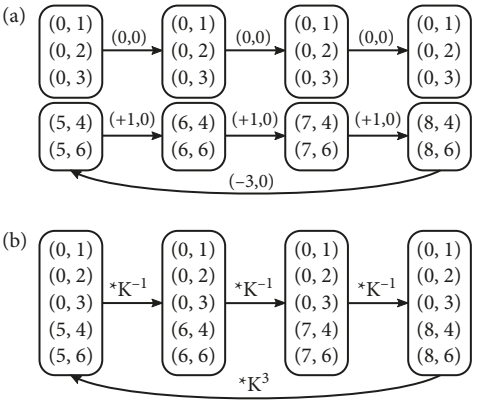


Figure 4.13 Transformation networks for looping schema from Rosenwinkel, "Zhivago," mm. 17–32: (a) network with fretboard transpositions; (b) network with variant of K.



hand shapes—that is, new chord voicings—*they involve comparable movement along the fretboard*.

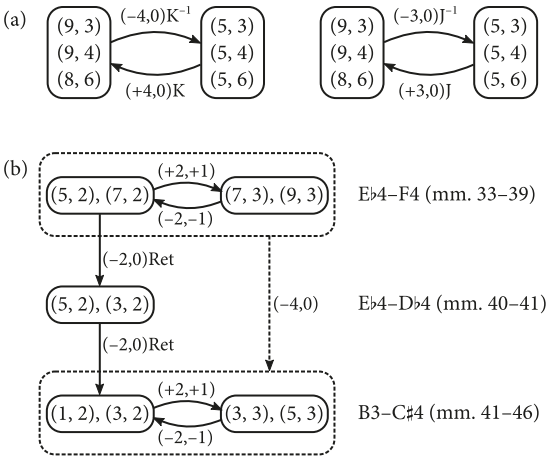
The second section reverses and extends the K motion from mm. 7–9. It takes a parallel shape up the neck, against stable higher strings (see Figure 4.13 and Video 4.5). Rosenwinkel loops the process four times, adding to the higher strings with each repetition. The step-by-step action on the lower strings can be modeled as the inverse of a K variant—call it *K—which would move the frets from a shape's lowest *two* strings (instead of just the lowest).[9]

The new theme at m. 33 also involves cycling between hand positions (mm. 33–39, 47–52, 63–68). The chords that support it can again be modeled by J or K, alternately straightening the shape and offsetting the lowest-string note (see Figure 4.14a and Video 4.6). The melody itself, though, introduces the first cross-string movement as it explores the instrument's many-to-one place-to-pitch mapping. The "same" melodic figure is alternately realized on different strings, related by the first transformations involving string crossing, (+2, +1) and its inverse (–2, –1). As shown in Figure 4.14b, this figure is also shifted along the fretboard by (–2, 0), outlining part of a whole-tone scale. In later sections (which are not shown here), this action loop forms an antecedent that is answered differently each time.

These analytical sketches highlight some characteristic physical positions and movements in "Zhivago." Rosenwinkel privileges along-the-string movement and bass-pivoting or bass-displacing gestures (modeled by J and K). These sections can be further understood as a series of action cycles: an eight-measure loop, repeated

9. With the second pass through the cycle, Rosenwinkel adds the top string; with the third, a held note on the top string's seventh fret. In the last place in the loop, the eighth fret is fingered on the fourth string—but this fret is *sounded* only after the final repetition of the cycle, shifted onto the *third* string (in m. 32).

Figure 4.14 Transformation networks for Rosenwinkel, "Zhivago," mm. 33–46: (a) chord pattern from mm. 33–39; (b) melodic transformations for mm. 33–46. In (b), "Ret" stands for retrograde.



twice (mm. 1–16); a four-measure loop, repeated four times (mm. 17–32); a two-measure loop, also repeated four times (mm. 33–39). Each loop is shorter, more focused, than the one that precedes it.

The way Rosenwinkel lingers in these grooves, which make up most of the composition, foregrounds a kind of haptic engagement with the music. By this I mean that physical shapes on the instrument take precedence over usual harmonic labels. Rosenwinkel discussed this in a 2010 master class:

> What was cool about it was that I didn't really know what this chord was. [Plays a chord.] What is that? I don't know. It seems like a major seventh. I wasn't sure, you know, and I didn't know what the notes were. So I had to take a tuner, to plug into a chromatic tuner to tell me what that note was, you know, so I could write it down. And then I kind of started to figure out what the harmony was. Slowly, very slowly. But it was really cool because no longer did I have this intellectual relationship with it. It was just pure sound and discovery.[10]

This suggests that Rosenwinkel's motor habits and auditory expectations readjust more quickly than his theoretical awareness. Even as his hands and ears become familiar with the altered fretboard used in "Zhivago," his "intellectual" perception of the music lags behind. Rosenwinkel's retuning temporarily disrupts his

10. A brief video from the event can be viewed at http://www.youtube.com/watch?v=QVSNccMNtJU. Of course, this master class is a performative and pedagogical situation, in which Rosenwinkel consciously models a certain type of musicianship. Still, his comments fit with my own experience of "Zhivago" and its unusual guitar tuning. I find it difficult to name the notes or chords as I play it, even though I have transcribed and analyzed the piece.

symbolic experience of the music and instead foregrounds its sensory, "aesthetic" qualities.

Prepared Instruments: Fred Frith, "Hello Music"

The English multi-instrumentalist Fred Frith (b. 1949) has more than four hundred items in his discography. He has played with experimental rock, folk, and jazz groups, written film scores and orchestral pieces, and taught composition at Mills College. One of his most acclaimed recordings, though, is a forty-minute set of unaccompanied improvisations, simply titled *Guitar Solos*. For this 1974 album, Frith modifies a 1936 Gibson K-11 archtop by adding a second pickup at the nut (that is, the end of the strings farthest from the bridge). He then taps the strings with his hands or with found objects, recording the results. This explores, Frith says, "the difference between the touch of stone, the touch of glass, the touch of wood, the touch of paper—those kinds of basic elements that you're using against the surface of the strings which produce different sounds" (Milkowski 1983, 24).[11] Clearly, like Rosenwinkel, Frith seeks to defamiliarize the guitar. But instead of retuning, his approach involves *instrumental preparation*.

Where retuning changes an instrument's pitch mapping, preparation incorporates foreign objects *at the site of sound production*, and this often transforms pitches into complex inharmonic sounds. Preparation, in a sense, turns any instrument into a percussion instrument. It disrupts habitual associations by crossing categories. That is, a prepared instrument may not simply produce unexpected notes. It may instead produce unexpected *noises*—metallic or wooden, thudding, rattling, or ringing.

Preparing an instrument, then, suggests a certain openness to noise that Frith first encountered in John Cage. "Reading [Cage's] *Silence* when I was about eighteen changed my attitude completely, far more profoundly than listening to any music ever would have," says Frith. "That book brought very sharply into focus the idea that sound, in and of itself, can be as important as … melody and harmony and rhythm. The sound itself is just as important. And from that notion I started viewing the guitar itself from a different point of view altogether, just to see what I could get out of it" (quoted in Milkowski 1983, 23). Frith's exploration of the guitar, of course, parallels Cage's approach to the piano. The composer "invented" the prepared piano in the late 1930s, adding screws and bolts to the instrument's strings to make it sound like a percussion ensemble. Cage (1979, 8) describes this as a process of "continual discovery," full of delight and surprise.

That sense of surprise is central to Cage's concept of *experimental action*, "an act the outcome of which is unknown" (1961, 13). Experimental music for Cage disrupts the "straight line between anticipation of what should happen and what actually happens" (167–68). When the composer formulated this idea in the

11. For more details of Frith's performance techniques, see Dawe (2010, 78). They are also documented in the film *Step Across the Border* (Humbert and Penzel 1990).