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The Shape of Synchrony

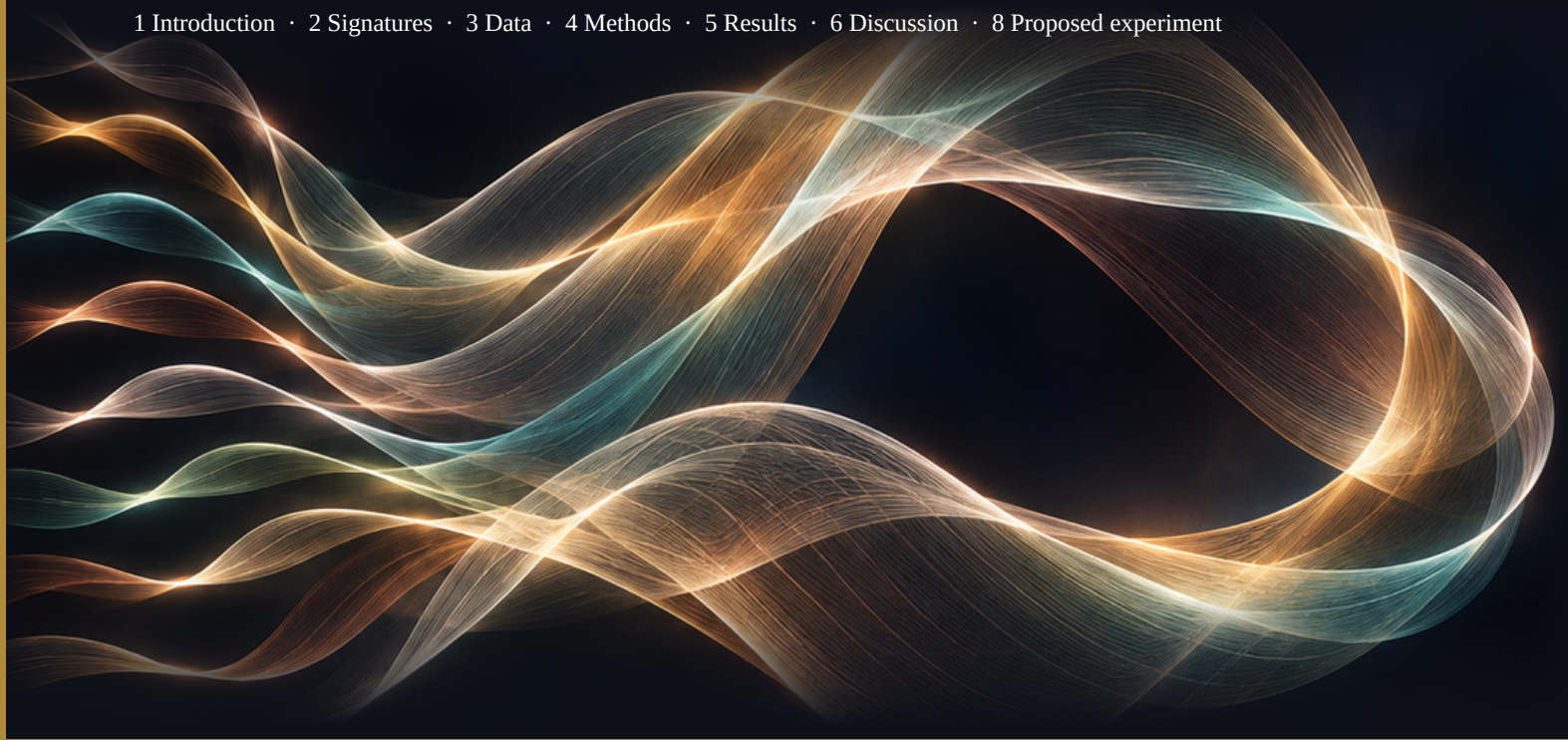
Testing a superposition picture of social influence in group heart data

Individuals, Dr. Norbert Schwarzer writes, radiate influence in sphere-like waves that superpose into apparent plane waves. Three public datasets ask whether hearts in a group carry that signature, and whether anything beyond a shared rhythm is needed to explain it

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An exploratory analysis of public heart recordings with correlation and recurrence methods, the latter developed by Dr. Charles Jorgensen, former Chief Neuro Scientist at NASA Ames. Motivated by Dr. Norbert Schwarzer's posts on X. Any error is the author's.
Cover: conceptual illustration.

Abstract

Background. In a post on X on 9 November 2026, Dr. Norbert Schwarzer wrote that in societies "single individuals or even groups of the latter are radiating their influence to the environment (rest of the society) in multidimensional sphere-like waves," which can be "superposed to globally appearing (and acting) as apparent plane waves" [1]. We derived three testable signatures of this picture for physiology, namely coupling between group members, a group-wide mode, and the absence of a consistent leader, and tested them in heart recordings.

Methods. Three public datasets, each recording every member of a group at the same time, provided four settings:

- **Choir:** a professional choir of nine singers during a 69-minute performance; beat-to-beat heart intervals sampled four times per second.
- **Bass trio:** three of the same choir's basses, in two 4.7-minute excerpts, one from rehearsal and one from performance; same recording method.
- **Decision groups:** 32 groups of three to six people in an unscripted group decision task; heart rate every 2 seconds, 5 minutes per group.
- **Surgical team:** a cardiac surgical team of three (consultant, registrar and physiologist) recorded for 116 minutes at work; beat-to-beat heart intervals sampled four times per second.

Each setting was compared with a chance baseline. For the decision groups, each real group was compared with 100 pseudo-groups assembled from people in other groups who never met. For the choir, bass trio and surgical team, each recording was compared with 200 time-shifted copies of itself, which keep each heart's own rhythm but break the timing between people. Synchrony was measured in four ways: mean pairwise correlation (coupling), the share of variation carried by one group-wide pattern (global mode), cross-recurrence rate and determinism (shared patterns over time), and a lag-based score for whether one member's changes come first (leadership).

Results. Each setting was tested for the three signatures: coupling, a group-wide mode, and the absence of a leader.

- **Choir (nine singers, 69-minute performance): all three signatures.** The singers' hearts were in step in 40% of one-minute windows, against 5% expected by chance; the group moved as one more than chance allows ($p < 0.005$); and no singer consistently led (the most frequent leader led in 19% of windows, close to the 16% expected if leadership were random).
- **Bass trio (three of the same choir's basses, two 4.7-minute excerpts): coupling in rehearsal only.** Their hearts were in step during rehearsal (mean correlation 0.27, $p = 0.02$) but not during a performance excerpt.
- **Decision groups (32 groups of three to six people, 5 minutes each): weak coupling only.** Members' heart rates moved together slightly more than those of strangers (on average, real groups ranked at the 64th percentile of their pseudo-groups; $p = 0.02$, on one of seven measures tested). There was no group-wide mode and no leader, and the recurrence measures did not distinguish real groups from strangers.
- **Surgical team (three people, 116 minutes at work): no signatures.** Their hearts showed no synchrony beyond chance.

Conclusions. Hearts in a group can synchronize with no single member leading. In these data, however, strong synchrony appeared only in the choir, where the singers shared an outside rhythm: the music they were performing. Where no such shared rhythm existed, in the decision groups and the surgical team, synchrony was weak or absent. Because a shared outside rhythm can produce synchrony by itself, these datasets cannot show whether people also

influence one another directly. The proposed experiment tests the account that shared coherence arises when music or movement, a shared emotional experience and aligned intent come together, varying each of the three to measure what it contributes.

Status. This is an exploratory analysis of public data; measures were chosen with the hypothesis in mind but were not registered in advance. Dr. Schwarzer's posts on X motivated the work, and the recurrence methods follow Dr. Jorgensen. Any error is the author's.

1. Introduction

1.1 The scaled-metric framework and the turn to subsystems

Einstein described gravity as the geometry of space and time. In the framework developed by Schwarzer [5], the physical metric carries an additional scale factor F, a function of a scalar field, so that $G_{\alpha\beta} = F \cdot g_{\alpha\beta}$. A region of different F stretches every length and changes every clock rate in it. Inserted into Hilbert's variational principle and restricted to weak gravity, the field equations reduce to a wave equation of Klein–Gordon form for the field, with mass and potentials attributed to additional dimensions, possibly very many of them. The effect of a change in F on clocks is expected to shrink roughly in proportion to that number.

Earlier work from this lab searched for such a field in the atomic clocks on GPS satellites, looking for slow walls, clock-type differences, oscillations and light-speed walls in a month of public data, and found none [14]. Schwarzer has since written on X that a change of scale across the whole universe "would not be visible for any observer inside the universe" [3]. If an effect cannot be seen in the universe as a whole, the natural place to look is in its parts: brains, bodies and the coupling between people. Hearts beating in a group are among the simplest of these to measure with public data.

1.2 Schwarzer's superposition picture

In Part I of a series on X, Schwarzer described a compact source whose influence arrives everywhere as superposed plane waves [2]. In Part II, citing his book *Mathematical Psychology* [4], he applied the same mathematics to society [1]:

> *"In bigger socio-economic systems (societies), single individuals or even groups of the latter are radiating their influence to the environment (rest of the society) in multidimensional sphere-like waves. Thus, the mathematical structures of any form of communication or information-transmittance is quite similar to the ones shown in the equation and hence, are equipped with the same potential to be superposed to globally appearing (and acting) as apparent plane waves."*

The equation he shows is the classical expansion of a plane wave into spherical waves,

$$e^{ikz} = \sum_{\ell=0}^{\infty} (2\ell + 1)\, i^{\ell}\, j_{\ell}(kr)\, P_{\ell}(\cos\theta),$$

where j_{ℓ} are spherical Bessel functions and P_{ℓ} Legendre polynomials. Read socially, each person is a small source, and the combined influence of many can act as one global wave with no visible origin (Figure 1); this is the sense of his title, how God "changes the world without showing his hand."

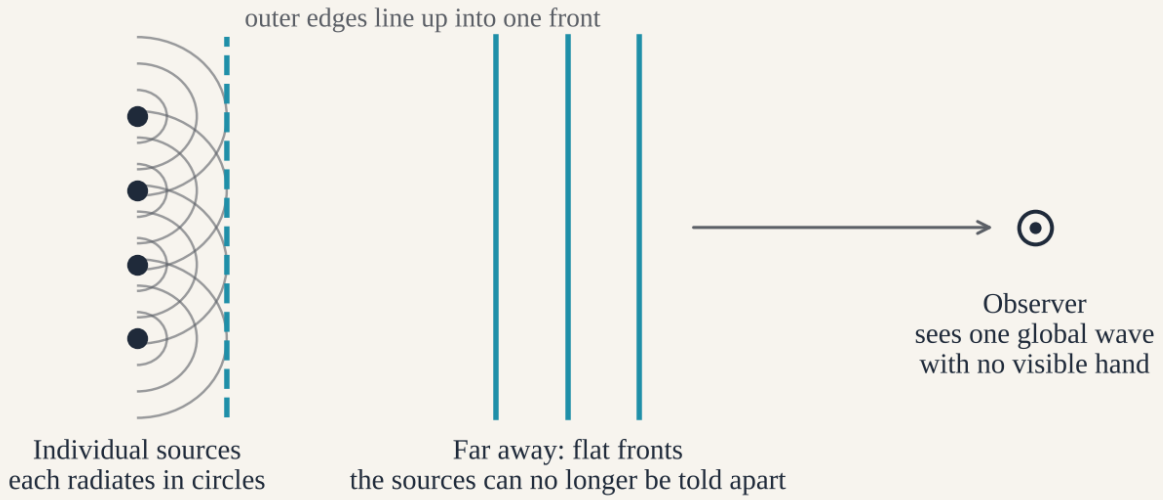


Figure 1. Schwarzer's superposition picture. Circular waves from individual sources combine into one front; far away the fronts are flat and the sources can no longer be located. The circles form one flat front only when the sources are timed together, as in a phased-array antenna, and a shared outside rhythm can supply that timing.

1.3 Physiological synchrony

The interval between heartbeats varies from moment to moment with breathing, effort and emotion, and the beat-to-beat patterns of people together can rise and fall in step. Vickhoff and colleagues found that "unison singing of regular song structures makes the hearts of the singers accelerate and decelerate simultaneously," through the breathing the song imposes [6]. Sharika and colleagues reported that heart-rate synchrony in small groups predicted how well a group used the information its members held [7]. Plonka, McCraty and colleagues monitored 104 people in five countries for 15 days with no shared task and found long-term correlations within two of the five regional groups, which they attribute in part to shared weekly rhythms and propose reflects social closeness [8]. The ordinary drivers of synchrony are shared breathing, movement and posture, one person speaking while others listen, and shared emotion; any further influence must be separated from them.

1.4 Aim

We ask whether group heart recordings show the signatures implied by Schwarzer's picture, and whether, where they do, anything beyond a shared outside rhythm is needed to explain them.

2. From the picture to testable signatures

If influence between people spreads as superposed waves, three signatures follow:

1 **Coupling.** Members of a real group move together more than people recorded separately.

2 **A global mode.** The whole group moves as one, not only in pairs, so that a single common pattern carries an unusually large share of the group's variation.

3 **No visible hand.** A global wave built from many sources has no single origin, so no member consistently leads. One person radiating to the rest would instead appear as a stable leader whose changes precede the others'.

Two cautions apply. The expansion above is exact but uses standing (sourceless) spherical waves; waves radiating from real sources add to a plane wave only if their timing is coordinated. And an outside rhythm shared by the

group, such as music, breathing cues or a speaker, produces all three signatures without any new physics. The design below therefore compares settings with and without such a rhythm.

3. Data

All three datasets are public, require no registration, and record every member of a group on a shared clock (Table 1).

Dataset	People	Setting	Signal	Analyzed
Sharika et al. [7], data released with SMdRQA [10]	32 groups of 3–6 (of 44 recorded)	Unscripted hidden-profile group decision	Heart rate every 2 s, Polar H10	5 min per group, after the first 10 s
Hemakom et al. [9]	9 singers (5 sopranos, 4 basses)	Professional choir, performance	Beat-to-beat intervals resampled at 4 Hz; respiration for 6	69 min
Hemakom et al. [9]	3 basses	Rehearsal and performance excerpts	Beat-to-beat intervals, 4 Hz	4.7 min each
Hemakom et al. [9]	3 (consultant, registrar, physiologist)	Cardiac surgical team at work	Beat-to-beat intervals, 4 Hz	116 min

Table 1. Datasets. Groups were included from the decision data if they had at least three members and at least 5 min of recording. The choir and surgical data are released under CC0; the decision data are released with the SMdRQA software under GPL-3.0 and are used here for analysis only, with credit.

4. Methods

4.1 Preprocessing

Each decision-group series was cut to 150 samples (5 min) after the first 10 s, gaps were filled by linear interpolation, and a quadratic trend was removed to suppress slow drift. Choir and surgical series were used as released, with epochs containing missing values removed.

4.2 Measures

For a group of k members with standardized series $x_1 \dots x_k$, coupling is the mean pairwise correlation,

$$\bar{r} = [2 / k(k - 1)] \sum_{i<j} \mathrm{corr}(x_i, x_j),$$

computed on first differences (second-to-second co-fluctuation) and on levels. The global-mode share is $g = \lambda_1/k$, where λ_1 is the largest eigenvalue of the members' correlation matrix; $g = 1/k$ for independent members and 1 for a group moving as one. Leadership was scored from the lag at which each pair's cross-correlation peaks (within ±20 s for the decision data and ±3 s for the 4-Hz recordings); each member's score is the mean signed lag, and the group's is the largest absolute member score. In windowed analyses, the leader of a window is the member whose changes come first.

Cross-recurrence, following Jorgensen's use of recurrence analysis for physiological records [13], embeds each standardized series in $m = 3$ dimensions with delay $\tau = 2$ samples and marks the times at which one person's state comes within $\varepsilon = 0.5\sqrt{m}$ of the other's,

$$CR_{ij}(t, s) = \Theta(\varepsilon - \|u_i(t) - u_j(s)\|).$$

The cross-recurrence rate is the fraction of marked pairs; determinism is the fraction of marked points lying on diagonal lines of length two or more, which indicates that two people follow a shared pattern rather than meeting by chance [11].

4.3 Comparison sets

Pseudo-groups. For each real decision group of size *k*, 100 pseudo-groups of the same size were built from one randomly chosen member of each of *k* other groups, aligned from the start of recording. Pseudo-group members performed the same task but never met, so any excess synchrony in real groups reflects their being together. A real group's percentile is the fraction of its pseudo-groups it exceeds; without coupling, percentiles average 50.

Time-shifted copies. For the choir and surgical team, each person's record was shifted circularly by a random offset of at least 2 min (1 min for the 4.7-min trio excerpts), 200 times. This keeps each heart's own rhythm and spectrum but breaks timing between people. Recordings were analyzed in one-minute windows stepped by 30 s.

4.4 Statistics

Across the 32 decision groups, the difference between each real group's measure and the mean of its pseudo-groups was tested with the Wilcoxon signed-rank test. For continuous recordings, p-values are the fraction of shifted copies whose mean measure equals or exceeds the real one (with one added to numerator and denominator). Seven measures were computed for the decision groups; no correction for multiple comparisons was applied and the result is reported with that caveat.

5. Results

Only the choir met all three signatures; the decision groups met the first, weakly (Table 2).

Setting	Coupling	Global mode	Leader
Choir, 9 singers, 69 min	Strong: mean correlation 0.09 vs 0.00 in shifted copies ($p < 0.005$); 40% of one-minute windows synchronized vs 5% expected	Yes: 31% of variation vs 28% ($p < 0.005$)	None reliable: most frequent leader in 19% of windows vs 16% by chance
Bass trio, rehearsal, 4.7 min	Strong: 0.27 vs 0.00 ($p = 0.02$)	Yes: 56% vs 48% ($p < 0.005$)	Too short to judge
Bass trio, performance, 4.7 min	None: −0.09 vs 0.01	No ($p = 0.21$)	Too short to judge
32 decision groups, 5 min each	Weak: mean rank 64th percentile; 72% of groups above the median ($p = 0.02$)	No: 54th percentile ($p = 0.42$)	None: 45th percentile ($p = 0.43$)
Surgical team, 3, 116 min	None: −0.002 vs −0.001; 5% of windows, as chance predicts	No ($p = 0.15$)	None

Table 2. The three signatures by setting. Comparisons are with time-shifted copies for continuous recordings and with pseudo-groups for the decision groups; p-values as in Section 4.4.

In the choir, synchrony came in bursts lasting one to a few minutes, reaching mean pairwise correlations of 0.4 to 0.5, separated by stretches at chance level (Figure 2). Across 137 windows, the singer who most often led did so in 19% of them, close to the 16% expected if leadership were assigned at random; with overlapping windows this does not identify a leader.

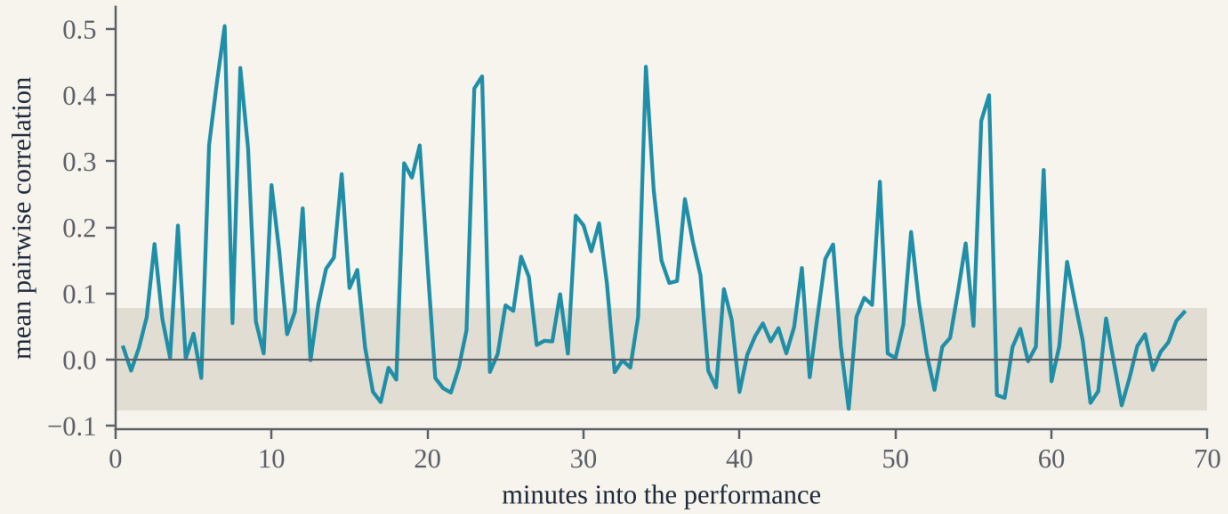


Figure 2. Choir of nine singers. Mean pairwise heart correlation in one-minute windows across the 69-minute performance. The gray band spans the windows obtained from time-shifted copies, up to their 95th percentile (0.078); values above it are synchrony beyond chance. 40% of windows exceed it.

In the decision groups, real groups ranked above their pseudo-groups on second-to-second co-fluctuation more often than chance (mean rank 64, Wilcoxon p = 0.02), but not on the global mode or leadership (Figure 3). Cross-recurrence rate (p = 0.92) and determinism (p = 0.76) did not separate real from pseudo-groups, most likely because heart rate sampled every 2 s is too coarse for recurrence structure. The direction of the coupling result agrees with the original study [7].

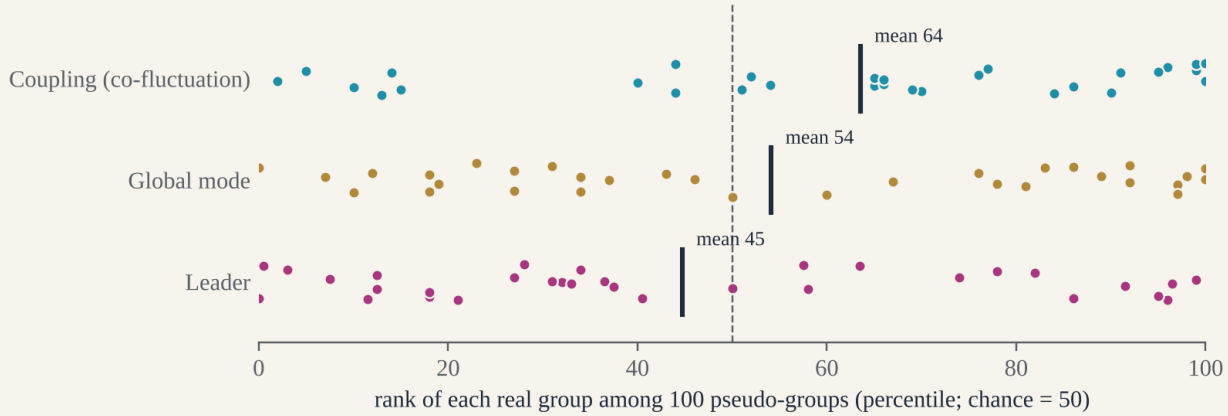


Figure 3. Decision groups. Each dot is one of 32 real groups, placed at its rank among 100 pseudo-groups of strangers on three measures; vertical bars mark the mean, and the dashed line marks chance. Only coupling departs from chance.

In the choir, the six respiration channels did not explain heart synchrony window by window (r = −0.03 between respiratory and cardiac synchrony), but respiratory synchrony was itself weak in these recordings (mean 0.013 against 0.002 in shifted copies), so this is not strong evidence either way.

6. Discussion

6.1 The shape Schwarzer describes is real

Nine hearts in the choir formed a group-wide wave with no member in charge, the pattern of superposed sources that look like one plane wave. Collective physiology does behave this way, and the measures used here can detect it.

6.2 The hand is still showing

The choir shares a score, a conductor and a breathing structure, which are exactly the coordinated timing that Figure 1 requires. The same three basses synchronized in rehearsal but not in a short performance excerpt; the surgical team, focused on one task but not on one rhythm, showed nothing; and the unscripted decision groups showed only a faint excess over strangers. So far, the evidence fits a shared outside rhythm and ordinary social interaction, not influence that spreads without them.

6.3 Subsystems and mechanism

If an effect exists, it may show in tightly coupled parts of the world, such as the brain, rather than in the universe as a whole. Hearts are then a downstream readout, and the cleanest test pairs heart with brain recordings in people who share no outside rhythm. Some accounts of such coupling invoke quantum entanglement between neurons; that is contested, because warm brain tissue is expected to destroy entanglement in far less than a millisecond [12], an estimate that proponents of quantum brain theories dispute. The measurable claim is coupling between people’s physiology, whatever its mechanism.

6.4 Relation to the lab’s earlier work

The GPS clock searches tested the global form of the scaled-metric idea and found nothing, consistent with Schwarzer’s statement that a global change of scale is invisible from inside [3, 14]. This paper moves the question to a level where suppression by a large dimension count need not apply and where Jorgensen’s recurrence tools are the natural instrument. Its result is a calibration: the instrument detects group synchrony where a common rhythm exists and reports chance where it does not.

7. Limitations

- **Small numbers.** One choir, one surgical team and two short trio excerpts; only the decision data contain many groups.
- **Coarse decision data.** Heart rate every 2 s hides beat-to-beat detail and likely blunted the recurrence measures.
- **No silent condition.** No dataset contains people together without a shared task or rhythm, the condition that would separate influence from a common driver.
- **Exploratory analysis.** Measures were chosen with the hypothesis in mind but not registered in advance, and no correction for multiple comparisons was applied.

8. Proposed experiment: the three conditions of shared coherence

8.1 The working model

Practitioners who lead group ceremonies, music and movement practices describe shared coherence as arising when three conditions come together: **music or movement**, such as singing, drumming or dance; **a shared emotional experience**; and **aligned intent**, the group holding one purpose. The proposed experiment takes this account as its working model and tests it directly. Two of the three conditions have documented effects on heart synchrony; the third has not been tested in controlled form (Table 3).

Condition	Evidence today	How it is varied
Music or movement	Documented: the choir in this paper; singers' hearts follow the breathing their song imposes [6]	Group music or movement to a shared beat vs. sitting still in silence
Shared emotional experience	Documented: spectators' heart rhythms tracked a relative's fire-walk [15]	An emotionally moving shared experience vs. a neutral one
Aligned intent	Not yet tested in controlled form	One shared intention held by the whole group vs. a private, unrelated focus for each person

Table 3. The three conditions of the working model and how the experiment varies each.

8.2 Design

Each condition is either present or absent, which gives eight combinations, from all three together to none. The same groups of six to ten people take part in all eight, in counterbalanced order, so that every group serves as its own comparison. The full combination, music or movement with shared emotion and aligned intent, is expected to produce the strongest synchrony; the design asks what each condition contributes to it.

1. **Does the full combination produce coherence?** All three together against none of them. This tests the working model as practitioners describe it.
2. **Does aligned intent add anything?** The full combination against the same session with private intentions in place of a shared one. Music, movement and emotion are identical in both, so any difference belongs to intent. This is the primary test.
3. **Do the conditions reinforce one another?** Whether the three together exceed the sum of their separate effects, the synergy the working model implies.
4. **Can intent work on its own?** Shared against private intention in silence and stillness. Because music, movement and emotion are absent, this is the most demanding test, and it is repeated with members together, apart at the same time and apart at different times.

8.3 Measurement and analysis

Hearts are recorded beat to beat with chest straps on a shared clock, with breathing and movement recorded alongside, because music and dance change both and their contribution must be measured, not assumed. EEG is added where possible. Every session is compared with pseudo-groups and time-shifted copies, using the four measures of this paper, so that synchrony is always judged against chance and never against zero.

9. Conclusions

Hearts in a group can move together as one wave with no visible leader, as Schwarzer's superposition picture describes. In three public datasets, strong synchrony appeared only in the choir, where the singers shared an outside rhythm in the music itself, and it was weak or absent in groups without one. The picture is therefore consistent with the data but not yet required by it. The proposed experiment tests the working model that shared coherence arises from music or movement, a shared emotional experience and aligned intent together, and asks in particular whether aligned intent adds anything that rhythm and emotion do not.

Data and code availability

All data are public (Table 1). Analysis scripts (Python 3; NumPy, SciPy, pandas, Matplotlib) are available from the author and will be posted with the lab's tools at bryaningram.com.

Acknowledgments

We thank the authors of the choir, surgical and group-decision datasets for releasing them openly. Dr. Norbert Schwarzer's posts on X motivated this work. The recurrence methods follow Dr. Charles Jorgensen, former Chief Neuro Scientist at NASA Ames. Any error is the author's.

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Appendix A. Glossary

Term	Meaning in this paper
Beat-to-beat interval	The time between two heartbeats; it speeds up and slows down from moment to moment
Physiological synchrony	Two or more people’s heart patterns rising and falling together
Pseudo-group	A comparison group built from people recorded in different groups, who never met; it shows how much synchrony arises by chance
Time-shifted copy	A person’s record moved in time, which keeps their rhythm but breaks timing with others
Global mode	The single pattern the whole group shares; its share of the group’s variation measures how much the group moves as one
Leader	A member whose changes come first, before the others’, consistently over time
Percentile	Where a real group ranks among its pseudo-groups; 50 means no different from chance
p-value	How often a result this strong would appear by chance alone; 0.02 means about 2 times in 100
Recurrence, cross-recurrence	A signal returning to an earlier state; one person’s pattern matching another’s
Spherical and plane waves	Waves spreading in circles from a point; waves with flat fronts that seem to come from everywhere
Scale factor F	Schwarzer’s field that stretches lengths and changes clock rates in a region