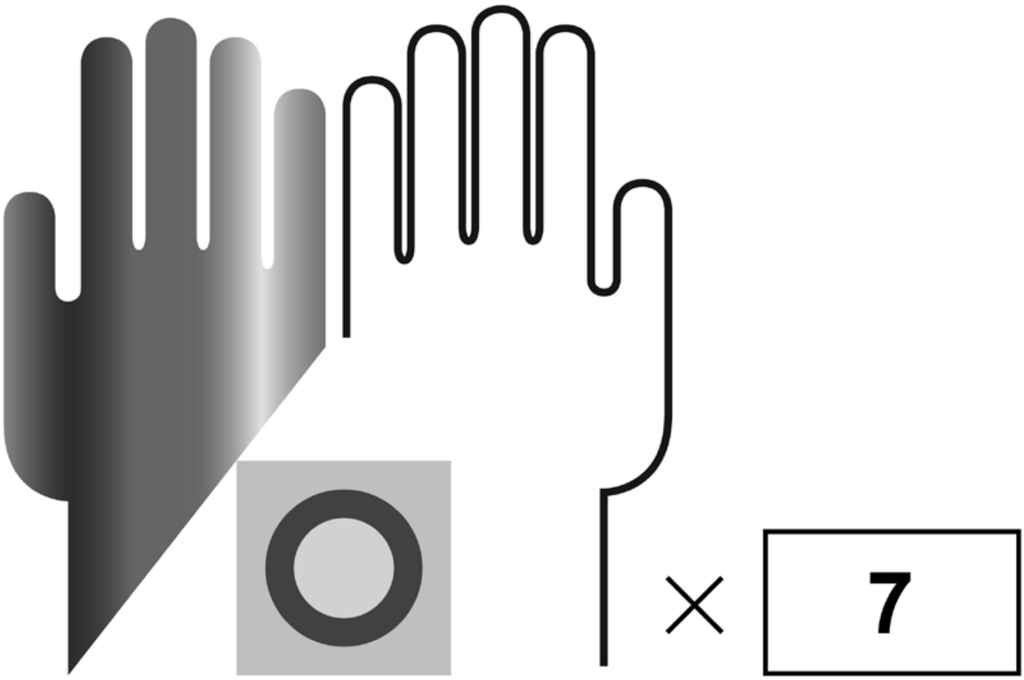

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Cover Image: Detail from the PALMAS handclapping drum machine software interface, included with Sufi Plugins for Ableton Live, written by Jace Clayton, released by Low Income Tomorrowland, and designed with Rosten Woo

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Every Friday, I visit my friend at his studio. I show up, we chat for a few minutes, then spend an hour clapping together. We're learning Steve Reich's 1972 composition "Clapping Music." The piece consists of one simple rhythmic phrase clapped repeatedly by two performers over the course of 13 sections. It begins with both players — named "clap 1" and "clap 2" in the score — beating the phrase in sync. Clap 1 loops the same pattern throughout the piece, while clap 2 shifts and inverts the phrase for each section. You can imagine it like two analog stopwatches set off at the same time, gradually going out of phase with one another; they remain *in time* but are passing through the minute cycles at different moments, creating dense syncopated effects. Played in a particularly resonant room, with echo and reverb as your backing band, Reich's study in phased rhythm can sound like the noise of three or four people, rather than just two.

With no melody or harmony involved, the score looks austere and mathematical. Beats are grouped into recurring patterns of ones, twos and threes, interspersed with rests. Precise instructions dictate the number of times each section is to be repeated. The score looks like a piece of music that should involve careful counting — a numbers game that might have been written by an Oulipian egghead more interested in questions of probability than musical lyricism. "Clapping Music" is easy to understand theoretically, but, for amateurs, exacting enough to present a challenge to play. Over the course of our Friday sessions, each of us have discovered that the best way to master the piece is to feel it rather than count it. We quickly lock in step, one player's rests filled in by the other's claps. It can feel as if your claps are almost physically bouncing off the sound of your partner's, creating a sense of momentum that propels the piece forward. Sometimes that momentum pushes us faster, our tempo accelerates beyond our capacity to stay in control of the performance, and the whole thing collapses. The sensation is almost sculptural; there's a tangible sense of parts interlocking, of cogs and shifting gears, a sweet spot between being focused on what you're playing yet not so self-aware of your activity that you stumble and fall. It's like walking; the moment you start to wonder how your brain is able to move your legs and feet in tandem and continue doing so as your mind concentrates on other things, is the moment you trip. Learning "Clapping Music" is a noisy meditation for the hands.

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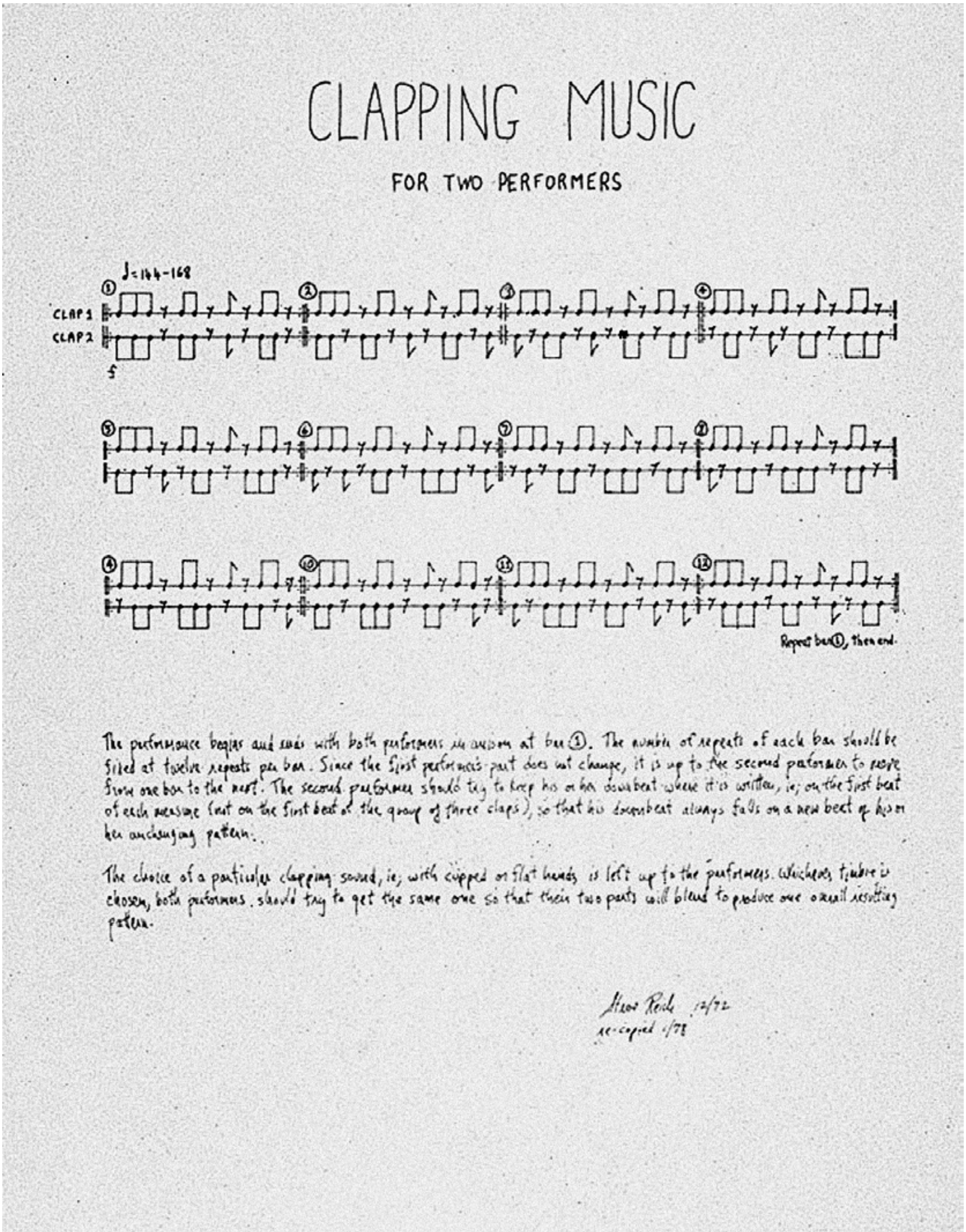
CLAPPING MUSIC
FOR TWO PERFORMERS
♩=144-168
CLAP 1
CLAP 2
f
Repeat bar ①, then end.
The performance begins and ends with both performers in unison at bar ①. The number of repeats of each bar should be fixed at twelve repeats per bar. Since the first performer's part does not change, it is up to the second performer to move from one bar to the next. The second performer should try to keep his or her downbeat where it is written, ie, on the first beat of each measure (not on the first beat of the group of three claps), so that his downbeat always falls on a new beat of his or her unchanging pattern.
The choice of a particular clapping sound, ie, with cupped or flat hands is left up to the performers. Whichever timbre is chosen, both performers should try to get the same one so that their two parts will blend to produce one overall resulting pattern.
Steve Reich 12/72
re-copied 1/73

I enjoy feeling rather than counting rhythm because I've never been very good with numbers. My relationship to them is borderline synesthetic. Even numbers are blue or creamy, round and airy. Odd numbers tend to come in rustic tones of dark greens and woody browns, their shapes thin, crisp, wiry. I associate even numbers with the right hand side of my body, and odd numbers with my left. Maybe you can blame that on my neural paths turning promiscuous at an early age. The department of my brain that's supposed to deal with logic and mathematics forged secret bonds with the departments of shape and color. As a result, I am embarrassingly slow at getting these even, fat blues to stack up with the odd, thin greens—don't look at me if you want to divide a restaurant bill between nine people and figure out the tip.

While learning piano and clarinet as a kid, I developed a keen ear for the limitless permutations of harmony, pitch, and timbre. I also had a natural sense of timing, yet when it came to learning those parts of music theory governing rhythm—counting beats, observing time signatures, getting the time value of notes and rests on the page to add up to the correct total for each bar—I tended to rely on intuition, on nothing more concrete than whether or not the timing "felt right." You could call this a sense of groove, or a dependable internal metronome. You could also call it fear. Bad experiences in mathematics classes put me off dealing with numbers head-on in music, and although my body was fluent rhythmically, the numerical and linguistic parts of my brain could not account for why. As a result, I could fudge pretty far in music exams, but I was never going to get into the Juilliard School.

Unless completely lacking a sense of rhythm, most people can tap their feet or click their fingers in time with a piece of music. According to neuroscientist Daniel J. Levitin, in his pop-science book *This is Your Brain on Music* (2006), our sense of timing is governed by the cerebellum; the oldest part of the brain in evolutional terms, and the area that is thought to control movement. The cerebellum helps us maintain a constant pace when we walk, run or tap our feet in time with a piece of music. Levitin uses the term "metrical extraction" to describe our ability to follow rhythm.

The brain needs to create a model of a constant pulse—a schema—so that we know when the musicians are deviating from it … We need to have

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a mental representation of what the melody is in order to know — and appreciate — when the musician is taking liberties with it.

Levitin holds that small variations in tempo help provide emotional depth to a performance. One of the pleasures of music is the subtle push and pull in rhythmic flow that the human hand can create. That moment when something *feels* right. Anyone who has ever tried to play in time with a digital click track knows how the strictures of mechanical time don't always fit the way our bodies want to play them; just as you feel settled into a tempo, you find yourself lagging behind the tick-tock of the metronome. It's said that Rolling Stones guitarist Keith Richards gets his louche playing style from keeping time with the bass rather than the drums; he's hitting the note a fraction of a second behind someone playing another fractional second behind the drummer. A counter-example might lie in the strict pulse of electronic music — the machine precision of Kraftwerk, for instance, is one of its pleasures. Same with 1990s Detroit techno, which marries soulful melody to exacting drum machines. (In the early 2000s, a subgenre of British house music called "wonky" involved producers playing their rhythm tracks manually rather than sequencing them on a computer, to give the music a vaguely woozy quality.)

A standard feature of music processing technology is quantization, which takes a rhythm performed live and adjusts any imprecisions, fixing each beat to a precise rhythmic grid. The rhythms may be technically correct, but they don't always sound that way, partly because quantization doesn't recognize what in music theory is called "tempo rubato" — the slight variations in speed that lend the performance of a piece its expressiveness. Musician and writer Jace Clayton observes that:

Ears are the most numerically precise sense because we can hear minute differences in cycles and frequencies, noticing small differences in wavelength — for example, when something is vibrating at say 440 hz as opposed to 442 hz.

This is because the ear can respond to tiny pressure variations — less than one billionth of atmospheric pressure. This fine calibration allows us to perceive pitch, amplitude, timbre, timing, and to locate ourselves spatially. Hearing and understanding occur simultaneously.

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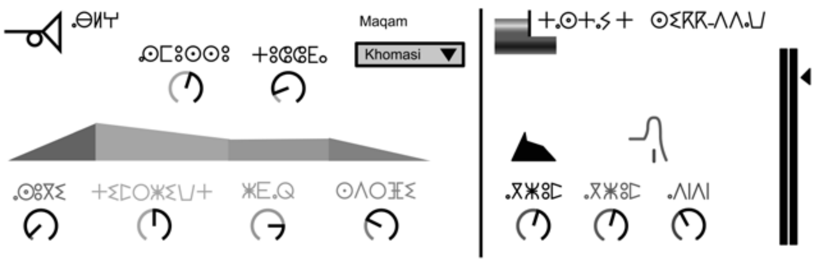
In 2012, Clayton released Sufi Plug Ins (SPI), a set of free digital tools for use with the music production software Ableton Live. SPI (developed in collaboration with Bill Bowen, Rosten Woo, Hassan Wargui, Maggie Schmitt and Juan Alcón Durán) grew out of Clayton's experiences living in Spain and working with North African musicians. When they tried to map their musical approach onto commonly used music-processing software such as Ableton, Garageband, Logic, and ProTools, the cultural assumptions built into the programs came to light. Written almost exclusively in Germany and the U.S., these software packages default to Western tuning systems and 4/4 time signatures, which are alien to musicians from polyrhythmic Maghrebi or Arabic musical traditions. Clayton wanted to create a set of tools that would help those musicians short-circuit digital cultural defaults.



SPI includes four synthesizers tuned to North African and Arabic Maqam quartertone scales, a drone generator, and a feature called Devotion, which lowers the volume on your computer five times a day during the call to prayer (settings include "Fervent," "Agnostic," and "Devout"). SPI's drum machine is called PALMAS. It generates claps and has five parameters: number of hands, velocity, pitch, stereo spread, and synchronization of hands (how loose or precisely timed the claps are with each other).

The SPI interface is entirely labeled in the Moroccan Berber Tamazight language. There are no numerical guides for any tools, and a roll-over script shows the user quotes from Sufi poetry rather than practical information—a little like a Middle Eastern version of Brian Eno's *Oblique*

Strategies, the set of aphorisms he assembled with Peter Schmidt in 1975 to foster lateral thinking and escape creative block. Clayton wanted the interfaces labelled in Tifinagh, a Berber writing system. One problem that he and SPI's interface designer, Rosten Woo, encountered was translating synthesis terms such as "sine wave oscillator" and "grain delay," which have no equivalents in Tamazight. According to Woo:

Luckily, Tifinagh (based on the examples I had access to) and Ableton have similar libraries of glyphs so the direction suggested itself. I knew I didn't want it to look "ancient" or play on any kind of Orientalist "otherness" so I just tried to design an interface as I imagined that a Tifinagh reader who was familiar with standard synthesis techniques would want the interface set up.

The Sufi influence comes from Clayton's work with Khalid Bennaii in the band Nettle. Bennaii considers his musical collaborations an extension of his Sufi beliefs, a way of interfacing with other philosophical systems. Broadly speaking, Sufism places an emphasis on the personal over the theologically doctrinal, a form of intuitiveness that Clayton reflects through the SPI interfaces:

What if the important information to impart was not how to use the drone but rather some emotional states or architectural spaces or a play between fog and visibility?

To use SPI, you have to feel SPI. We can think of SPI as being closer to a physical musical instrument than a software tool. If you look at an instrument, there are no numbers or labels to tell you what each part of the instrument does, but certain visual clues suggest the way in which it's intended to be used. A mouthpiece or reed implies that air needs to be blown through it. A key or valve invites the player to press it. Strings tell us that plucking or bowing is involved. Similarly, with SPI, we can see that there is a dial to be turned, but we don't know what that turn will do; you have to find your way through the mechanics without a map.

Clayton says that the most requested SPIs are for those dealing with rhythmic subtleties like polyrhythms.

It's interesting to me because to make those rhythmic subtleties work in a digital environment, you need to really codify and math them out, which in turns sets you thinking about loops, which are cycles, but which move though the cycle at different speeds at different points rather than at the regular metronomic BPM. So those corporeally felt shifts in counting appear really natural, but translating them into straight digitals unfolds huge complexities.

Codifying subtlety and deliberate conflicts of pulse is no easy task. A sense of swing in a rhythm comes from small, constantly changing shifts in relationships between different elements in the pattern; a snare drum coming just ahead of the beat, a cowbell hit just behind the beat—and hit by the stick at different points on the bell to produce variations in emphasis and timbre. Swing is also generated in the interaction between percussion and other instruments—the ways in which the rhythmic duties are "shared" by an ensemble. (The song "Vitamin C" by Can provides a good example: the bass plays a repeated riff of six notes, but fast, multiple rolls on the snare and kick drums create the auditory illusion of the bass playing eight or ten notes in the riff.) A plurality of rhythmic options is hard to achieve if you assign one time signature to it, but that's what a computer requires.

For example, to understand "tempo rubato," a computer needs every possible permutation of rubato explained, which is a little like the musical equivalent of explaining a joke. The joke is its own definition: to dissect it is to kill it, and often the best description of music is music itself— its form is a description of its form. Coding software that can produce the shimmer of relationships between parts played by different limbs, different people, and varying levels of energy and concentration, isn't too far off from trying to program a computer for the Turing test. Computer scientists have labored for years to find ways of coding linguistic semantics, teaching machines to identify subtle distinctions in meaning between words. Programming musical intuition is similar territory. Paradoxically, to loosen the quantization, you have to add more precision and detail to the coding, which makes the SPI less widely usable. To make "Clapping Music" sound convincingly TIGHT, you have to stop counting. To make a computer sound LOOSE, you have to feed it instructions in greater numbers.

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SPI doesn't yet offer a perfect solution to the problem of cultural presets.

People sometimes think that SPI offers a way out of that ("I can't wait to explore these Sufi riddims" was a recent one I heard) — they don't, at least not yet. It's complicated because the host software sets BPM and time signature, so a plug-in within that needs to exist in mathematical relation to the host environment to be useful.

Yet Clayton is developing other methods for humanizing the technology. One solution he is considering involves only providing the player with a basic set of standard rhythm patterns, like a cheap old keyboard. Instead of allowing the player to program their own patterns, the SPI might provide a standard 6/8 Moroccan chaabi beat, but which includes multiple layers that can be muted, humanized, tinkered with. Reducing the amount of available options and narrowing the focus also, paradoxically, allows for a greater degree of detailed variation to be built in. For SPI v.2, Clayton plans to include a layer for forgetting.

Digital files are fixed and unchanging until saved over or deleted, so I decided to humanize the software by having it slowly change the shape of each stored musical memory, and the more the user accesses a particular file, the more it will drift from what it originally was. The drift will be imperceptible from one day to the next but noticeable over time.

In principle, this emulates the way in which analog synthesizer sounds change due to fluctuations in the heat of the circuit board, or the way an instrument's timbre changes according to humidity and temperature — wood expanding, metal contracting, strings stretching.

For example, if you design a nice sound on the synthesizers and save it, then open it a day later, you won't notice anything, but if you opened it a year later the synth might sound substantially different — perhaps the sharp attack has smoothed into a second-long volume ramp, or it has drifted out of tune, or something glassy has become buzzy.

Since the dawn of recorded music, we've become attached to the idea of there being a definitive, "correct" version of a piece of music, against which we measure versions of it performed live or by different musicians.

The layer of forgetting encourages creative fluidity; it resists our memory's desire to quantize musical performance, to fit it within a rigid grid of right and wrong interpretation.

Early in our attempt to learn "Clapping Music," I tried to make a version of the composition using the program Logic in order to get my head around how the piece is structured. Sequenced using the software's built-in drum machine, my Logic version followed the score precisely. But with incremental changes in tempo and inflections in each clap eradicated, to my ears it sounded lifeless. The computer has no cerebellum, no capacity for getting a rhythm wrong, hitting a note slightly ahead or behind the beat. It will never choose to follow the bass player rather than the drummer. Sometimes numbers just don't add up. That's when you need to start thinking even, blue and round; odd, green and crisp.

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