Composer's Note

Biodata Improvisations: Externalizing the Internal Temporal Voice

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Abstract

This paper presents *Biodata Improvisations*, a series of collaborative improvisational works developed by sound artist Danny Hynds and rhythm researcher and musician Shinya Fujii, in which the real-time heartrates of both performers serve as the primary temporal material. Routed through custom-built biodata sensing hardware, a Eurorack modular synthesizer, and Max/MSP, the physiological signals of each performer drive independent musical parameters, placing two biological rhythms in proximity with one another while not strictly imposing a shared pulse. This paper introduces the concept of physiological groove as the temporal character of specific bodies, which exists prior to any musical encounter or interpersonal entrainment, and discusses how *Biodata Improvisations* makes this interior quality audible as compositional material. The paper also addresses the compositional decisions surrounding mediation and routing, reflects on a pivotal moment of unplanned convergence during the first recording session, and considers what this practice offers that conventional groove-based performance cannot. The work is situated within the broader methodology of *Temporal Counterpoint*, an on-going study in the externalization of bodily time, in which real-time physiological data functions as an independent temporal voice alongside composed or improvised sound.

1. Introduction

Groove is a loaded word in the far-reaching lexicon of musical studies. Coming up through jazz studies as a bass player, I spent years learning to feel and create it. Finding the "pocket", as we would typically refer to it, was one of the more pressing concerns I had as a member of the rhythm section, serving as the backbone for the ensemble at large. Much of this is about inhabiting the rhythms of the pieces to a point where active thought is not given to it, but rather it is felt throughout the body. The assumption embedded in this training consistently pointed to groove being something that happens between people. It emerges from the interaction of bodies in time. Almost imperceptible adjustments musicians make toward one another and the shared gravity of a pulse that nobody in particular imposes constitutes this collective sense of rhythm and musical synchronization.

Psychological research has formalized this understanding. Groove has been defined as the pleasurable urge to move associated with sensorimotor coupling (**?**), with studies demonstrating that medium degrees of rhythmic complexity, particularly syncopation, eliciting the strongest desire to move and the greatest pleasure (**?**). This body of work has established groove as a phenomenon of encounter: something that emerges from the interaction between music and a listening, moving body, shaped by the structural properties of the rhythm and the motor predictions of the listener. Studies examining how syncopation creates the sensation of groove have similarly focused on the structural properties of the musical signal rather than the interior temporal character of the performer (**?**).

What I did not consider for a long time was where the groove originates before any musical encounter. When I began working seriously with physiological data as compositional material, one of the earliest surprises was how the data moved. Heart rate is not metronomic, but rather an aspect of our being that breathes, shifts, recovers, and responds. There are patterns in it that have duration and character, much like that of the music that we compose. When I began routing heartrate into tempo, translating the body's own rhythm into the music's rhythm, something became audible that was a surprise tome. The resulting musical works had quite a unique feel to them, as opposed to the chaotic and unmusical result that I had anticipated. This embedded musicality was not something that was intentional or orchestrated necessarily, but rather something that was existing within the bodies which were being sensed. While these sensing platforms were not directly composing or performing musical gestures on their own, they provided a curious genesis for a process of integrating our body's own rhythms into discernible musical works.

This paper introduces the concept of physiological groove,

or the temporal character of an externalized set of bodily processes, and presents *Biodata Improvisations* as the work through which this concept became most clearly audible.

2. Temporal Counterpoint

Biodata Improvisations exists within a broader compositional methodology I have been developing called *Temporal Counterpoint*. The central commitment of this methodology is that real-time physiological data such heartrate, breathing, galvanic skin response, and HRV can function as an independent temporal voice within a musical composition. These bodily processes are not presented as direct control signals, nor as a representation of the body's exact states, but rather as a coexisting voice with its own rhythm and counterpoint, which shape the music alongside composed or improvised material without being subordinated to it.

In this practice, physiological processes are not treated as data used to control musical outcomes in a one-to-one manner, but as independent temporal voices existing alongside composed sound. Music and bodily processes unfold together, forming a counterpoint between external sound and internal duration. This approach shifts composition away from the production of events and towards the cultivation of conditions for listening. Rather than listening for what should be played in an improvisational setting, it allows for a stronger sense of listening to what is being pulled from within the performers or audience, and accompanying that guidance.

Temporal Counterpoint remains intentionally open-ended. Its central question is how music might allow the temporal life of the body to appear without representation or translation. In works which are intimately intertwined with the body's unique signals, how might sound exist beside lived time rather than impose itself upon it? The work seeks a space in which listening becomes shared between performer, listener, and the quiet processes that sustain human presence.

This approach is in a sense separate yet strongly inspired by related practices in biofeedback music (**?**), where physiological signals are used to regulate a performer's state, and from live data sonification, where the data is translated into sound as a representation of underlying information. In *Temporal Counterpoint*, the physiological voice is not translated or interpreted. It is allowed to be present in the music the way one voice is present alongside another in a counterpoint. Each voice, whether actively executed by a performer or led by an internal process, is distinct, independent, and in dialogue with all other voices.

The methodology emerged from a growing conviction that the body's temporal rhythms of the autonomic nervous system running underneath conscious experience could constitute genuinely musical material. It is not metaphorically musical, but rather literally so in the patterns, durations, and specific relationships to time that belong to a specific person at any given moment.

3. Physiological Groove

Groove research has established that the pleasurable urge to move to music is shaped by rhythmic complexity, sensorimotor prediction, and reward processing (**?**). The phenomenon is understood as relationally emerging from the encounter between a structured musical rhythm and a body that entrains to it. In ensemble performance, groove is understood as something found between people: produced by the interaction of bodies in time rather than residing in any single body before the musical encounter begins. Research has further shown that individual factors such as listeners' musical backgrounds, familiarity, and personal taste exert a stronger influence on groove experience than the structural properties of the music itself (**?**).

A compelling scientific basis for this connection emerges from research into the statistical structure of musical timing. Virtuoso musical performances have been shown to contain 1/f fluctuations, a form of scale-invariant variability in which timing deviations are neither fully random nor strictly periodic, but exhibit long-range correlations across multiple timescales **??**. This quality is widely associated with natural, expressive, and aesthetically compelling temporal behavior. Crucially, heartbeat rhythms exhibit the same 1/f fluctuation structure **???**. The statistical character that makes expert musical performance feel alive and human is thus present in the body's own rhythmic output prior to any musical act. Routing heartrate into musical tempo is therefore not merely a conceptual gesture. It introduces a signal whose intrinsic temporal structure shares measurable properties with expressive musical performance itself. This provides a physiological foundation for what the methodology makes audible, that the body's time already possesses the qualities we associate with musical groove before any encounter with music has taken place.

What this practice of working with physiological data has revealed is that groove precedes these musical encounters. The body's interior temporal life has a character that is both consistent enough to be recognizable and specific enough to belong to a particular person. When this interior rhythm is externalized through sound, what becomes audible is not simply a tempo source but a temporal personality: the felt quality of how a specific body inhabits time.

This is what I refer to as physiological groove. It is not produced by interaction or entrainment, but it exists inside the individual before any musical encounter begins. What the methodology allows is not the creation of groove but its externalization and sonification. For the first time, at least in my experience, it became possible to hear someone's temporal character in isolation, not as something they performed or expressed but as something they inherently have within their body.

However, this concept does not stand against what groove research has established. The relational phenomenon

that prior research has documented is real, and it is something I know from years of ensemble performance. What I am suggesting is that it starts earlier. Before a shared pulse or finding the pocket, there is the individual's own time, which in this approach becomes intertwined with the gestural and performative layers already inherent in musical performance.

4. Biodata Improvisations

4.1. Concept and Setup

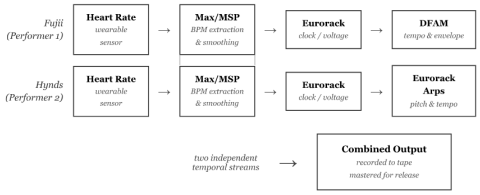
Biodata Improvisations grew from a collaboration with Shinya Fujii, whose research into the psychological and neuroscientific dimensions of musical groove (**?**) made him a particularly generous partner for exploring what physiological groove might mean from inside an existing expertise in the field. His background meant that he was encountering the concept from within a deep familiarity with conventional groove research and able to see both where the idea extended what he already knew and where it departed from it.

The premise was simple: both of our heartrates would serve as clock sources, routed through hardware to generate improvised music. His rhythm is driving certain elements, while mine is driving others, and at times our shared internal grooves would converge to create a collective third stream of tempo. The performance system was designed to allow for in-the-moment decisions pertaining to the implementation of the two independent clock sources as well as the aggregate clock source. The hardware system was intentionally kept minimal, consisting of a Moog drum sequencer, an 88HP/6U eurorack case, Max/MSP, and live drums. We decided to devote a day to improvising with this setup with the hopes that we might get some tangible results to work with, and in the end both takes proved to be strong enough for us to release as a 2-track EP.

4.2. Routing and Implementation

The heartrate signals from both performers were captured using wearable sensing devices, processed through a custom signal processing software pipeline, and relayed to Max/MSP over the network. These extracted BPM values, given as floating point numbers, were primarily used to drive clock signals in the Eurorack modular synthesizer. Once introduced into the eurorack system, they were multiplied and sent into a number of modules, including clock dividers/multipliers, multiples, and externally sent to the drum sequencer. Fujii's heartrate primarily controlled the DFAM (Drummer From Another Mother), driving its tempo and shaping its envelope characteristics through the rate of change within the heartbeat over time. My heartrate controlled arpeggiator patterns, speeds, and pitch selection in the main Eurorack voice system. This basic setup was established as the core starting point for each of the improvisations, which were then performatively changed and manipulated throughout the performance. These clock signals were flexible and allowed for performative routing and assignment within both systems, while the sensing software also provided a means for recording the timestamped raw data for further anaylsis.

FIGURE 1. SIGNAL FLOW — BIODATA IMPROVISATIONS



Each performer's heartrate is captured by a wearable sensor, processed in Max/MSP for BPM extraction and smoothing, and routed as voltage to independent voices in the Eurorack modular synthesizer. The two physiological streams coexist without entrainment or a shared imposed pulse. Output was recorded directly to tape.

Figure 1. Signal Flow — Biodata Improvisations.

In determining the tonal elements of these works, I intentionally kept things somewhat simple and akin to drone music. Each song consists of a persistent tonal center of B minor, with two main arpeggiations devised for each performance (x and y axis). Our heartrate data independently drives the temporal and musical organization within a Cartesian sequencing structure via the Make Noise Rene 2, with the third lane of the sequencer acting as an aggregate from those two primary lanes. One heartbeat is assigned to the first axis, while the second heartrate is assigned to the Y axis. The pitches were pre-determined for each axis but the behavior of the sequences were independently controlled from the other heartrate through a gate logic built in Max/MSP. In this logic, for every n heartbeats, a decision is made whether to continue in the same direction through the pattern or switch to a different direction. Due to the differing pace at which our hearts were beating in the performance, these changes were not in line with one another, creating a more expansive musical palette.

The x and y axis from the Rene 2 were further sent out into the rest of the eurorack system, which allowed for an additional layer of chance operation and hands-on manipulation of this limited pitch set. Whereas the Rene 2 was almost entirely beholden to the direct heartrate data, the copies of it throughout the rest of the system were designed to allow for more active performative control.

One critical compositional decision concerned the update rate for the BPM signal within Max/MSP. Depending on how frequently the system recalculated and applied the current heartrate to the tempo, the tempo might jerk uncomfortably or lose contact with what the body was actually giving. Finding a range within which the physiological groove reads as itself was part of the compositional work that was developed prior to this set of improvisations. The composer/performer mediation of the incoming signals is always present, and its design shapes what is heard as directly as the routing itself.

A further safeguard was built into the Max patcher in the event of a signal drop, in which the parameters would hold their last position rather than falling to zero. This prevents abrupt discontinuities that would disrupt the performance without announcing themselves as failures, allowing the system to recover imperceptibly if connectivity fluctuates.

4.3. The Recording Sessions

We conducted two long-form improvisation sessions at the X-Music Lab recording studio at Keio University SFC. Each session lasted approximately twelve minutes and were both recorded directly to tape and subsequently mastered for release as *Biodata Improvisations // 2025.12.22*. There were no rehearsals or extensive planning sessions prior to the recording, which allowed us to perform the improvisations without unnecessary guidelines or restrictions. In the end, both sessions felt much more coherent and musically sensible than I had expected. Although I had prepared an externally-driven click track for Shinya to use as a guide, he instead preferred to use the sounds themselves as a reference point, ensuring that the sterile feel of the click track did not hinder our performance. The tempo was not consistent for either session as they followed our heartrates in real-time, but the rhythm and movement of the heartbeat-driven clocks provided the music a strong enough backbone to afford a musically cohesive experience. This approach proved to be a sufficiently new experience for us both without veering too far away from the comfort level we would require to perform freely and without hesitation.

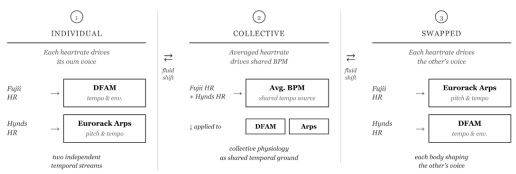
4.4. The Routing Swap

Approximately halfway through the first session, I made a decision that I had not planned in advance. I switched the routing so that Fujii's heartrate moved to the Eurorack arps and my heartrate moved to the DFAM that he had been using as a kind of temporal reference point. Each of us was now driving the instrument the other was playing, with his body's time shaping my music and my body's time shaping his drum patterns.

What followed was one of the more unexpected musical moments in this practice. The dynamics between us shifted, and the tempos began pulling against each other in a new way. It wasn't rhythmic or textural dissonance exactly, but it was a new feeling of tension that wasn't there before. Two grooves displaced from their source, each now animating a new sonic palette almost immediately. Following a brief moment of disconnected rhythmic activity, the two physiological grooves found a new coherence in which the two independent temporal streams seemed to resolve toward each other. It lasted a short time and then the music continued to evolve in more expected ways.

This moment was not engineered and neither of us pre-composed it. It arrived because two interior temporal characters, placed in a new relational context, produced something that neither would have produced alone. In the framework of conventional groove research, such convergence might be understood as a form of entrainment, or the natural tendency of coupled oscillators to synchronize (**?**). In the framework I am working within, it was something more compositionally intentional. Not the goal of the work but a "happy accident" the work produced by holding two physiological grooves in proximity and allowing them to navigate new musical possibilities.

FIGURE 2. DYNAMIC ROUTING STATES — BIODATA IMPROVISATIONS, SESSION 1



Routing configurations shifted dynamically throughout Session 1 rather than occurring as discrete sequential phases. At different moments, each performer's heartrate drove their own instrument (State 1), the averaged collective heartrate provided a shared BPM source applied to both voices (State 2), or the routing was fully swapped so each body's time shaped the other's musical voice (State 3). The transitions between states were made in real time by Hynds during the improvisation.

Figure 2. Dynamic Routing States — Biodata Improvisations, Session 1.

5. Reflections

The collaboration with Fujii was generative precisely because of the friction it produced. His background in groove research meant that he encountered physiological groove from the inside of an existing expertise — bringing questions that a non-specialist might not have thought to ask, and a sensitivity to what was genuinely new here versus what only appeared new. Our conversations about the work have been as generative as the sessions themselves.

Several questions remain open and are guiding ongoing development of the work. Whether a listener who does not know the source of the material can perceive the groove as belonging to a specific person and whether physiological groove is detectable as personal rather than generic is something the recordings suggest but do not resolve. Whether the moment of convergence in the first session was structurally inevitable as a property of any two physiological rhythms placed in proximity for long enough, or whether it was genuinely musically synchronous remains unclear. What the sessions confirmed is that the body keeps time in a way that has its own feel, and that feel is not random. When externalized through a system designed to preserve rather than flatten it, that character becomes audible. It is not presented as a full demonstration of the methodology but as something with inherent musicality and performability.

6. Conclusions

Biodata Improvisations proposes that groove, understood as a relational and intersubjective phenomenon emerging from entrainment and shared pulse, has a foundation that precedes any musical encounter. The temporal character

of a specific body, existing prior to any interaction, and the relationship between multiple temporal characters, sits at the center of this work. The methodology of *Temporal Counterpoint* makes this interior temporal quality audible by routing it into sound, allowing it to coexist with improvised material as an independent voice with its own rhythm and its own contrapuntal results.

The collaboration with Shinya Fujii placed two physiological grooves in proximity without imposing a strict shared pulse, creating conditions in which something unexpected could arrive. This work is on-going, and each new performance retains its own unique character. The questions it raises about the relationship between physiological time, musical feel, and the nature of groove are questions we are still exploring in the future work of this project.

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7. Author's Profile

Danny HYNDS

Danny Hynds is a Yokohama-based composer and sound artist whose work explores listening, duration, and embodied temporality through electronic performance, installation, and physiological interaction. His practice investigates how internal bodily rhythms and states of attention may coexist alongside musical sound — an approach he describes as Temporal Counterpoint. He completed his PhD at the Graduate School of Media Design, Keio University in 2024, and currently serves as Project Assistant Professor in the X-Music Lab at Keio University Shonan Fujisawa Campus. He also works as a Creative Technologist with VIE, Inc., developing performances and installations exploring sound, perception, and embodied interaction. His recent works include *Endogenous Music*, *Biodata Improvisations*, and *Collective Somatic Counterpoint*.
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Shinya FUJII

Shinya Fujii is a drummer and an Associate Professor in the Faculty of Environment and Information Studies at Keio University. He directs the Research Center for Music Science at the Keio University Global Research Institute and is the Principal Investigator of the x-Music Laboratory and the NeuroMusic Laboratory at Keio University SFC. His research interests lie in the neuroscience of music, particularly the neural origin of rhythm and beat perception and production.
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