Rhythm and Textural Temporality: Experience without Subject and Duration as Effect[1]

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Abstract:

We explore the relation between the rhythmic aspect of lived experience and 'bodies' in 'movement' through inhomogeneity, via abductive, radically empirical, experimental studies of lived experience. With these examples in hand, we use the consideration of rhythm to propose (1) a field-like or *textural* approach to the co-articulation of subjects and objects, and (2) duration not as an abstract index or independent parameter of which action is merely a function, but as an *effect* of activity and observation. What's at stake is a nuanced example of how sense emerges in the textural dynamics of lived experience.

Keywords: temporality, rhythm, process, embodiment, non-anthropocentric, new materialism, experiential experiment

Body + Movement + Irregular Matter → Rhythm

Let us begin with a simple — and provisional — proposition: rhythm as a feature of experience (rather than an abstract pattern) arises from a body encountering variation in matter through movement. Without a body there would be no *sense*. In a perfectly homogeneous experience of a perfectly homogeneous world there would be no (non-degenerate)[2] rhythm regardless of movement. Running your finger across this irregular surface, you feel irregular pressure on your skin that you can interpret as a rhythm — a variation of sensation correlate with your

[1] Based on a chapter under review for On Rhythm: Technics, Culture and Capital, ed. Paola Crespi, Sunil Manghani, with co-author Garrett Laroy Johnson.

[2] In mathematics it is common to say 'degenerate' referring to the most reduced case, for example in the set of all functions mapping a real number to a real number y = f(x), the degenerate function could be the constant function f(x) = constant c for all x.

movement. Stopping your finger's movement you would feel no variation. If the surface were perfectly smooth, you also would feel no variation. So, corporeal movement and irregularities in matter are necessary to rhythmic experience, at least in this preliminary formulation. Notice that corporeal movement compounds the body as a necessary ingredient in this experience. Feeling via embodied engagement is an inextricable component of experience. Thus, according to our formulation, body, movement and inhomogeneous matter are necessary for rhythm *as sense*. Regarding sense, Merleau-Ponty writes:

> The sensing being [*le sentant*] and the sensible are not opposite each other like two external terms…the movement of my hand subtends the form of the object. In this exchange between the subject of sensation and the sensible, it cannot be said that one acts while the other suffers the action, nor that one gives sense to the other. Without the exploration of … my hand, and prior to my body synchronizing with it, the sensible is nothing but a vague solicitation. (Merleau-Ponty 2014: 221-22)

However, variation of matter and corporeal movement, while elemental as ingredients of a sense of rhythm, may not exhaustively account for the phenomenon. Rhythm as a temporal pattern in experience lies beyond or in between sense perceptions. One gets to a sense of rhythmic pattern via perception, but rhythm itself is not sense data. *To borrow phenomenological vocabulary, rhythm is not perceived but apperceived*.

The reader may find it completely obvious that rhythm is not to be found 'out there,' to be represented by sense or sensor data, but rather is a feature of lived experience, and thus inextricably part of phenomena rather than data. But in the age of machine-perception, sensor

technologies and big data, and zombies,[32] it seems useful to recall Merleau-Ponty's scientific meditations on temporal experience. He writes: 'We are not saying that time is for someone, which would once more be a case of arraying it out, and immobilizing it. ...We must understand time as the subject and the subject as time' (Merleau-Ponty 2014: 490) Merleau-Ponty provides an integral account that steers clear of purely idealist as well as purely realist positions:

> Existence cannot be anything – spatial, sexual, temporal – without being so entirely, or without taking up and assuming its 'attributes' and turning them into the dimensions of its being, such that a relatively precise analysis of each of them in fact has to do with subjectivity itself.…If we succeed in understanding the subject, this will not be in its pure form, but rather by looking for the subject at the intersection of its various dimensions. (2014: 433)

In other words, felt time (ditto space) is not an abstract frame inside of which we position an event or an individual. Instead the temporal sense is one aspect — a dimension — of an individual's experience. Merleau-Ponty draws striking consequences about events from his experiential account:

> [T]he very notion of an event has no place in the objective world. When I say that the water currently passing by was produced by the glacier two days ago, I imply a witness fixed to a certain place in the world and I compare his successive perspectives.…[T]here are no events without someone to whom they happen.…(2014: 433)

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3 In the philosophy of mind, a zombie is a being who exhibits all the features and behavior of a human being, but has no consciousness. In modern times, David Chalmers has prominently used the conceivability of zombies as a counter-example to physicalism. Chalmers, D. J. (1996) *The Conscious Mind: In Search of a Fundamental Theory*, New York and Oxford: Oxford University Press. Ironically today we see robots caricaturing humans and people doing mechanical algorithmic activity.

Moreover, temporality as a relation between a subject and the world implies that, in Merleau-Ponty's words,

> time is neither a real process nor an actual succession that I could limit myself simply to recording. It is born of my relation with things. (2014: 434)

Departing however from the presumption of a pre-given Cartesian cogito in cognitivist and phenomenological projects, we keep in play various commitments to particular notions of *subject*, *body* and *time*. This methodological attitude draws from both pragmatism's radically empirical approach based on experience (as found in the work of William James) and Edmund Husserl's injunction to attend to the phenomena themselves. Thus, we start from neither theoretical abstractions like time or numbered metric nor unperceivable mechanism, but rather from lived experience, succinctly put in the Introduction to the 1912 edition of William James' *Essays in Radical Empiricism* as follows:

> (1) [T]he only things that shall be debatable among philosophers shall be things definable in terms drawn from experience.… (2)… the relations between things, conjunctive as well as disjunctive, are just as much matters of direct particular experience, neither more so nor less so, than the things themselves. (1912: 3)

Informed by such a perspective, we keep in play notions like *subject*, *body*, or *time* rather than invoking them as primitive building blocks of experience, which risks turning them into abstract forms under the disembodying and deterritorializing optics of cognitivist and computationalist theory. Toward the latter part of this essay we will reverse our consideration and use our understandings of rhythm to derive some insight into what may be meant by *temporal subject* and *temporality*. The approach to rhythm that we describe also avoids commitment to a particular notion of the anthropic subject, whether phenomenological, psychological or cognitive. In this sense, it shares with pragmatists and process philosophy and some aspects of contemporary materialism the proposition of *experience without a subject*. One of our method's

most distinctive features pursuing these philosophical questions not only empirically but *experimentally*. For us, to experiment means to reproducibly and precisely vary the *conditions* of experience, which is quite different from reproducing an event or experience in rehearsed performance for an audience.

pink: omitted descriptions of research-creation experiments

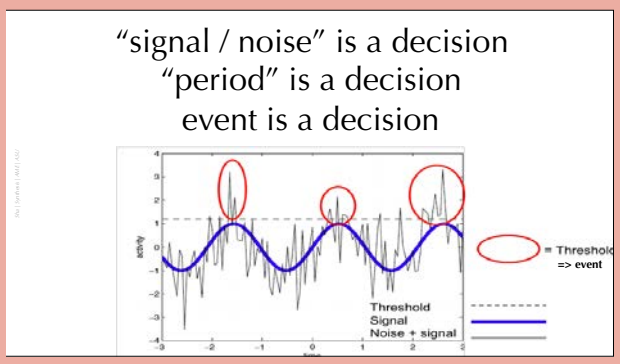
Empirical Work

Over 15 years, the first author's Topological Media Lab (TML) constructed experimental, gestural media and performative techniques for exploring philosophical questions. By experiment we mean reproducibly conditioning, but *not* determining or representing, experience according to some proposition. This is not about testing disconfirmable hypotheses. In our work, we condition affective, logical, causal, symbolic aspects of experience in a live event.

With over 140 computational media artists and programmers, musicians, dancers, choreographers, philosophers, architects, computer scientists, applied physicists, literary scholars, puppeteers, anthropologists and designers, the TML and now the Synthesis Center at ASU systematically created experimentally conditioned experiences ranging from structured improvisatory movement studies, vegetal motion and dance, acoustic ecologies, and experiential climate simulations. The second author has conducted more recent experiments with faculty, students and researchers in Synthesis, which we describe in the following.

First we will describe some initial experiments which approach rhythm in the ordinary sense of beat-based duration patterns because they helped us to understand what we *do not mean* by rhythm. We follow those examples by others that illustrate aspects of rhythm as textural, sensed with the body, generating subjective experience through ensemble activity.

Discretized Rhythm: Tapping, Clapping, Beats



In preliminary rhythm studies we (Garrett Johnson, Gabrielle Isaacs, Julian Stein, Todd Ingalls, Sha Xin Wei) asked participants, including ourselves, to play in ad hoc ensemble activity according various conditions. Inspired by biofeedback research-creation work with Teoma Naccarato and John Maccallum (2016), we began with two variant activities characterized as entrainment exercises.[43] Entrainment is usually understood as a synchronization of gesture to a periodic beat. While one may entrain to a metronome, a drummer, or someone's gait, our initial hunch led us to vary the perceived source of the beat in entrainment. Our first pass replaced Naccarato and MacCallum's modulation of heart rate with a simple tapping mechanic. A system with a contact mic was tuned to register the taps as beats. Participants tapped out different regular time intervals to 'discover' an implicit beat. The difference between the participants' tap interval and the implicit beat varied the color of the room's ambient light, blue if they were tapping too slowly, red if too fast, white if in sync. Single participants found success quickly by beginning at an extreme tempo and slowly changing the tempo and monitoring fluctuation in the lights' color. We had much less success when attempting the same task in a group of three or more. As a group, we found we were more concerned with delivering correct inputs to the system (through turn taking or other systematic approaches) than we were with the activity at hand. The color of the lights did not convey anything about the target speed of beats itself; the participant had to interpret the schema we imposed upon it ahead of time.

[4] See http://vimeo.com/synthesiscenter/heartbeat, beat matching experiment by dancer Teoma Naccarato and composer/media-programmer John MacCallum, hosted at Synthesis ASU, 11-17 January 2015.

What this experience suggested was that we would not uncover anything new about the felt experience of tapping a pulse by registering time intervals alone. There was also the issue of the implicit tempo, which was generated by the computer pseudorandomly each time we began. This exercise gave us the sense that we needed to tune into a rhythm which was already out there, unheard, somewhere. To recall a quote attributed to Johann Sebastian Bach,[5] 'all you have to do is touch the right key at the right time' (Marshall 1999). But there was no given rhythm; there was only an integer stored in the computer's memory. We might be inclined to say that the color of the light guided the participant towards an arbitrary rhythmic interval. But the interval, as measured by the contact mic, suggests the atomic or modular conception of rhythm which Bach hinted towards. The time interval has nothing to do with our felt experience of pulse and even less to do with rhythm as we have construed it above.

To this point, consider a variation of this experiment. We retooled the software so the average of the previous ten intervals was compared to the most recent. The same color mapping was reflected the difference between the average and the most recent. Our inclination was to find a better way to make a uniform and consistent pulse as a group. We thought to leverage the relative uniformity of our gaits, so we walked in a circle while the contact mics sensed our footsteps from the floor. We expected a tempo to emerge like sometimes happens in an audience's applause (Neda 2004).

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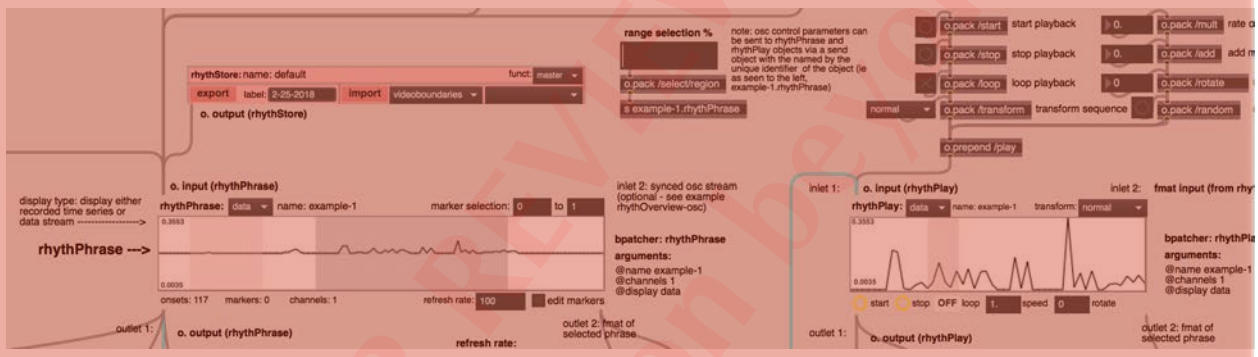
[5] This attribution is often taken out of context to invoke due laughter given Bach's widely regarded brilliance as both a composer and a performer. It is revealing that Bach was referring here to the organ, and not other more sensitive instruments. In any case it is clear that there is quite a lot glossed over in the phrasing 'at the right time.' Attributed to Bach by J.F. Köhler, *Historia Scholarum Lipsiensium,* 95, cited in Spitta 1880 ii 744 as quoted in Marshall 1999

Our results were rather revealing however. Different people would beat with different parts of their step, or a single step would be be registered by the system twice, or three peoples' step would be registered as three separate onsets. But, rather than a defect of method, not identifying rhythm with specific 'fleshy' bodies exposed us to a consideration of the rhythm of the entire ensemble, indeed of the entire event. We asked: how can we address the rhythmicity of a single step? when and where and how do we make the cut and say 'step'?

The Rhythm Kit: *Gradus ad Rhythmus*

<INSERT FIGURE 1 | CAPTION: Rhythm kit, by Julian Stein, Synthesis.>



Julian Stein at the Synthesis Center wrote software called the Rhythm Kit to capture mathematical rhythm for the Synthesis Center's work on rhythm. The Rhythm Kit records and plays back time onsets or intervals paired with measured values like brightness or activity in a scene – the *observables* of an event. These intervals and associate observable values could be played back, re-scaled and mapped to parameters of media synthesis (such as the centroid frequency of a filter). Most importantly, the kit also enables artist-researchers to *contrapuntally* restructure and recompose the time patterns of the responsive media system. In other words, *time intervals* become the compositional elements, which can even transform *in accordance to contingent activity as well as prior design.* Some transforms resemble the techniques of Baroque musical counterpoint (retrograde, inversion, retrograde/inversion, stretching or shrinking), while others are more abstract (sort time intervals from longest to shortest, shortest to longest, scramble the sequence of intervals). Abstraction at the level of interval and intensity lends itself to the transduction of rhythm across different media (light to haptic, sound to robotic, etc.), to borrow

from Simondon's notion of dynamical material-informational process. We will turn to this more fully at the end of this essay.

One of the most interesting aspects of Stein's rhythm kit is that it focuses attention not on the measurement modality and units — e.g. pressure, velocity, color — but on the times of onsets and durations between onsets of sense or data. This focus on onsets of events and their durations surfaces the intermodal aspect of rhythm which is primordial to sensor modality.

Textural Rhythm

But let us examine more closely the formal assumption behind understanding rhythm as that which is denominated by series of events (e.g. beats), indeed a series of 'the same.' Between one downstroke of a conductor's baton and the next, between one clap of the hands and the next, does any rhythm happen? How can we say where one step ends and another begins? When and how do we differentiate any repetitive, two-part movements– especially when a skilled violinist may tell you the key to maintaining a smooth sound during a bow change is to realize that the upbow has already begun before anticipating the downbow? In signal engineering, the *how* may be called segmentation, the *when* calibration. Segmentation reminds us of Gilles Deleuze and Felix Guattari's figure of striation (1987: 363–364):

> . . . we are told that rhythm has nothing to do with the movement of waves but rather that it designates 'form' in general, and more specifically the form of a 'measured, cadenced' movement. However, rhythm is never the same as measure. . . .There is indeed such a thing as measured, cadenced rhythm, relating to the coursing of a river between its banks or to the form of a striated space; but there is also a rhythm without measure, which relates to the upswell of a flow, in other words, to the manner in which a fluid occupies a smooth space.

From this we can take away first caveat to avoid conflating measure for rhythm, but also that movement is constitutive of rhythm but not measure, metric, or other modes of striation.[6] Indeed as Pascal Michon has put it in his most extensive archeology of the notion of rhythm:

> The Greek word rhuthmós simply signified something like a 'form that is not permanent' or better yet, a 'way of flowing'… [P]arts of this tradition provide us with tools that are much more convenient to deal with dynamic phenomena as art or ethics or politics, than the very narrow concept of rhythm that is today commonly taken for granted. (Michon, 2017)

Does it make sense to think the rhythm of a single event, or would that be what Wittgenstein would consider an 'ungrammatically' formed question that introduces unnecessary philosophical conundrums? Can what marks an event be discerned before the event? And who is to say? In *Difference and Repetition*, Deleuze writes, 'Repetition is a necessary and justified conduct only in relation to that which cannot be replaced. Repetition as a conduct and a point of view concerns non-exchangeable and non-substitutable singularities.' (1994: 1) But what is nature of the singular event?

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[6] See Deleuze and Guattari's explication of the concept with respect to the music of 20th century Serialist composer Pierre Boulez in (Deleuze and Guattari, 1987:477-478).

Simondon's notion of information could help furnish a fuller elaboration of textural rhythm, but that would take us beyond the background of this essay. Deleuze and Guattari's figure of 'flow and manner in which a fluid occupies a smooth space' invokes dynamics on manifolds. Chapter 6 'Topology, Manifolds, Dynamical Systems, Measure, and Bundles' in Sha 2013 provides fuller treatment of the relevant background notions.

Taking the figure of a stroke of lightning, Deleuze writes: 'Lightning, for example, distinguishes itself from the black sky but must also trail it behind, as though it were distinguishing itself from that which does not distinguish itself from it.' (1991: 28) In this essay we will embed denominations of rhythm marked by discrete, atomic, 'repeated' events inside a more general, and *non-pre-dimensionalized*, substrate in which objects and event take form. The more nuanced and precise account uses notions from point-set topology (Sha 2012, 2013). We adopt the term ***texture*** to refer to an approach to phenomena via dynamic, material *fields* and *substrates* (vs. atomic objects and subjects) in parallel with but not reduced to some recent physics theories that derive time (and spacetime) as *effects* of, rather than pre-given backgrounds to, the dynamics of quantum fields. We will return to this at the end.

Rhythm and the Felt Experience

Treating rhythm as intervals and intensities unchains us from reducing our temporal sense merely to sense and sensor data, but risks dematerializing rhythm to an untenably ideal 'form'. Therefore we avoid as much as possible the notion that the intervals and intensities registered by the rhythm kit cohere to any notion of 'rhythm' as abstract or transcendental (as if the set of all possible rhythms could identified by only their interval and intensity — as if music were reducible to MIDI notes or notated scores). As Simondon pointed out in his discussion of the difference between mechanical memory and human memory, a magnetic tape registers the hiss of noise and a human voice with equal ease, *indifferently*. This same indifference distinguishes electromechanical sensors from human sensing, and mechanical metronomes from musical performance. (Experiments with mechanically generated sound notwithstanding.)

Instead, we attend to what Eugene Gendlin would call the *felt experience*[7] of rhythm. But how can we work with experience without an a priori subject or object, and without a pre-given units of measure or structure of narrative with which to denominate experience? In this essay since we are concerned with temporal phenomena, we will employ a *processualist* approach that accounts for sense-making, or better, the *emergence* of sense. After considering some experiments in rhythmic aspects of the lived experience of structured ensemble improvisation conditioned by responsive media, we will consider a notion of sense-making as the highlighting of subgroups of transformations on the dynamic space of configurations of movement, gesture, attitude, intensity, energy, affect.

Coming Togetherness: Ensembles and Entrainment

Thinking of how subjects may be constructed in rhythmic experience, we refocused our sights on activities in which the boundaries between subjects appeared to us less crisply defined. Given the insuperable methodological difficulties raised by the conventionality of the distinction between **'signal' and 'noise', 'event**' (or 'onset' to use the vocabulary of computer music) and background, our experiments departed from the construction of rhythm as time interval from the beat-detection experiments and rhythm kit. In place of measuring intervals between discrete events, we considered instead how to construct experiments in which both rhythm and subject resist discretization, and appear instead salient mostly as continuities.

[7] See for example Gendlin 1997a and 1997b.

Bearing these considerations in mind, we took up the concept of entrainment. For the purposes of the essay, we understand entrainment as the emergent temporal structuring of togetherness, and as a critical hinge between a sense of rhythm and a non-Cartesian subject.

Perhaps the most widely familiarized notion of entrainment comes from the study of music. A person or animal is said to be able to entrain if it can move in ensemble with musical pulse (e.g. tapping your foot, dancing to a beat, playing an instrument). We recognize here the discrete notions of rhythm discussed before, but is entrainment possible without a beat? Indeed, many fields and disciplines use notions of entrainment in different contexts and different scales to describe different kinds of relationalities. In the physics of mechanical systems, entrainment describes how two harmonic oscillators come to share the same period with one another, as noted by scientist and mathematician Christiaan Huygens. Entrainment also refers to speakers' tendency to cohere around emergent spoken intonations and timings, or adopt an interlocutor's speech patterns. Biological entrainment describes the synchronized relationship between an organism's internal biological rhythms and external, environmental patterns.

These myriad understandings of entrainment suggest that entrainment describe more than just the temporal structure of synchronization, but rather the general rhythm of coming together. In his 'Semblance Taxonomy of Entrainments', Adrian Freed unpacks this notion of a general entrainment with examples of togetherness gathered from both lived experience and from literary figures (2014). These examples furnish us with our conceptions of rhythm which extend beyond time-keeping and into the processual, relational world. We will add and expand on some of these terms based on own experiments.

Syntonic	Together in frequency	metric music
Synchronic	together in phase	marching
Simultaneous	together in time	positron/electron pairs
Syntropic	together in direction	Greek dance

Syntenic	along same path	line dance
Isotropic	together in orientation	
Symplectic	plaited together	morris dancing
Syngamic	fused together	
Syndetic	bound together	three legged dance
Contort	twist together	
Symbiotic	living together	
Converted	turn together	
Commence	state together	
Continual	join together	
Contrite	rub together	
Coarticulate	move joints together	
Coterminous	same boundaries	
Coextensive	same region	
Contemporaneous	within same time interval	
Consequent	following	

<INSERT FIGURE 2 | CAPTION: Adrian Freed's semblance typology of entrainments (2014) based on etymologies.>

Correlation of orientation (togetherness)

Inspired by Freed's taxonomy, we set out to investigate what is meant by togetherness and connectedness in the domain of human movement. We created a proxy for connectedness (Krzyzaniak et al. 2015) between two *or more* people by implementing a correlation algorithm which would compare the orientations of sensors placed on various places on their bodies. Most importantly the proposition is that togetherness does not have to mean being physically in the same region of space at the same time. Nor does togetherness have to mean that bodies are

moving in parallel. Indeed one can imagine a group of children and adults in a living room peaceably doing their own thing: one can be cooking vegetables for dinner, another setting the table, a third could be playing with a sibling. Nothing in their poses or the trajectories of parts of their bodies need be isomorphic – 'parallel' – and yet they and most observers may affirm that they are 'correlated' in some way. In another situation they may feel uncorrelated. Consider when someone claps a hand sharply: people turn to face the source of that sound. We propose considering togetherness measured by correlation not of position or pose or even trajectory, but of orientation as a corporeal indicator of attention, intention.

hypercomplex signal correlation

a(t) and b(t) are quaternion-valued time series

$$a \circ b = \sum_{t=0}^{N-1} a(\tau + t)\overline{b(t)}$$

where $\circ$ indicates correlation, and τ is the time-lag between signals a and b

<INSERT FIGURE 3 | CAPTION: Correlation of streams of quaternion-valued orientation normals to points on bodies.>

This correlation selects for similarities in a small time-window, and is much more robust than a simple differential comparison based on locus or spatial extent. Our analysis is invariant to certain relational aspects: delay/lag, differences in amplitude, noise, and frequency. We used the result of this analysis as a real-time *relational* signal to drive expressive sonic and lighting media feedbacks. In a session with dancers and live musicians, we played with obviously correlated

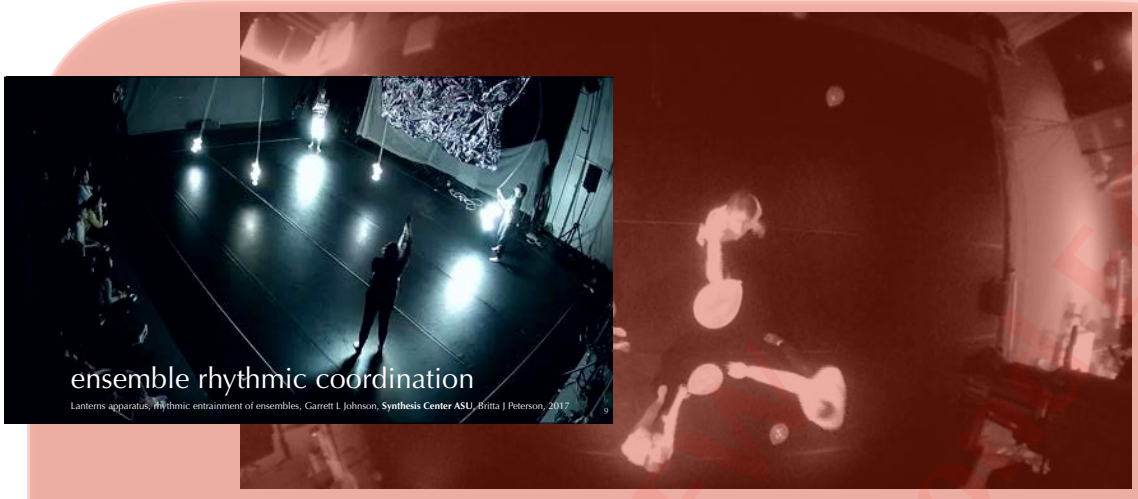
examples first and progressed towards some experiments which interrogated less apparent connections.[8]

<INSERT FIGURE 4 | CAPTION: Correlation of orientations, as sensed by body-borne sensors. Three dancers are asked to improvise under general constraints: as an ensemble act like a clock, and fill the negative space between their bodies.>

Finally the dancers improvised together, and *togetherness* became the central expressive aspect which was sustained, diminished, weakened. In a sense this interplay of coming together and falling apart with which they constructed phraseologies — without having to declare in advance a vocabulary of movements. Correlation of orientation of parts of bodies gives us a more adequate measure of togetherness than measures of individual bodies' pose, trajectory or speed because this measures how a group of people's corporeally indexed *collective* attention comes together. Such measures give us a more continuous notion of togetherness that aligns more clearly with our lived experience.

[8] See https://vimeo.com/synthesiscenter/correlation

Balloons, Lanterns, and Rhythmic Ensembles



<INSERT FIGURE 5 | CAPTION: Balloon game: five people bat and volley balloons among themselves.>

The correlation algorithm practically limited us to looking at relations between two data streams, so we had to come up with other scenarios and systems to explore collective rhythm in groups of three or more people, or rhythmic entities. Why three? Dyadic relations tend to be overly determined by conventions (caller/responder, observer/observed, leader/follower) so that it becomes much harder to study the emergence of novel temporal pattern which is important for experiment.

One scenario consisted in with groups of four or five people trying to keep slightly-heavier-than-air balloons aloft by batted the balloons among themselves. We observed how our group experience changed as we varied the conditions, for example by scaling the number of balloons relative to the number of players. We tired quickly of some configurations, but found ourselves most engaged when the number of balloons was one more *or* one less than the number of players – just enough mismatch to challenge attention without too much complexity. Under those conditions we noticed a shift from 'parallel play' to an ensemble of shifting roles and interwoven

attention. Too fast-paced for explicit signaling via spoken language, the scenario demanded participants enlarge attention to a 'peripheral attunement' to total activity.

Our enactment differs from the accounts of what Edwin Hutchins calls distributed cognition (1995: 175–228), evoking distributed computational architectures as a model for dynamics of a social system. Whereas Hutchin's example is the sailing crew, our group had no fixed roles. As computational models require us coding interactions in advance, it would fail to do justice to the group's emergent, relationally constructed coordination. Moreover, participants played without talking, indicating a pre-linguistic dynamic exceeding that of a operating system managing 'parallel' chains of pre-scripted steps.

The balloon experiments also led us away from our initial strategy of interpreting rhythm directly as discretized time intervals. In the correlation experiments[9] rhythm was relational between two gesturing bodies measured by the mathematical correlation of the time series data streams from pairs of body-borne sensors. The balloon play experiment naturally extends beyond dyadic, relation to NxM-dimensional patterns with groups of N people and M balloons. Correlation measures emphasize the temporal aspect of rhythm. Rhythm has no locus. More precisely, rhythm is not characterized by referring to a point in physical space.

Another example of ensemble rhythmic activity is theater director Peter Brook's stick passing exercise: people stand in a ring facing each other. Each person has a stick about the height of a person in their right hand. They pass the stick to their right and take their left-hand neighbor's stick. After they are comfortable with this task, they each take one step back and repeat the exercise, now spaced farther apart from one another. They try to do this as fast and as smoothly as possible. Repeated over weeks and months, ensembles of people incorporate a skilled practice that can speed up greatly as they learn to rhythmically couple as an ensemble.

[9] Lighting and rhythm correlation experiment: vimeo.com/synthesiscenter/correlation

A third example of ensemble activity is the Filipino children's game Tinikling of jumping in between sticks. As the video[10] shows, children bob and sway in time to the music before they step in between the bamboo poles. More than simple anticipation of movement, they are entraining to a temporal pattern; this example will furnish more productive insights in more detail later.

In light of these experiments and examples, we decided to create an experimental apparatus where we could compose and reproducibly vary the behavior of the media according to improvised activity.

<INSERT FIGURE 6 | CAPTION: Lanterns suspended from ceiling. Sound and lamp intensity vary according to the lanterns' movement.>

Lanterns is physical-digital responsive media system consisting of several clusters of light bulbs are suspended by cloth-covered electrical cable from a theatrical grid (Johnson et al. 2015). Like the balloons, they are ballistic objects. We built the lantern clusters for full-bodied, full-contact interaction. We used extremely rugged LED light bulbs so they could be freely swung, vigorously swirled, even hurled against a wall.

[10] Tinikling rhythmic stick dance game: https://youtu.be/JtVjo76X-ws?t=109

Having learned that trying to synthesize rhythm as discrete patterns (via 'ticks' or events) tends to lead to chaos as the number of participants and props increase, we designed the system to continuously render the movement of swinging lanterns in sound or light to amplify or accompany motion so people could introduce rhythms into the system. In other words, the angle or speed of the lanterns was mapped directly to sonic texture, not analyzed and reduced to an abstract token like '60 beats per second'.

In order to understand how such characterizations are abstract, we summarize the construction and the material logic of the media system. Sensors mounted on the lanterns' cords stream real-time data that indicate the position of the lantern in space as a function of the angle of the cord. From the position, we compute real-time measures of speed, acceleration, velocity, and proximity to drive responsive sound and lighting behaviors which reflect either 1) the movement of each individual lantern or 2) their movement as a group. First, each lantern makes sounds tuned to a set of frequencies which distinguishes them from others. Acceleration pulses each lanterns' lights as its speed changes (The cable of each light bulb goes into its own DMX-controlled dimmer box, so we can dynamically control the intensity of each light bulb).

Then, the system computes numerical indices — "features" — as a function of *relations among bodies* rather than individual bodies' properties. From the set of the all lanterns' position, we calculate distances between each cluster of lightbulbs and sum them to create a general measure of proximity. This analysis is mapped to the frequency and amplitude of low pulsing tones. Amplified by subwoofers, these bass tones are inaudible when the lanterns are hanging at a stand still and crescendo in volume and activity as they come together, descending from audible bass range (~100hz) to a frequency which is at both heard and felt with the body (~30hz). The intensity of this pulsing bass feedback also directly flickers the lights. This collective, relational and non-solipsistic measure resonates with suspending commitment to pre-given subjects and objects. More subtly, this constitutes a step toward abductively constructing measures that are

more sensitive to contingent phenomena which are a function of *textural* dynamics.[11] Much of this system's behavior is shaped by its dynamic-material construction. The responsive media mappings amplify and transpose physical movements into other registers which are sensible in different ways, and by highlighting some of the observable dynamics (speed and changes in speed, closeness, place) impart a sense of performativity to our interactions with the physical system.

As with the balloons, our research with this system started with *ad hoc* play. Without pre-stating the modes of interaction, the dynamics of interaction emerged in lab sessions and with guests at public open houses (Garrett Johnson, Britta Peterson). The interaction dynamics between players and the system resembled games but produced no winners and losers and had no finite goal, no puzzles to solve, and no points to accumulate. More predictable than balloons, the lanterns afforded a broader diversity of interactions. The deterministic relation between lanterns' movement and the variation of sound and light constituted precisely reproducible conditioning of the event accompanying *any* activity that the players were moved to invent. Moreover the relation was intricately crafted to yield sonically, visually, and kinesthetically rich augmentation.

	DESCRIPTION	TACTICS
Swinging	Lanterns swing like a pendulum	Run alongside swinging bulbs; catch and release (using sight, using hearing); grouping people with specific lanterns.
Circling	Lanterns swing like a circular pendulum, in or out of phase; moving in the same or opposite direction	Sit in the center; lie underneath.

[11] The mathematical field of measure theory generalizes the notion of area to the widest class of sets, which need have no geometric structure whatsoever. See (Tao 2011).

Twisting	Lanterns wrap around each other	Constraint about number of lanterns which may be touched. -
Gathering	Bring all the lanterns together	Gather and release (seated); twisting or wrapping them to hold them together.

<INSERT FIGURE 7 | CAPTION: Semblance typology for interaction with lanterns.>

In the table above, the items in the leftmost column describe a certain variety of the lanterns' movement. We permuted these varieties in obvious ways (e.g. two, three, or six lanterns should swing in phase together, out of phase, in the same direction, etc.). The rightmost column lists tactics which emerged to shepard the lanterns towards these movements. What we find most salient about these tactics is they constitute a refiguration of the relation between the human movers with respect to the lanterns. In summary there are not two but three coupled dynamical systems: the pendulums that are most closely modeled by the ballistic physics of harmonic oscillators, the algorithmically driven lamps and sounds as coded in Max/MSP/Jitter in response to both lantern and human movement, and the ensemble of humans playing.

Now, regarding how children playing Tinikling or musicians improvising in ensemble together sway and 'get into' rhythm before jumping into joint activity, we see that rhythm conjures a 'subject', and ensemble activity foregrounds the thick interleaving of shared rhythmic experience. What is then this subject that is conjured? Given the examples of ensemble experience, we are already well adjusted to discussing experience without a subject, and with this clean slate may begin to consider other conceptions of subjective organization. We recall, for instance, Deleuze and Guattari's notion of the 'machinic assemblage of bodies, of actions and passions, an intermingling of bodies reacting to one another' which function at the same time as 'a collective assemblage of enunciation, of acts and statements, of incorporeal transformations attributed to bodies' (Deleuze and Guattari 1987: 88).

In 'The Three Ecologies,' Guattari dispenses with the term 'subject' entirely, formulating subjectivity as three interpenetrating registers considered processually and interdependently (ecologically): the mental, the social, and the environmental. Guattari's proposition allows for the flux of *experience* (*without a subject*) to produce emergent subjectivities. In *Chaosmosis,* he refers to a study by Daniel Stern which characterized as trans-subjective the experience of infants, 'which do not dissociate the feeling of the self from the feeling of the other.' (Guattari 1995: 8) Subjectivity is refigured a processual emergence through 'components of subjectification.' He distinguishes the individual from subjectivity, which he characterizes as 'a "terminal" for processes involving human groups, socio-economic ensembles, data-processing machines: a terminal through which, of course, not all the vectors of subjectification necessarily pass.' We keep in mind the danger of mistaking what we can discern for an adequate understanding of experience. Thus this investigation simultaneously draws from 'scientific' as well as ethico-aesthetic problematics. Instead of referring to groups of individuals, or networks of actors, or systems of hierarchies, we can regard these ensembles as heterogeneous assemblages of matter-energy-affect-symbol, which, in movement and sensation, construct our concept of rhythm as a viscous and animated texture.

Textural Subject

In Gyorgy Ligeti's *Poeme Symphonique* (1962), 100 mechanical metronomes are wound up to exhaust themselves at approximately the same time.[12] It is essential that these metronomes be mechanical to allow for energetic physics and contingency. Very gradually, as the machines wind down, and as your hearing attention wanders, relaxes and refocusses, waves of rhythms emerge from an ocean of what initially sounds like noise. Most interestingly, the resultant sense of rhythmic pattern as heard by each human listener *is conditioned by but different from* the mechanical oscillations of

[12] See performance staged 4 September 2011: vimeo.com/50606554, starting at 1:00.

the individual metronomes. Moreover, we can surmise that every single human listener hears different rhythms, according to differences in physiology and expectation as well as physics. In other words, rhythm is not perceived but apperceived. Given this, we suggest that the 'rhythm's subject' — that which hears a given rhythm — does not pre-exist the moment of the 'performance', but *emerges in the course of the event as experienced*. In light of this, we propose to consider the *subject* not as a pre-given constituent of rhythm but rather as an effect of the rarefaction and condensation of textural fields in *assemblages*: territorializing and deterritorializing configurations of bodies, actions, passions, expressions that provisionally function together (Deleuze and Guattari, 1987: 88). And we consider rhythm in turn as a mode of temporality – by which we mean the sense of passage, becoming, change, dynamic.

How shall we understand the co-articulation of subjects? Every differential operator — an operator in Simondon's ontogenetic sense[13] (Simondon 2009) – acting on the textural material field of matter plus energy plus affect – can be co-constructed together with particular subjects and objects of experience and apparatuses or instruments of articulation. The *subjects* may be called hearing subjects, and the *objects* may be called rhythms in this more general dynamical field constituting the structuration of experience. What rhythm especially picks out are the temporal aspects of these dynamics. We have reversed the arrow of consideration: whereas we began our essay by thinking of rhythm as the resultant of body + movement + inhomogeneous matter, and sense of rhythm as a resultant of subject's action in the world… we reverse this, starting with examples of rhythm in ensemble activity and deriving bodies and objects out of the dynamical inhomogeneities of assemblages.

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[13] Simondon borrows from and resonates with the mathematical notion of *operator* in for example functional analysis, where 'function' carries a distinct meaning from what 'function' may mean to theorists in philosophy or the humanities.

Extending Husserl's motto 'to the things themselves' from phenomenology to our non-anthropocentric project would require conceiving experience without an *a priori* subject. To summarize, every differential operator produces vectorial (directed) fields out of the manifold of experience (See Sha 2013). James conjectured in his essays on radical empiricism vectorial relations of knowing that co-articulates parts of experience as the knowers and the known.

In more nuanced accounts of temporality – understood, as we stated above, as the sense of passage, becoming, change, dynamic – one consequence of a primordial temporal vectoriality is the triadic 'ekstatic' structure of temporality: the senses of past, present and future. In phenomenological terms, the subjective senses of past and future would be retentive and protentive intuition, but our account does not require *a priori* subjects (e.g. listening beings that cognize rhythm) or objects (e.g. mathematical rhythms as 'objective' patterns.) Now, the sense of rhythm – not as an ideal form shaping formless substance but as a mode of temporality – constitutes an *asymmetric* relation between past and future. Think of the example of the children playing Tinikling swaying before jumping in between the rhythmically moved bamboo sticks. A classically constituted observer would see a local asymmetry which co-articulates three regions of the universe relative to each compact occasion. Two regions are the retrospected and the anticipated, which are the experiential analogues to the causal past and future, respectively, and the third region is the indeterminate portion of experience that has no material causal relation to

the occasion.[14] Thus rhythm can be understood as a structure of non-anthropocentric retention and protention inside textural dynamics of the assemblages of bodies, actions, passions, and utterances. But if we do not presume such a pre-constituted observer, how else could we understand this situation?

Some physicists have recently begun to consider quantum gravity models — called Loop Quantum Gravity (LQG) — in which spacetime are effects of the field dynamics. As Carlo Rovelli puts it: 'No more fields on spacetime: just fields on fields' (See Rovelli 2004: 71). For our purposes this release from spacetime as a 'dependent variables' or as 'background' to the physics and the attempt to think of time as operator(s) is the physics analogue to thinking of time, or better duration and rhythm as effects of activity and event.

Loop Quantum Gravity as a physical theory does not account for the felt experience of the difference between past and future and the sense of flow. Indeed Loop Quantum Gravity's eventful world is a bubbling magma of occasions rather than a differentiable manifold with a smooth metric that at every point marks out locally causal future, causal past, and acausal regions. Rovelli proposed in a talk at The Royal Institution that it is the selective arraying of

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[14] This last region must stand in ethico-aesthetic relation to the given occasion exactly because of causal indeterminacy: by definition there can be no relation of material causation between any occasion in this third region and the given occasion. Here we borrow from A.N. Whitehead's *Process and Reality*:

> In respect to any one actual occasion M there are three distinct nexüs of occasions to be considered:
> (i) The nexus of All's contemporaries, defined by the characteristic that M and anyone of its contemporaries happen in causal independence of each other.
> (ii) Durations including M's any such duration is defined by the characteristic that any two of its members are contemporaries. (It follows that any member of such a duration is contemporary with M, and thence that such durations are all included in the locus (i). The characteristic property of a duration is termed unison of becoming.)
> (iii) M's presented locus, which is the contemporary nexus perceived in the mode of presentational immediacy, with its regions defined by sensa. (Whitehead 1985: 125-6)

disordered configurations as subsequent to more ordered configurations that gives rise to the sense of anisotropy of the flow of time:

> What makes entropy low down there in the past is not the fact the universe was arranged in a very ordered way… the universe is arranged however it is arranged — it is the fact that we look at the universe , we as a pjhsycial system interacting with the rest such that under this perspective the past was special ….We are special subsets of the universe that interact with the rest of the universe in such a way that the past looks ordered to us. What is special is not the inverse, it is the subset of the universe to which we belong we call this idea the **perspectival origin of entropy**… "[15]

We can give this a more propositional twist. First, we adapt William James (in the genealogy of Leibniz, Whitehead, Deleuze and Guattari). In his 1912 essay "Does 'Consciousness' Exist?" James writes:

> "There is no general stuff of which experience at large is made. There are as many stuffs as there are 'natures' in the things experienced. … [*and earlier*] …If we start with …[this] primal stuff …'pure experience,' then knowing can easily be explained as a particular sort of relation towards one another into which portions of pure experience may enter. The relation itself is a part of pure experience; one of its 'terms' becomes the subject or bearer of the knowledge, the knower,[4] the other becomes the object known."

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[15] https://www.youtube.com/watch?v=-6rWqJhDv7M, Carlo Rovelli, The Royal Institute, 30 April 2018 (42:56 - 43:45).

Rather than *presume,* as Rovelli seems to do, pre-given subsets of the universe endowed with such a "perspectival entropy", instead we *characterize* contingent chunks of experience that happen to make such construals as *temporal subjects, humans.*

Finally, what about the emergence of *sense* ? For that we appeal to work by Noah Brender in Montreal on symmetry-breaking as a motor of sense-making.[16]

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16 Brender, Noah Moss, 2013, "Sense-Making and Symmetry-Breaking: Merleau-Ponty, Cognitive Science, and Dynamic Systems Theory".

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