CHAPTER Three

Idiomaticity; or, Three Ways to Play Harmonica

In an experiment at the Max Planck Institute for Human Cognitive and Brain Sciences, guitarists were asked to finger a chord in response to an on-screen cue (Drost, Rieger, and Prinz 2007). The chords were not difficult, either A major or A minor. But as each visual prompt appeared, the participants heard a chord that might—or might not—match the one they were supposed to play. That is, sometimes they heard A major when they had to play A minor (and vice versa). The mismatched chords slowed reaction time *but only when they had the timbre of a guitar*. If the distractor sounded like a piano, an organ, flutes, or voices, it had no significant effect on the guitarists' performance. When pianists did this same task, though, they were influenced by piano sounds *and* organ sounds. The researchers explained this result in terms of affordances: because piano and organ are both keyboard instruments, they afford similar actions and musical textures. Despite differences in action-sound coupling, expert pianists may hear organ music kinesthetically, sensing movement on the keys.

A subtle difference between the guitarists' and pianists' tasks raises further questions. Guitarists played A major and minor, but pianists played C major and minor. Why would the designers of the experiment choose one key for the piano, another for the guitar? The answer, for a guitarist, is obvious. The chord voicings used in the experiment involve open strings, and they are particularly easy to play. The corresponding hand shapes for C major and minor, though, are barre chords—that is, chords where the index finger stops multiple strings at the same fret. Similarly, C has a special relationship to the piano, since the key of C major entails only white notes. Such contrasts have less to do with the instruments' modes of sound production than with the way they organize pitch materials. With other instruments, the experimental task would have to be further modified. The diatonic harmonica, for example, cannot play a major and minor triad over the same root. How, then, do particular instruments realize pitch spaces in physical space? How are instrumental interfaces structured? And how might they structure players' actions?

These questions evoke broader debates about technology and agency, which are often framed around two theoretical poles.[1] On one side, voluntarism and social reductionism suggest that tools are merely vehicles for human intentions. The most common expression of this view might be the National Rifle

1. For further discussion of such debates, see Ihde (1990, 4–5) and, in a musical context, Taylor (2001, 25–31).

Association's slogan, "Guns don't kill people. People do." On the other, technological determinism claims that tools shape or control their users. This is conveyed by Marshall McLuhan's famous claim that "the medium is the message" (1994, 7). Both extremes are problematic. Clearly we make choices when using instruments, and yet it sometimes feels as though they have a hold on us.

Ecological perceptual theory avoids deterministic oppositions here. As emphasized in Chapter 1, affordances and abilities are always codefined. But Gibson also insists that a thing's affordances exist independently of an agent's needs or skills. As he puts it, "The object offers what it does because it is what it is" (1979, 139). This realism distinguishes Gibson's "affordance" from Gestalt psychology's earlier term, "valence" (*Aufforderungscharakter*). Though both concepts suggest that objects invite particular actions, the Gestalt theorist Kurt Koffka argues that valences belong to a perceived "phenomenal object," not the physical object itself. Gibson rejects this dualism. Noticing or ignoring affordances does not change them. They are "always there." Note how this invariance unsettles voluntarism and social reductionism. Affordances are not produced by agents' intentions, nor are they merely projected onto an object. That is why my attempt to use an object might fail, why the object might resist certain uses, why it might do things that I do not want it to do.

Given those real constraints, though, an object's affordances are potentially endless. A chair never forces me to sit in it. I could stand on the chair instead. I could hide behind it. I could use it as a doorstop, an end table, a clothes horse, or a music stand. It is impossible to list all of the chair's uses or features. This openness subverts technological determinism. A tool can always be put to some unexpected use.

This nondeterministic reciprocity between agent and thing challenges both sides of the dialectic. But it also raises new problems. If affordances are theoretically innumerable, why are certain uses of an object preferred over others? Why does it seem that a tool should be used in a certain way? Extending ecological psychology here requires an account of artifact-based skills that are learned, culturally and technically situated, and directed toward goals. To this end, David Kirsh offers the idea of the "enactive landscape," a set of affordances that are activated for an agent. In other words, an enactive landscape is a space of possibilities, in which technology and technique coevolve. As Kirsh puts it, "Music teaches us that these … landscapes multiply furiously" (2013, §2.6). Musical instruments, specifically, "provide musicians the physical landscape necessary to change their possibilities—to create a perfect niche for making music" (§2.6).

This chapter investigates enactive landscapes associated with a specific instrument: the diatonic harmonica, colloquially known as the "blues harp." Though the harmonica's origins are poorly documented, it was likely invented in Germany around the 1820s as part of a vogue for free-reed instruments that also produced the accordion, the concertina, and various forgotten cousins (like Christian Buschmann's "aura" and Charles Wheatstone's "symphonium").[2] In the second half

2. These free-reed instruments were directly or indirectly inspired by traditional Asian mouth organs such as the Chinese *sheng*, which had been known in Europe since the seventeenth century (for example, Marin Mersenne described such an instrument in his 1636 *Harmonie universelle*). On the origins of the diatonic harmonica, see Missin (n.d.) and Field (2000, 23–24).

Figure 3.1 A ten-hole diatonic harmonica, or “blues harp.”

of the nineteenth century, the diatonic harmonica would be industrially mass-produced and exported globally (Wenzel and Häffner 2006). It was portable, fairly durable, and inexpensive—and these features contributed to its widespread popularity. The harmonica’s use in folk music, blues, and jazz shows how this seemingly simple instrument supports multiple enactive landscapes. Such landscapes call for a mode of analysis that investigates performers’ moves through instrumental space, an approach that may be informed by statements from expert players and by Lewinian transformational models. At the same time, this analysis motivates theoretical reflections on instrumental spaces and idioms—and ultimately an argument about technical agency.

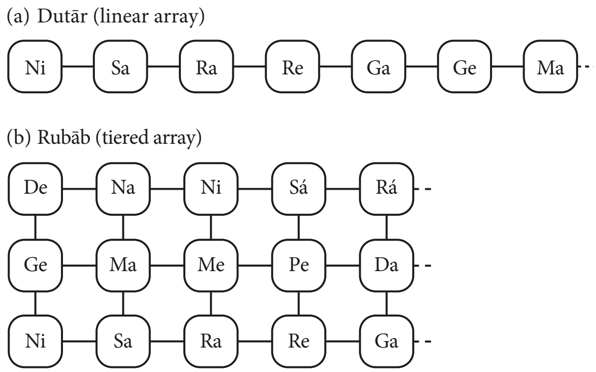
Instrumental Spaces

The harmonica fits in my palm, but my hands cannot make it sound. The harmonica, after all, is a particular sort of wind instrument, a “mouth organ.”[3] It has ten square holes, lined up on a comb (Figure 3.1). Breathing through these holes activates tuned reeds hidden beneath the instrument’s metal cover plates. Here air and sound are immediately joined, in their timing and their strength. The instrument is louder when I blow harder; it stops resonating when I stop moving air through it. Briefly put, the harmonica converts my breath into music.

This action-sound coupling differentiates the harmonica from free-reed instruments that have bellows. With the accordion, squeezing and pulling arms activate sound while fingers control pitch. With the harmonica, breathing provides both power and steering. Breath strength controls dynamics, while breath placement and breath direction control pitch. Because of its two sets of reeds, inhaling and exhaling through the same hole give different notes. Moreover, the “draw” notes (produced by inhaling) and the “blow” notes (produced by exhaling) form two tonally distinct collections. Each of the harmonica styles analyzed here somehow

3. This is reflected in its original German name, *Mundharmonika* (mouth harmonica). Note, however, that it affords breathing-through for other animals too: for example, the Smithsonian’s National Zoo has a harmonica-playing elephant that holds the instrument in her trunk (Fazeli Fard 2012).

Figure 3.2 Two instrumental "arrays" (after Baily 2006, 116): (a) with the *dutār*'s linear array, the player moves *along* a single string (for example, the pitch "Ma" is five "steps" to the right of "Sa"); (b) with the *rubāb*'s tiered array, the player can also move *across* strings (finding "Ma" at the same fret as "Sa," on the adjacent string).



responds to this complementarity between the instrument's pitch affordances and human physiology. In a sense, the harmonica musicalizes respiration.

At the same time, the ten holes on the comb set out a pitch continuum much like a keyboard. Low notes are on one end (typically held on the left); high notes, on the other. Such linearity is common among instruments, though not universal. (Instruments that set out pitch space in a nonlinear way include mbira, steel drums, and bandoneon.) As I play, I coordinate my lips and the holes, moving the harmonica left or right with my hands and sliding my mouth along the comb. Since I can also change pitch by reversing the direction of my breath, harmonica space offers two basic ways of moving—side to side and in and out. It has two "dimensions."

The ethnomusicologist John Baily explores this multidimensional aspect of instrumental interfaces in his study of two Afghan lutes, the *dutār* and the *rubāb* (1977, 2006). Though their repertoires overlap, their instrumental spaces are quite different.[4] With the *dutār*, melodies are usually played on one string, shifting along a single dimension. With the *rubāb*, melodies are usually played across three strings. Baily calls the former a "linear array" and the latter a "tiered array."[5] He illustrates their difference with a diagram resembling Figure 3.2.

Thinking in terms of "arrays" highlights different kinds of *proximity* in instrumental space. I imagine their dimensions in terms of intersecting instrumental "scales" (using Dmitri Tymoczko's [2011, 116] expansive definition of "scale" as "a kind of musical ruler"). If I am blowing through the harmonica's third hole, I can move "one step" along the comb to the fourth-hole blow *or* I can move "one step"

4. In fact, musicians in the city of Herat devised the fourteen-stringed *dutār* in the 1960s so they could play classical music associated with the *rubāb*.

5. Baily and Driver (1992) extend this thinking to folk-blues guitar playing.

with my breath, changing to the third-hole draw. In both cases, I sense a kind of adjacency, although neither move would sound a diatonic "step."[6] Before investigating the harmonica's pitch affordances, however, I want to formalize this idea of instrumental spaces with particular dimensions.

Instrumental arrays—instruments with dimensions that are divided into steps—can be represented via Lewinian transformational theory. As mentioned in the preceding chapter, this approach uses mathematical groups to model various kinds of musical spaces and actions, involving pitch, rhythm, texture, or other domains. Joti Rockwell (2009), for example, has used transformational techniques to analyze picking patterns on the five-string banjo. Since transformational theory deals with grouplike structures involving discrete quantities, it may not apply to instrumental spaces that lack countable steps (such as the timbral space of a drumhead). Nonetheless, it offers a productive way to model many kinds of instrumental patterns.

Tiered-array instruments like *rubāb*s and guitars involve two dimensions—across and along the strings. In other words, any spot on the fingerboard can be modeled as a combination of fret position and string position. I write this as an ordered pair of the form (f, s), with both variables represented by integers.[7] Elements can then be transposed in either dimension: across-string operations would take the form $(0, +x)$ or $(0, -x)$, where x is any nonzero integer; along-string operations, $(+x, 0)$ or $(-x, 0)$. Note that the numbers in my operation labels are marked with a plus or minus sign. This emphasizes that they indicate movement and also differentiates them from the notation for elements. That is, (+1, +1) represents an action (going up one string and up one fret), whereas (1, 1) represents a place (the first fret on the first string). Such transformations can be applied either to individual elements in the space (that is, notes) or to sets (melodies or chords). The network in Figure 3.3, for example, models such moves in a passage from the Kinks' 1964 song, "All Day and All of the Night." This sequence moves a single fretboard shape around the fretboard. There is, however, more than one way to realize this: moving along and across the strings or staying on the lowest three strings throughout (see Video 3.1▶).[8] As with Heyde diagrams, transformational graphs and networks can be read in various ways. It is generally useful, however, to trace the pathways formed by the arrows.[9]

By comparison, elements in harmonica space can be modeled as ordered pairs of the form (h, σ), where h is the hole (represented by an integer) and σ is a sign (+ or −) that corresponds to blow or draw. For example, (3, +) is the third-hole blow. (This labeling method resembles common forms of harmonica tablature.) In

6. The first move, from third-hole blow to fourth-hole blow, creates a perfect fourth; the second, from third-hole blow to third-hole draw, produces a major third.

7. For a more technical treatment of fretboard transformations, see De Souza (2016b).

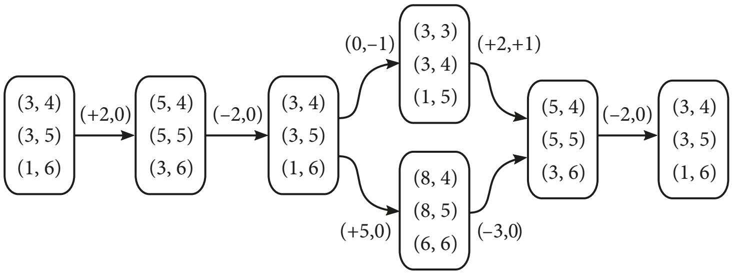
8. Timothy Koozin analyzes this passage in a network that combines "fret-interval types" with neo-Riemannian operations and pitch-class transposition (2011, ex. 2). I analyze more complex along-string transformations in Chapter 4 and more complex cross-string transformations in Chapter 5.

9. The layout of Lewin's graphs and networks was partially inspired by Jeanne Bamberger's use of Montessori bells in cognitive research (see Lewin 1993, 45–53). These bells can be arranged in diverse ways, effectively enabling children and adults to design their own instrumental spaces.

Figure 3.3 Introduction/verse riff from the Kinks, "All Day and All of the Night" (1964): (a) notation; (b) transformation network, showing two ways of realizing the riff in fretboard space. The riff uses a single fretboard shape. The upper route in the network includes cross-string transformations, whereas the lower route includes only along-string transformations. Note that guitar strings are conventionally labeled 1–6, with 1 as the string with the smallest diameter (typically the highest string) and 6 as the string with the largest diameter.

(a)

(b)



the ordered pairs that label harmonica transformations, though, the signs + and – represent preservation or change in blowing direction.[10] This is illustrated by the spatial network in Figure 3.4. In the nodes, the signs refer to breath direction; on the arrows, they refer to preservation or change. To get from the third-hole blow (3, +) to the fourth-hole draw (4, –), for example, I move one step up the comb and reverse my breath (+1, –). Again, this works for individual elements or sets.

Readers who are familiar with transformational theory may note that the group structures underlying these two models reflect different kinds of dimensionality. The tiered array is based on a group that is isomorphic with $\mathbb{Z} \times \mathbb{Z}$, while harmonica space is based on a group that is isomorphic to $\mathbb{Z} \times \mathbb{Z}_2$. Neither is modular like pitch-class space—that is, the top never flips around to the bottom. This also means that they must be theoretically infinite, that an actual instrument partakes of only a selected range of the abstract space.[11]

10. Julian Hook's uniform triadic transformations use these same signs for modes and modal changes. As Hook explains, "The set {+, –} forms a multiplicative group isomorphic to the additive group $\mathbb{Z}_2$ of integers mod 2" (2002, 62). Multiplying a sign by itself gives +; multiplying the two signs together gives –. This group can model other instrumental features too: for example, bowing or picking direction readily maps onto $\mathbb{Z}_2$, and trumpet valve positions can be represented as ordered triples of the form (σ, σ, σ).
11. Imposing boundaries here would cause formal problems, since it would no longer be possible to define intervals or transformations that hold for any element in the space (see Lewin 1987, §2.3.1; Rings 2011, 19). This is why the models of Rockwell (2009) and Koozin (2011), which specify finite sets of strings, cannot define cross-string transformations (see De Souza 2016b).

Figure 3.4 Spatial network for three adjacent harmonica holes. Reversing breath on the same hole is represented by the operation (0, –); moving along the comb, by operations of the form (+*x*, +) or (–*x*, +). These are combined in (+1, –), which moves up one hole and changes breath. Note that many operations in this space are not shown on this network. These include inverses—for example, (−1, +) is the opposite of (+1, +)—and compound moves, such as the (+2, –) action that would take (3, +) to (5, –).

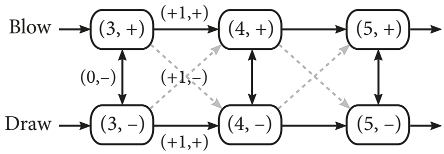


Figure 3.5 Stevie Wonder, electric-piano introduction from “I Wish” (1976). The head of this riff starts on E♭ and moves up through black-key space. Its tail starts on C and moves up chromatically to E♭. Though each measure repeats the same sequence of key and pitch classes, they have distinct pitch contours.

Some instruments, though, can be modeled as modular spaces. For example, it is possible to imagine the twelve “key classes” on a piano in terms of the integers mod 12 ($\mathbb{Z}_{12}$)—that is, the mathematical group that corresponds to the numbers on a clock face. This keyboard space, unlike fretboard or harmonica space, has a single dimension. Yet it, too, involves more than one kind of adjacency. I can move chromatically to the next key, or I can move to the next key *of the same color*, as in various “white-note” or “black-note” pieces (like the Chopin étude in Figure 1.8).[12] Mark Spicer (2011) cites the electric-piano riff from Stevie Wonder’s 1976 hit “I Wish” as an example of a black-note figure (see Figure 3.5).[13] In fact, this riff involves *both* types of adjacency in keyboard space. Though it initially climbs through a black-note pentatonic scale, the riff later drops to C and ascends chromatically to its starting note. While chromatic movement would be represented

12. In a presentation at the Society for Music Theory’s mathematics interest group, Hook (2014) discussed key-color invariance and pitch-class transformations, an issue with interesting consequences for fingering choices. James Bungert (2015) also considers key color in his analysis of performance gestures in a Bach corrente, though his approach eschews mathematical formalism.
13. Noting that Wonder’s keyboard riffs often highlight black keys, Spicer (2011) speculates that the blind musician might use these raised keys to orient himself at the instrument. Will Fulton confirms the tactile significance of the black keys, showing a distinctive hand position in which “Wonder keeps the thumb of his right hand at or below the ridge of the keys’ surface, allowing him to gauge his position, with his remaining digits on the black keys” (2015, 275).

Figure 3.6 (a) "Key-class" space and (b) a transformation network that shows the mapping for an operation Key. Key takes each key class "up" to the adjacent key class while preserving key color, creating a white-key cycle and a black-key cycle.

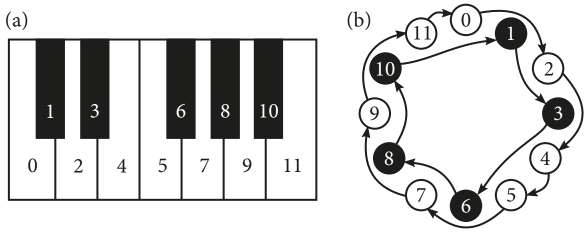
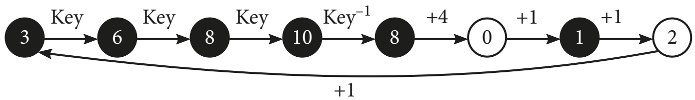


Figure 3.7 Transformation network for Wonder, "I Wish" riff. Node shading indicates key color.



via mod-12 addition, same-color movement can be modeled by an operation that I will call Key. As shown in Figure 3.6, this function neatly partitions the key classes into discrete white-note and black-note families. Note also that it can be compounded and inverted: for example, Key^2 moves up two same-color key classes, and Key^{-2} reverses that. With this new theoretical tool, it is easy to create a transformation network for the "I Wish" riff, which highlights these two kinds of movement at the keyboard (see Figure 3.7).

This model of key-class space conveniently replicates numerical note labels from pitch-class set theory. However, my networks represent locations on the instrument, not notes themselves.[14] In other words, *the topography of an instrumental interface is theoretically independent of any particular tuning*. Before particular melodies or harmonies can be derived from these networks, the space must be connected with some set of notes. I call this an instrument's *place-to-pitch mapping*.

The piano has a *one-to-one* mapping: each pitch has a single location on the keyboard. Yet other instrumental spaces—such as the guitar's tiered array or the organ's multiple manuals—have a *many-to-one* mapping, in which the same pitch might be found in more than one place.[15] This kind of many-to-one place-to-pitch mapping is also common to woodwinds like the clarinet, whose side keys permit a range of alternative fingerings. Still others have a *one-to-many* mapping. On the

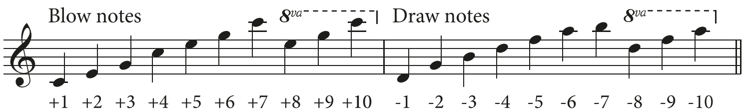
14. In this regard, my approach aligns with Joti Rockwell's transformational model of five-string banjo music. Rockwell defines a function called PITCH that maps fret/string locations on the banjo to pitches (2007, 205).
15. In mathematical terms, such mappings are "onto" or "surjective" (see Rockwell 2009, 140).

Figure 3.8 Pitch layout for a ten-hole diatonic harmonica in C: (a) chart of pitch layout for a harmonica in C, opposing blow and draw notes on each hole; (b) pitches of a harmonica in C in notation (with tablature). Note that pitch references follow the nomenclature established by the Acoustical Society of America, where C4 is middle C.

(a)

Blow	C4	E4	G4	C5	E5	G5	C6	E6	G6	C7
Hole	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Draw	D4	G4	B4	D5	F5	A5	B5	D6	F6	A6

(b)



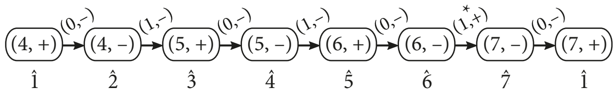
trumpet or tuba, for example, a particular set of valve positions affords not one note but a series of harmonics. The harmonica's mapping is, in a sense, both many-to-one and one-to-many. One pitch appears in two distinct places, and certain hole–breath direction combinations offer multiple notes.

Blowing through a standard ten-hole harmonica gives a major triad spanning three octaves; inhaling gives the remaining notes of a diatonic scale (see Figure 3.8 and Video 3.2). This tuning pattern—known as "Richter tuning"—has several idiosyncrasies.[16] It repeats $\hat{5}$ among the drawn notes (in an isolated many-to-one mapping), so the in-breath and out-breath give tonic and dominant chords. The bottom octave (holes 1–4) opposes these triads, skipping $\hat{4}$ and $\hat{6}$. The other end of the instrument omits the leading tone. That is, the harmonica does not just lack nondiatonic "chromatic" notes: depending on register, certain diatonic scale steps are absent too. (In its middle register, for example, the harmonica affords "Oh! Susanna" but not "Amazing Grace.") This might be understood in terms of a distinction, made by Tymoczko (2011, 11), between "scale" (again, a musical ruler) and "macroharmony" (the total collection of pitches actually appearing). The notes on the harmonica can be reckoned in terms of a diatonic scale, but its macroharmony is a pattern of nineteen pitches where no two octaves are identical.

Register also affects the relation between blow and draw notes. On holes 1–6, draw notes are higher than blow notes; this is reversed for holes 7–10. In the words of one player, above the sixth hole "is where the harmonica flip flops" (Holmes 2002). This spot stands out when one is learning to play a major scale on the instrument. As the network in Figure 3.9 shows, movement along the comb is consistent throughout the scale: after every second note, I move up one hole. (Note the regular alternation of 0 and +1 in the first part of the ordered-pair labels on the network's arrows.) But I must change my breathing pattern above hole 6: when

16. As Pat Missin (n.d.) shows, we do not know exactly who "Richter" was or when he developed this tuning.

Figure 3.9 Network for a harmonica's central major scale. The asterisk between scale degrees 6 and 7 marks a deviation in breathing pattern: this is the only place where the player preserves breath direction, inhaling twice in a row.



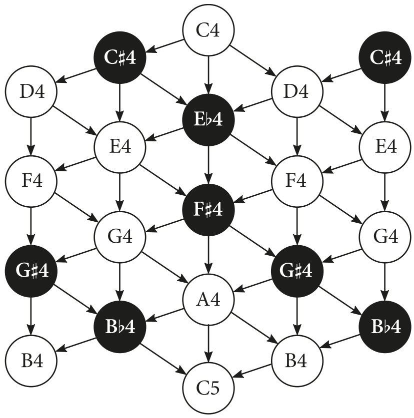
I move to the seventh hole, I keep my breath direction the same and inhale for two notes in a row. This (+1, +) transformation, marked with an asterisk, is the only one in Figure 3.9 that involves a + sign for breathing direction. More generally, this "flip-flop" means that any tune that combines blowing and drawing will have a different breathing pattern for each octave. Note, in fact, that only one pair of holes has the same pitch-class affordances. (Holes 1 and 4 both offer $\hat{1}$ on the blow and $\hat{2}$ on the draw.)

Many harmonica players explore the instrument's two dimensions without explicitly thinking about individual notes from Figure 3.8. Picking up the instrument as a child, I simply felt the consonant stability of the blown major triad. Draw notes, from this perspective, could fill in the gaps in this triad. This shows how an instrument's place-to-pitch mapping may involve hierarchical levels, somewhat like the nested pitch spaces theorized by Fred Lerdahl (2001, 49–50). Here the harmonica's major triad—the piano's white keys, the five-string banjo's open G chord, perhaps even the diatonic notes of the saxophone's finger keys—functions as a *referential pitch framework*, whose steps can be subdivided. In the cases just mentioned, the referential structure is essentially diatonic, which adds a certain asymmetry to the interposition of intermediate notes.

Because of its characteristic gaps, the harmonica's place-to-pitch mapping exhibits a certain *irregularity*. That is to say, consistent moves in harmonica space produce variable pitch intervals. The (+1, +) transformation, as highlighted in Figure 3.9, produces a major second when it starts from (6, –). But this move—going one step up the comb while maintaining breath direction—more commonly sounds a minor third, major third, or perfect fourth. There is a mismatch here between instrumental scale and pitch scale. By contrast, chromatic button accordions like the Russian *bayan* have a *uniform* place-to-pitch mapping. The evenness of its equal-tempered pitch collection is matched by its physical topography. The *bayan*'s regularly spaced melody buttons set out three maximally even interval cycles: as Figure 3.10 shows, the vertical axis moves by minor thirds, creating a diminished-seventh space; the major seconds of the northwest/southeast diagonal offer whole-tone scale segments; the minor seconds of the northeast/southwest diagonal, chromatic-scale segments.[17] This means that each pitch interval or melodic pattern has a consistent shape, which may theoretically start on any button. Furthermore, keyboard shapes transpose and invert just like pitch collections.

17. On symmetrical divisions of the octave in the English concertina, see Gawboy (2009). On the theory of maximally even sets more generally, see Clough and Douthett (1991).

Figure 3.10 Partial map of a *bayan*'s tuning pattern. Unlike the piano, the *bayan* offers the same pitches in multiple places. This network shows the octave between C4 (middle C) and C5. (Lower pitches are at the top of the network, reflecting the way that the instrument is held.) Each button, represented by a node, can be understood as the intersection of three consistent dimensions. Descending arrows move +3 semitones in pitch space; rightward arrows, +2 semitones; leftward arrows, +1 semitone.



Because of the *bayan*'s many-to-one place-to-pitch mapping, there are also many opportunities for alternative fingerings. These features, of course, differ in significant ways from the nonrepeating breathing patterns of the harmonica and the one-to-one mapping of the piano.

For emphasis, let me briefly present another variation on irregularity/uniformity with strings instead of free-reed instruments. The standard tunings for violin and double bass involve consistent intervals between adjacent strings, moving by perfect fifths or perfect fourths, respectively. This means that a fingering pattern generally creates the same sounding intervals, starting on any string.[18] The five-string banjo, though, is tuned to a G-major chord. Its place-to-pitch mapping is irregular, much like the harmonica's. Because each pair of adjacent banjo strings forms a different pitch interval, melodic fingerings change depending on their position in cross-string space.

If uniform mappings facilitate transposition, irregular ones may foster the sense of a privileged "home key." Players of instruments with irregular mappings, then, often change their instrument when they want to change keys. I put a capo on the banjo to create open strings that fit a new key, or I get another harmonica from the case.[19] Such adjustments can help preserve connections between locations in

18. To be precise, this works only for fingering patterns that do not involve the open strings—a boundary of the instrumental space.
19. A capo is a small device that clamps onto the neck of a guitar or banjo, stopping all the strings at the same fret. By transposing the open strings, it allows a player to use familiar chord voicings in any key. For example, I might use a capo to play in A♭ major: playing in "G major" with a capo on the first fret, in "E major" with a capo on the fourth fret, and so on.

an instrumental space and particular tonal qualia. It is easy to switch from one harmonica to the next because their physical interface is identical and their instrumental scales are related by exact pitch transposition.[20] (A similar situation applies to the various members of the saxophone family—and is reflected in their transposing notation, which specifies the note on the instrument, not the concert pitch.) That said, there are subtle differences in the feel and timbre of harmonicas that are tuned in different keys. In terms of ecological acoustics, these distinctions between high and low harmonicas are related to differences in material, specifically the reeds' restoring force (see Gaver 1993, 10). Lower-pitched harmonicas—for example, in A or G—speak easily and have a more mellow sound. Their reeds are more flexible. Higher-pitched harmonicas, like E, require stronger, supported breathing and have a brighter tone. The reeds' flexibility also affords one of the harmonica's most characteristic gestures: bending.

Once again, my breath not only initiates but also sustains the harmonica's sound. I can use breath, then, to add accents or vibrato. By changing breath pressure, along with mouth and tongue position, I can temporarily shift the pitch. This adds a degree of *mobility*, a term that I borrow from the Renaissance theorist Gioseffo Zarlino (1588, 218–20). The concept emerges from Zarlino's disputes with Vincenzo Galilei about tuning.[21] "Mobile" instruments can bend notes. This means that, like voices, they can make music in just intonation (which Zarlino believed to be numerically perfect). By contrast, "stable" instruments have fixed pitches and, therefore, require tempering. Violin, trombone, and theremin are mobile instruments, while piano and xylophone are stable ones. The former group can slide through the pitch continuum, whereas the latter divides it discretely. Since the intonation for mobile instruments is not strictly governed by holes or keys, playing them in tune relies on physical and auditory feedback. Players of these instruments, in other words, have to worry about tuning in a way that pianists do not. That said, they also have greater flexibility in the pitch discriminations they can employ, which makes it possible to more precisely match their pitch to that of other players. Zarlino includes a subcategory for stable instruments with some measure of mobility, since performers of certain instruments can alter pitches through blowing or fingering. The harmonica belongs here, combining stability and mobility.

The harmonica affords bending only in particular places (see Figure 3.11). This depends on the physics of the paired reeds.[22] Only the higher note on a hole can be

20. This suggests that canonic music-theoretical relations may be relevant to instrumental pitch mapping. Open strings on the violin and mandolin share the same pitches, while those of the viola and cello share pitch *classes*. Viola and violin have the same pitch intervals between strings, but with different pitches. Ukulele strings share unordered pitch-class intervals with the highest four strings of a guitar (but neither pitch classes nor pitch intervals). This is far from abstract for a guitarist picking up the ukulele for the first time: recognizing it allows a guitarist to use familiar fretboard shapes on the unfamiliar instrument.
21. For a discussion of Zarlino and Galilei's relationship and its historical context, see Palisca (1961). Note that Zarlino's distinction—in terms of Heyde's organology—would roughly correspond to a distinction between "continuous volume control" and "discrete state control" for pitch.
22. For an experimental investigation of harmonica pitch bending, see Johnston (1987).

Figure 3.11 Bending chart for a diatonic harmonica in C.

										B♭6
Blow bend								E♭6	G♭6	B6
Blow	C4	E4	G4	C5	E5	G5	C6	E6	G6	C7
Hole	1	2	3	4	5	6	7	8	9	10
Draw	D4	G4	B4	D5	F5	A5	B5	D6	F6	A6
Draw bend	D♭4	G♭4	B♭4	D♭5		A♭5				
		F4	A4							
			A♭4							

bent, meaning that the breathing direction for bends again "flip-flops" around hole 6. The bent note is always pulled down, and notes can be bent only into the space between the blow and draw. That is why there are the most possibilities on hole 3, where the blow and draw are a major third apart, and why bending is impractical on holes 5 and 7, where they are only a semitone apart. In general, the draw bends on the bottom half of the instrument are the easiest to play, because the reeds are lower-pitched and therefore more flexible. And this difference is important for various styles of harmonica performance.

Idiomatic Multistability: Folk, Blues, and Jazz Harmonica

Mapping an instrumental space only begins to reveal how players inhabit it, for the enactive landscapes that an instrument supports appear most fully in performance. Here the investigation proceeds on two levels. It examines individual performances, using transcription and close analysis. Yet these details also inform broader comparison. Like a set of phenomenological variations, interlinked analytical vignettes bring out broader patterns of variance and invariance. They show how an instrument's affordances ground its styles without fixing them. Analyzing harmonica performance thus drives a music-theoretical argument against technological determinism. It demonstrates how instrumental idioms are negotiated, emerging from the interaction of player and instrument.

Bob Dylan, "Queen Jane Approximately"

Such negotiation is particularly clear when a melody needs one of the harmonica's "missing notes." My grandfather played this way at family sing-alongs, either substituting a nearby pitch for the missing note or breaking away from the melody