JoyScore Experiment

Overall concept

Joy, belonging and social connection are strongly linked to human health, but remain difficult to quantify in biologically meaningful ways. The JoyScore Experiment is a multimodal observational framework designed to measure these experiences as components of the human 'exposome' (encompassing the totality of environmental exposures, including chemical, physical, and social factors, that affect human health).

We have completed Phase 0 MVP (San Francisco, December 2025) and Phase 1 (Honduras, February 2026). A poster informed by the findings from Phase 1 of the study was presented at the Global Exposome Summit in April 2026 (abstract here). The project has been registered as an open science projectin the Center for Open Science here.

In Phase 2 design described in this document, all participants will be asked to contribute core data on subjective EMA monitoring, wearable EEG, ECG, salivary biomarkers and exploratory biological anchors including metabolomic, epigenetic and glycomic measures.

The framework distinguishes exposures, mediators and outcomes, and tests the hypothesis that synchrony across behavioural, cardiac and neural systems is a measurable mechanism of human connection and co-regulation.

The initial use case is the 'Longevity Rave' in which the protocol combines repeated ecological momentary assessment with neural, cardiac, behavioural and biochemical measures collected across pre-event, peri-event and post-event windows.

Primary outcomes are the JoyScore composite, HRV recovery dynamics and movement synchrony. Secondary and exploratory outcomes examine neural state changes, cardiac synchrony, sleep recovery and associations with longer-horizon resilience markers. This design provides a scalable and preregistered approach for studying positive psychosocial experience as a measurable and biologically relevant exposure.

Scientific & Medical Advisers

Tina Woods is overall strategic lead of the JoyScore Experiment. Tina Woods is a mission-driven social entrepreneur and system architect bringing diverse stakeholders together in shared

endeavours to improve health, working at the cross section of science, technology, investment and policy/government. She is Founder and CEO of Collider Health and Business for Health and with Yukari Takehisa, co-founded Longevity Rave, a collective of entrepreneurs, scientists, DJs and artists using the power of music, joy and connection to bring the generations together and celebrate humanity. She is Executive Director of the International Institute of Longevity, combining her interest in taking the latest science and technology of longevity into the 'next frontier' of the Human Exposome to understand what drives human healthspan, resilience and flourishing. She is on the Steering Committee and Global Ambassador for Partnerships for the Exposome Moonshot - see here background on the Human Exposome Project linking human and planetary health.

Tina Woods is working with the following experts:

Professor David Furman, Professor and Director AI & Bioinformatics Core Buck Institute for Research on Aging, Head of Stanford 1,000 Immunomes Project. He is an academic entrepreneur with over 15 years of experience leading R&D programs focused on translating discoveries into products with applications across a range of areas including immunology, machine learning/data science, human biology, systems medicine and big data, exposome, nutrition medicine, wellness and preventative care, aging and longevity.

Professor Dr. Eric Verdin is the President and CEO of the Buck Institute for Research on Aging – a pioneering biomedical research institute dedicated to ageing and age-related disease. His research focuses on the fundamental mechanisms of immune system evolution over time and the profound influence of nutrition and lifestyle interventions on these processes. His work demonstrates that 93% of longevity outcomes derive from modifiable factors: nutrition, sleep quality, exercise regimens, and lifestyle choices.

Joanna Bensz is a visionary entrepreneur leading advancements in Europe's longevity healthcare sector. As a Founder and CEO of the Longevity Center Europe, and Founder and Co-President of the International Institute of Longevity, she has developed innovative clinics that emphasize personalized, preventive medicine, leveraging advanced diagnostics and biomarkers to foster healthy longevity. She is passionate about integrating evidence-based approaches in positive psychology, neuroplasticity, and lifestyle medicine to help clients thrive physically, mentally, and emotionally.

Prof Dr Michael Sagner is the Ageing Research at King's (ARK) Clinical Advisor in longevity and preventive medicine. He is a clinician and researcher specialising in sports medicine and preventive medicine, affiliated with Southeastern University Florida, Department of Health and Human Performance. He is a Certified Nutritionist and completed his MD at Technical University Munich. He specialises in Sports Medicine, Endocrinology and Preventive Medicine, and is. He is the Editor-in-Chief of *Longevity,* Lead Editor of *Lifestyle Medicine,* Fellow of the Royal Society of Medicine and Fellow of the European Society of Preventative Medicine. He is medical advisor to Enhanced Games.

Dr Evelyne Bischof: Professor of medicine, MD,PhD, MPH, FEFIM; specialist in internal medicine. Longevity physician leading elite executives as longevity patients, integrating precision diagnostics of HLI, AI-based monitoring with deep aging analysis and individualized therapies towards healthy

longevity, reversing biological age and achieving optimal performance. Clinician with over a decade of clinical practice experience in Switzerland, the USA and China. Professor of medicine with a research focus on healthy longevity, geroncology, precision medicine. Deeply passionate about next-generation medical technology, and the applications of AI for biomedical research and practice, digital health and innovative technology. A Harvard- and Columbia-trained physician, author of over 80 peer-reviewed papers and a frequent speaker at scientific and medical conferences.

Dr Tamsin Lewis: Dr. Tam is a physician and longevity specialist with over two decades of clinical experience across hospital medicine, integrative health, and personalised prevention. Trained in both conventional and functional medicine, she brings a pioneering lens of bioharmony — recognising that physiology, psychology, and environment interact as one dynamic system. With a profound understanding of the nervous system and emotional health, she leads with curiosity, compassion, and conviction. Her approach is trauma-informed and motivational by design, grounded in the belief that vitality is not simply the absence of illness but the presence of energy, resilience, and joy in living.

Toni Castells is an independent artist and composer known for his eclectic and transcendental music that defies traditional boundaries and genres. His innovative approach has led to collaborations with renowned artists and performances at prestigious venues worldwide. In addition to his musical career, Castells is a PhD candidate in biomedical engineering, exploring the therapeutic potential of music. His research focuses on the effects of sound on heart rate variability and chronic stress, with a particular interest in music's role in psychedelic therapy for treating chronic depression. He also shares his expertise as a lecturer on Music Technology at the London College of Music and Imperial College London.

Aleksandra Wingert, PhD candidate, Clinical Trials Coordinator, Centre for Psychedelic Research, Imperial College London. Background in clinical neuroscience.

Christin Rauter and *Leon Jean-Marie*, known collectively as The Sound Nutritionist, have spent the past 15 years exploring the profound effects of sound and music on human physiology and psychology. Their work explores the massive impact of frequencies, vibrations, and spatial acoustics on the nervous system, cognitive function, and emotional well-being. By blending principles from neuroscience and holistic healing, they have developed innovative sonic experiences that support relaxation, mental clarity, and personal transformation. Through research, practical application, and collaboration with leading wellness and corporate organizations, they continue to refine their understanding of sound's potential to enhance both physical and mental health.

Dr Shama Rahman, Founder & CEO, Neurocreate, is a neuroscientist, neurodesigner and AI practitioner with an expertise in AI/human collaborative systems, creative strategist and technologist, artist and entrepreneur. She is currently an Innovation Fellow at the University of Edinburgh, within Design Informatics and Edinburgh Futures Institute. Her R&D interests and expertise are at the confluence of designing AI tools, interventions and experiences for impact in enhanced innovation, cognitive augmentation, and healthy ageing with the lens of ethical neurodesign and responsible AI.

Dr Carina Kern is the CEO of LinkGevity an AI-powered biotech company driving innovation in drug discovery for aging and resilience loss. She is renowned for her pioneering work on aging mechanisms and lifespan extension, including a new Blueprint Theory of Aging, which takes an integrative approach to understanding aging, combining evolutionary theory, genetics, molecular mechanisms and medicine, and is used to structure LinkGevity's AI. Her research has led to the development of a first-in-class necrosis inhibitor targeting cellular degeneration (Anti-Necrotic™), with exciting potential as a breakthrough treatment for aging.

Prof *Fenna Sillé*, PhD, MS, Assistant Professor, Johns Hopkins, Bloomberg School of Public Health; Organizing Committee, Human Exposome Project. She is an immunologist studying the exposome, assessing how a lifetime of physical, chemical, biological, and psychosocial factors interact with the genome and impact human health. Guided by the motto " a healthy environment = healthy people," Dr. Sillé investigates how the exposome shapes immunity and disease across the life course. Focusing on early-life and chronic exposures—especially arsenic and heavy metal mixtures—her work examines impacts on vaccine responses, infection and cancer risk, and neuroinflammatory pathways tied to neurodevelopmental and neurodegenerative outcomes. She also leads a study characterizing the exposome in relation to childhood asthma in Baltimore City.

Gerome Guiot works at the intersection of health, strategy and investments with a focus on age-related diseases, healthspan and longevity. He is passionate about breaking silos and challenging consensus. His interests include the improvement of measures of health and aging, the quantification of the impact of behavioral changes to health via lifestyle changes or better adherence to treatment, and the quantification of the importance of psychological and emotional wellbeing. Gérôme is currently a Strategic Initiatives Director at LVMH and an advisor to the International Institute of Longevity.

Sofia Hagen leads an award-winning creative practice spanning art, design, technology, wellness innovation and cultural programming. Her work combines circular design, recycled bio-based materials and advanced technologies to create human-centred experiences. She has delivered projects internationally and regularly speaks at global conferences on design, AI and technology. Previously co-founder of HagenHinderdael, Sofia was Design Director at Design Haus Liberty and held roles at Heatherwick Studio, Zaha Hadid Architects and Odile Decq Architects. She trained in architecture under Zaha Hadid at the University of Applied Arts Vienna.

Community Partners

The following community partners and technology companies are supporting the JoyScore Experiment:

Frontier Tower, San Francisco (December 2025 MVP): Longevity lead. Laurence Ion
Frontier Tower is a self-governed community lab in frontier tech space with a constellation of longevity and biotech pioneers and innovative arts & music artists.

Infinita, Roatan, Honduras (February/March 2026 study): Community Lead Macsue Jacques
A community that brings together researchers, entrepreneurs, and citizens for a living experiment in how societies can advance health and human potential through freedom to innovate. The JoyScore Experiment formed part of the Longevity Biomarkers Competition (see here).

Playa.ai/Burning Man: Project Lead Alex Azzi
The JoyScore Experiment forms part of the plans of the Playa AI Foundation to build on an open-source, community-governed foundation model that utilises data ethically gathered from the unique environment of Burning Man to capture human insights and emotional presence that are missing from current AI. This effort forms a critical 'peak experience' cohort for the JoyScore Experiment, researching how we can encode the human spirit and dignity into the next generation of intelligence.

Neurotech Partners

AWEAR: Founder & CEO Antonio Forenza
Creators of single-ear neurotechnology that makes real-world EEG feasible for synchrony, emotion and cognitive state measurement.

Muse2 Founder and CEO Ariel Garten
Multi-sensor EEG headband supporting frontal and temporal neural activity measurement, as well as respiration and movement tracking. Within the JoyScore Experiment, Muse will be deployed in a deep phenotyping subgroup to characterise neural state (e.g. alpha/theta dynamics, frontal asymmetry) before, during, and after structured experiential sessions. Muse will function as a complementary neural measurement layer alongside AWEAR.

Neurocreate: Founder & CEO Dr Shama Rahman
A pioneering neurodesign agency that bridges neuroscience and creativity through an inclusive approach to unlocking peak human potential and fostering creativity and well-being.

Longevity Biomarkers

Deleon Technologies, Founder & CEO Chad Pozarycki
Deleón Omics provides advanced metabolomic profiling and recovery modelling, enabling quantification of metabolic stress and adaptive capacity from non-invasive biospecimens. In the JoyScore Experiment, Deleón supports deep phenotyping of stress–recovery dynamics associated with psychosocial and sensory exposures.

AgeRate Founder & CEO Cole Kirschner
AgeRate delivers DNA methylation–based biological age and resilience metrics using next-generation epigenetic algorithms. AgeRate quantifies DNA methylation patterns that correlate strongly with long-term ageing processes, inflammation, metabolic stress, and immune ageing. Changes in these patterns represent the *biological memory* of cumulative environmental, lifestyle, and psychosocial exposures.

GlycanAge Founder & CEO Nikolina Lauc
GlycanAge captures the structure and relative abundance of immunoglobulin glycans — sugar moieties on key immune proteins — which reflect systemic immune regulation, inflammatory tone, and biological ageing. Glycan profiles change more slowly and integrate signals across immune, metabolic, and stress pathways

Longevity Apps/ Wearables/ Platform Partners

Rejuve.ai: CEO Jasmine Smith and Data Scientist Macsue Jacques
A decentralised AI-driven wellbeing app supporting emotional tracking and EMA research.

Humanity Health: Co-founders Peter Ward and Michael Geer
A leading biological age and healthspan platform with millions of data points from users, including exposome data.

Healome One Founder & CEO Nikhil Yadala
Healome is a voice and text AI Powered habit tracking to improve clinical treatment efficacy and protocol adherence, serving the platform to discover causal relationships with aging endpoints.

OpenCures: CEO Kevin Perrott
Citizen scientist lab geared to create preventive and personalized medicine, supporting human trials and real world evidence data to achieve this.

Bleo: Co-founders Richard Skaife and Toby Sorabjee
A new wearable tracking health, sleep & activity in style with smart rings and bands, seamlessly connected to The Longevity AI.

Music partners
The Sound Nutritionist: Co-founders Christin Rauter and Leon Jean-Marie
Specialists in psychoacoustics, sound texture, and sensory nourishment.

MIM UK, Founder & CEO Emma Marshall
Music is Medicine provides science-backed education & research at the intersection of electronic music, movement, global culture and neuroscience. The organisation provides innovative training, masterclasses, courses, workshops and events that harness rhythm to regulate the nervous system, reduce stress, and enhance well-being, creativity, and productivity.

Willowave:Founder & CEO, Alba Tottemocha
Willowave turns sound into a tool for human transformation. Grounded in neuroscience and psychoacoustic research, their soundscapes restore nervous system coherence and reprogram subconscious beliefs, aligning you with the state you want to live in.

All advisers and partners are asked to sign up to the multi-stakeholder open science collaboration agreement here.

Next iteration partners proposed

Polar (ECG wearable)
Provider of ECG-capable wearable sensors enabling high-fidelity cardiac data collection. Within the JoyScore Experiment, Polar devices will support continuous RR interval capture, heart rate variability (HRV) analysis, recovery slope estimation, and inter-subject cardiac synchrony during collective experiences. Polar can serve as the primary partner for autonomic and cardiac physiology.

Salivary Biomarker Partner
A dedicated biospecimen partner (e.g. saliva-based assay provider) will support measurement of cortisol (primary) and alpha-amylase (supporting) as indices of stress and recovery dynamics. Optional exploratory markers (e.g. secretory IgA, oxytocin) may be included with appropriate assay validation and interpretation constraints.

Emotiv (optional deep phenotyping layer)
Multi-channel EEG platform enabling higher spatial resolution neural data acquisition. Emotiv may be deployed in a subset of participants to validate neural findings (e.g. frontal asymmetry, network-level dynamics, inter-brain synchrony) and strengthen the scientific robustness of EEG-derived measures.

Scientific Rationale
The JoyScore is a new scientific measure designed to quantify how joy, connection, synchrony, and emotional uplift affect our brains, bodies, and long-term health. It is being developed because the science is now unequivocal: human connection is one of the strongest predictors of longevity — with loneliness increasing mortality risk as much as smoking 15 cigarettes a day.

It is being designed as the world's first open-science study to build this new metric — one intended to become as mainstream and actionable as step count, sleep score, or heart-rate variability.

Chronic loneliness and social isolation elevate inflammation, accelerate biological aging, erode cognition, and increase all-cause mortality. As AI and digital platforms mediate more of our lives, we risk increasing social disconnection and dehumanisation.

We are designing JoyScore within the human exposome framework: the totality of environmental, social, and behavioral exposures that shape healthspan. Recent advances in aging biology, including the Blueprint Theory and necrosis-centered frameworks[1] [2], emphasise that healthspan loss arises from cascades triggered by environmental, behavioral, and psychosocial exposures. Chronic social disconnection and stress act as upstream triggers that amplify inflammatory, mitochondrial, and autonomic dysregulation, increasing vulnerability to degenerative pathways.

Epigenetic aging measures provide one of the most mature biological readouts of the exposome, capturing how social, behavioural, and environmental experiences are written into long-term biological regulation.

The JoyScore Experiment is designed to quantify and intentionally reshape the 'social exposome'—a modifiable exposure layer that may buffer or attenuate these cascades.

Positive Psychosocial Experience as a Reinforcing Exposure

An important feature of positive psychosocial experiences is that their effects may extend beyond immediate physiological state changes.

Emerging evidence from behavioural neuroscience and positive psychology suggests that positive affect, social connection, and emotionally meaningful experiences can reinforce future health-promoting behaviours through adaptive feedback mechanisms.

Barbara Fredrickson's "broaden-and-build" theory proposes that positive emotional states expand cognitive, behavioural, and social repertoires, increasing openness, resilience, social engagement, and long-term resource building (Fredrickson, *American Psychologist*, 2001).

Similarly, research in behavioural medicine has shown that positive affect is associated with:

- improved behavioural adherence
- increased physical activity
- stronger social participation
- improved recovery behaviours
- greater long-term resilience

(Cohen et al., *Psychological Science*, 2003; Pressman & Cohen, *Psychological Bulletin*, 2005).

Within the JoyScore framework, this raises the possibility that positive psychosocial exposures may operate not only as acute physiological modulators, but also as *self-reinforcing behavioural drivers.*

In this model:

- positive social experiences increase motivation for future engagement
- future engagement increases exposure to protective psychosocial conditions
- repeated exposure may strengthen behavioural, emotional, and physiological resilience over time

This creates the potential for a *"virtuous cycle" of connection, regulation, and health-promoting behaviour.*

Importantly, this may differ fundamentally from negative psychosocial exposures, which are often associated with behavioural narrowing, withdrawal, chronic stress activation, and maladaptive reinforcement patterns.

The JoyScore framework therefore seeks to examine not only whether positive social experiences generate measurable biological effects, but whether they also increase the likelihood of sustained participation in behaviours and environments associated with long-term health and wellbeing.

Commercial Rationale

While the longevity industry has poured billions into molecules, wearables, scans, and biological age clocks, one truth has been overlooked: the experiences that make us feel alive — movement, dance, synchrony, community, joy — are not "soft" factors. They are measurable biological regulators. The JoyScore aims to bring these human experiences into the centre of health science.

The experiment will generate early models for how JoyScore could be applied. Imagine if…

- 20 minutes of group dancing improved your emotional state and physiological recovery *more* than an hour of solitary cardio on a stationary bike?
- Wellness studios, spas, retreats, hotels and music venues used JoyScore to design experiences that measurably improve your health and wellbeing
- Big Tech starts to build “joy-optimised” content backed by biomarkers and informed with JoyScores
- A new category, ‘JoyTech’, emerges with evidence-based experiences, environments and tools reimbursable by insurers if they produce high JoyScores

See here the commercial application of JoyScore across industry verticals.

First Use Case

Longevity Rave is the first use case being tested in the JoyScore Experiment. Longevity Rave is being designed as a structured, evidence-based approach to health and wellbeing, where rhythmic synchrony acts as a biological mechanism for connection, stress recovery, and long-term resilience.

Raves are living laboratories where music, movement, light, and touch align physiology, brain activity, emotion, and belonging. In an age of AI-driven techno-isolation, we position raves as counter-technology that restores human connection and preserves what makes us human.

Scientific studies consistently show that high-energy dancing significantly boosts mood, reduces stress, and enhances emotional wellbeing. Dancing is associated with neurochemical and physiological processes linked to reward, social bonding, and stress regulation, though these are not directly measured in this study. Dance interventions have been proven to reduce symptoms of depression and anxiety, enhance quality of life, and build psychological resilience.

Dance is also a powerful form of aerobic exercise, improving cardiovascular fitness, metabolic health, and overall physical resilience. Studies have linked regular dancing with lower resting heart rate, improved blood pressure, and decreased levels of inflammatory markers like CRP. Longitudinal studies suggest that frequent dance activity can reduce all-cause mortality, particularly cardiovascular death.

Informed by the evidence, Longevity Rave is exploring a tiered tempo architecture for the music it plays, grounded in entrainment science:

- ≈60 BPM — relaxation/alpha entrainment, trust-building and intimacy blocks.
- 100–120 BPM — natural gait range; maximizes inclusive group synchrony and ease of movement (walking pace).
- 120–130 BPM — rave sweet spot; sustains energy and collective synchrony, linked to endorphin/oxytocin bonding.
- 130–140 BPM — peak-energy blocks, used sparingly to avoid crowd fragmentation.

This aligns with studies showing that movement synchronizes most easily around walking cadence (~100–120 BPM) with measurable effects on social closeness, and that synchronized group dance (commonly ~120 BPM in electronic genres) elevates bonding and pain thresholds.

In the JoyScore Experiment we test people's responses to music tracks which are structured as follows:

- CALM (60–80 BPM): recovery, trust-building, breath entrainment and closing rituals.
- FLOW (100–115 BPM): inclusive movement, warm-up and between-peak recovery.
- CONNECT (120–130 BPM): group synchrony & euphoria for raves/group classes.
- PEAK (130–135 BPM): short, high-energy climaxes that retain synchrony.

See the sonic framework here. The reference list in the Appendix backs up our concept.

Conceptual Data Framework

A central hypothesis of the JoyScore Experiment is that synchrony across neural, cardiac, and behavioural systems represents a measurable mechanism of human connection and co-regulation.

JoyScore will be operationalised as a composite latent variable derived from repeated EMA measures of affect, connection, meaning, and recovery, validated using multilevel factor modelling. The within-subject design reduces inter-individual variability and increases sensitivity to detect state-dependent changes. All analysis plans are pre-specified and aligned with OSF preregistration to reduce analytic flexibility and enhance reproducibility.

The study integrates biomarkers operating on different temporal scales: high-frequency experiential and neural measures (EMA, EEG, ECG), medium-horizon stress-recovery signals (metabolomics), and long-horizon ageing markers (epigenetics and glycomics). This layered approach enables internal cross-validation, reducing reliance on any single modality and strengthening inference about how psychosocial exposures become biologically embedded over time. Longitudinal biological validation (e.g. epigenetic aging trajectories) enables JoyScore to function not only as an engagement or wellbeing metric, but as a credible proxy for cumulative healthspan-relevant exposure.

Three-Layer Model

This study adopts an exposome framework to healthspan research, informed by emerging necrosis-centered and Blueprint theories of aging, which emphasise that cumulative environmental, behavioural, and psychosocial exposures act as upstream triggers for biological cascades of undesirable pathways (ie pathological pathways or patho-pathways for short) associated with inflammation, mitochondrial stress, and neuroendocrine dysregulation, amongst others , that ultimately functional decline.

Within this framework, the JoyScore Experiment is designed to quantify the social and psychosocial exposome and its proximal biological correlates, focusing on mechanisms that plausibly influence recovery, resilience, and vulnerability to degenerative processes.

The JoyScore Experiment organises measurement across three integrated layers that distinguish inputs, mediators, and outcomes — where joy and wellbeing are both drivers of experience and meaningful endpoints. This structure deliberately differentiates means (exposures and mechanisms) from ends (joy, purpose, resilience, and ageing trajectories).

Layer 1 — Context & Exposures (Inputs)

This layer captures the environmental, social, behavioural, and sensory conditions that shape human experience and the social exposome. These inputs include:

- Social context (alone vs collective, familiarity, social density)
- Sensory exposures (music, rhythm, tempo bands, light, space)
- Routine and rhythm (sleep timing, circadian alignment)
- Behavioural exposures (movement intensity, hydration, substance use)

These represent the designed exposures that JoyScore aims to quantify and optimise.

Layer 2 — Joy Mechanisms (Mediators)

Joy itself is conceptualised not merely as an exposure but also as a mechanism of action. This layer includes experiential and psychosocial processes that translate exposures into enduring psychological and physiological regulation:

- Affective uplift and vitality: how experiences influence momentary positive affect
  Belonging and social safety: felt security, trust, and co-regulation
- Meaning & purpose: forward-looking motivation, desire for future engagement, and life narrative coherence
- Emotional regulation & recovery: capacity to return to calm after stimulation
  These mediator constructs are captured using validated experience sampling alongside neural and biochemical proxies.

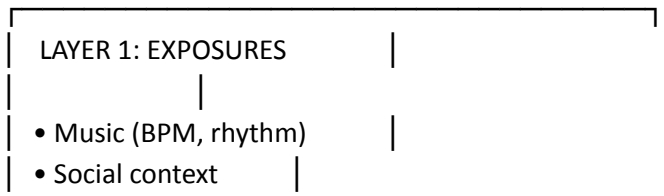
Layer 3 — Joy Outcomes (Ends)

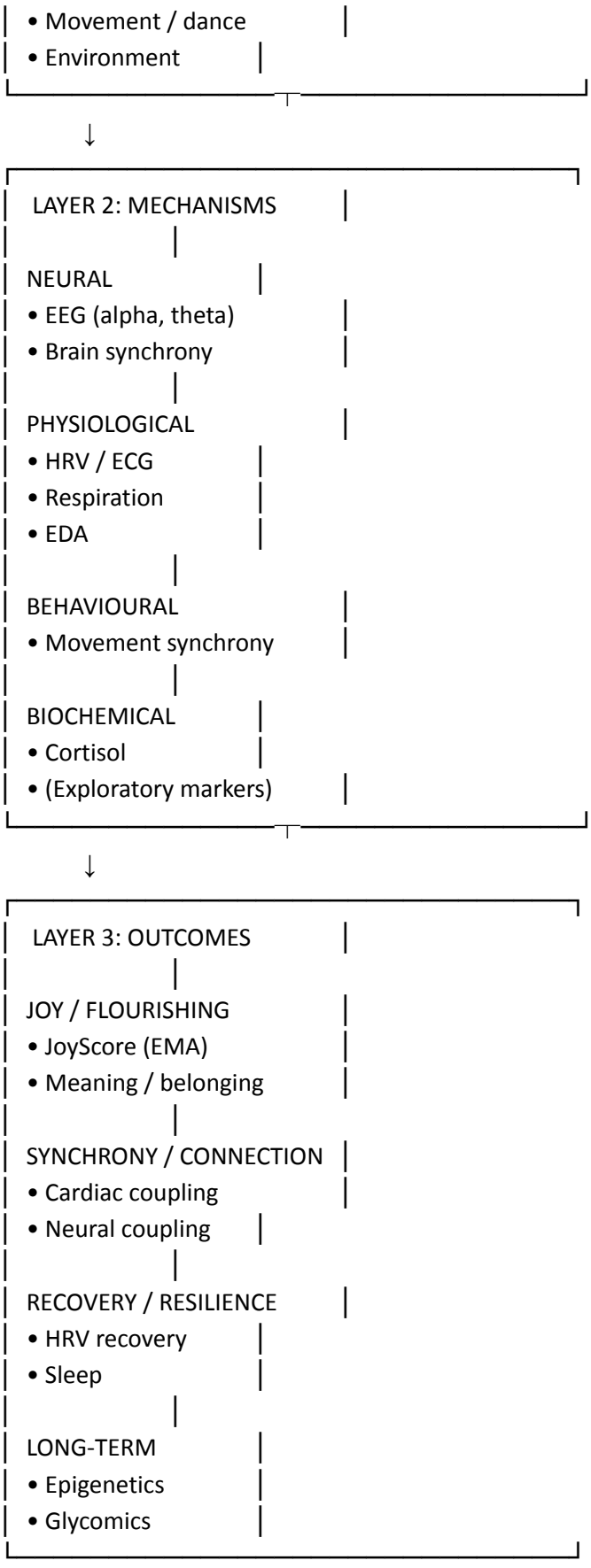
Joy outcomes encompass both subjective wellbeing and long-term resilience signals. These are the *goals* of intentional exposome design and inform what we aspire to influence:

- 'Joie de vivre' / psychological flourishing: meaning, hopefulness, agency, prosocial engagement
- Resilience & recovery: stability of affect and restored regulation after stimulation
- Biological ageing and deep phenotyping proxies: epigenetic and glycomic signals that reflect cumulative exposures over longer horizons

By structuring the model this way, we clarify that joy is both a mediator linking designed exposures to adaptation and an outcome in its own right — with measurable relevance to healthspan and resilience.

Refer to the figure below:





Study Protocols

Study volunteers have to meet strict eligibility criteria and sign the consent form here.

Phase 0 MVP Hypothesis (Frontier Tower)
The Phase 0 San Francisco feasibility pilot (n=20) conducted in December 2025 established signal detection, operational feasibility, and parameter stability.

The MVP assessed:

- EEG state shifts
- Nitrous Oxide strip change pre/post

See the piece written up by Longevity Technology in Joy Gets Measured and in San Francisco Standard, Welcome to Joyspan, the Hot New Trend in Longevity.

Phase 1 Longitudinal Cohort (Roatan, Honduras)

Findings from Phase 0 informed Phase 1 study in Roatan Honduras in February/March 2026 in key areas such as effect size estimation, assay validation, protocol refinement, refined block timing, larger EEG subgroup, and expanded biomarker schedule.

In addition to Phase 0 data capture this study measured:

- EMA affect and connection changes
- Changes in metabolites/metabolomics (Deleon)
- Changes in glycomics (GlycanAge)
- Changes epigenetics (AgeRate)

Neither epigenetic nor glycomic measures are designed to detect acute shifts from a single event, but each serves as a validated biological anchor that can be tested for association with JoyScore trajectories over time.

A poster informed by the findings from this study is being presented at the Global Exposome Summit in April 2026 (abstract here).

Next Stage Tiered Measurement Design

Informed by findings from Phase 0 and Phase 1, the next stage (Phase 2) will employ a tiered measurement architecture as follows:

Tier 1 — Core Cohort (all participants)

- Ecological momentary assessment (EMA; JoyScore)
- Movement synchrony (IMU-based)
- Cardiac measures (HR / HRV)
- Sleep and recovery metrics
- Contextual exposure logging

Tier 2 — Deep Phenotyping Subgroup

- EEG (AWEAR + Muse2)
- ECG (Polar)
- Salivary biomarkers (cortisol, alpha-amylase)
- Optional respiration and electrodermal activity

Tier 3 — Exploratory Subgroup

- Dried blood microsampling (e.g. GDF15 and exploratory analytes)
- Advanced metabolomics and recovery modelling
- Extended longitudinal follow-up

Temporal Structure

The temporal structure of the study is as set out below:

Pre-Event (Baseline)

- EMA baseline (affect, connection, state)
- Resting HRV (ECG)
- Resting neural state (EEG subgroup)
- Saliva baseline sample (subset)

Peri-Event (Exposure)

- Continuous ECG recording
- EEG during structured music blocks (subset)
- Movement synchrony (IMU)
- Timestamp alignment with music tempo and structure

Post-Event (Recovery)

- Immediate EMA (joy, connection, recovery)
- HRV recovery slope
- Post-event EEG (subset)
- Saliva repeat sampling (subset)
- Sleep and overnight recovery tracking

Data Collection Matrix

Psychosocial Exposure Measures

Psychosocial exposures are captured using brief, repeated ecological momentary assessments (EMA) to characterize real-time variation in social experience and emotional state. Core domains include:

- Connection and belonging
- Positive affect and emotional uplift
- Perceived stress and calm
- Recovery capacity following stimulation

EMA prompts are administered at baseline, immediately following structured music exposure, and post-event, with optional repeated sampling in extended cohorts. These measures form the core JoyScore exposure variables, representing modifiable social and emotional conditions that may influence biological stress pathways.

Confounding behavioral exposures—including caffeine intake, sleep duration, hydration, and acute illness—are logged to support interpretability and downstream modeling.

Neural and Physiological Mediators

Neural and physiological mediators are assessed using complementary wearable technologies.

EEG is recorded using both single-ear (AWEAR) and multi-sensor headband devices (Muse; subset) to capture spectral dynamics (alpha, theta), frontal asymmetry, and neural entrainment to rhythmic stimuli. A subset of participants may undergo higher-resolution EEG acquisition for validation and inter-brain synchrony analyses.

AWEAR provides ecologically robust in-event EEG measurement, while Muse2 supports higher-resolution state characterisation in a subset; optional multi-channel systems may be used for validation rather than primary measurement.

Cardiac activity is recorded using ECG-based wearables (Polar) enabling high-resolution heart rate variability (HRV) analysis, recovery dynamics, and inter-subject cardiac synchrony during shared experiences.

Movement synchrony is assessed using inertial measurement units (IMUs), enabling quantification of phase alignment and collective coordination.

Where available, respiration and electrodermal activity are collected as complementary indices of autonomic regulation.

Blood and Saliva Biomarkers

Biological sampling prioritises minimally invasive methods suitable for repeated field deployment.

Saliva samples are collected to assess:

- Cortisol (primary index of stress–recovery dynamics)
- Alpha-amylase (supporting index of sympathetic activation)

Saliva collection will follow standardised protocols controlling for time of day, recent food intake, and acute confounders to ensure interpretability. Optional exploratory markers (e.g. secretory IgA, oxytocin) may be included and will be interpreted conservatively given known assay limitations.

Dried blood microsamples are collected in a subset of participants to assess:

- GDF15 (mitochondrial stress and systemic load)
- Exploratory analytes where analytically feasible

All biochemical measures are treated as supporting indicators of physiological state, not direct measures of affective experience.

Downstream Functional Proxies

Downstream proxies relevant to healthspan include:

- Sleep architecture and recovery metrics (where wearable data are available)
- Brief mood and energy scales (e.g., POMS subscales)
- Composite physiological or recovery indices generated by partnered platforms

These measures are not treated as direct indicators of degeneration but as functional outputs reflecting short-term recovery and system-level responsiveness.

Primary and Secondary Outcomes

Primary and secondary outcomes are as outlined below:

Primary outcomes:

- JoyScore (EMA composite)
- HRV (RMSSD) and recovery slope
- Movement synchrony

Secondary outcomes:

- EEG-derived neural state metrics
- Cardiac synchrony
- Sleep recovery

Exploratory outcomes:

- Salivary biomarkers
- GDF15 and metabolomics
- Epigenetic and glycomic markers

Analytical Strategy

Analyses emphasize within-subject change and recovery trajectories rather than absolute biomarker values. Primary models examine associations between psychosocial exposure intensity (JoyScore variables), neural and physiological mediators, and short-term functional outcomes, adjusting for key confounders. Extended cohorts enable modeling of exposure–response relationships and recovery slopes over time.

Primary analyses will incorporate multimodal composite variables integrating neural, physiological, behavioural, and psychosocial data streams. Synchrony measures (movement, cardiac, neural) will be analysed both at the individual and group level to assess co-regulation and shared physiological dynamics.

The study emphasises cross-modal convergence**,** whereby consistent directional changes across independent systems (e.g. HRV, EEG, EMA) strengthen inference regarding underlying mechanisms.

A centralised data integration and analysis pipeline will harmonise multimodal data streams (EMA, EEG, ECG, IMU, and biospecimens), with pre-specified feature extraction and quality control procedures.

Other considerations

A general medical checkup and assessment of disease load could be warranted in certain situations (for example, bereavement, divorce, work burnout), noting that psychological stress can be a major factor in conditions like cardiovascular disease, stroke, etc that is often underestimated - but the literature shows strong trends.

Detailed Measurement Matrix

Phase 2 is explicitly designed to produce a tiered multimodal dataset enabling attribution modelling of how psychosocial exposures interact with neural, autonomic, behavioural, biochemical, and longer-horizon biological pathways across time. This next-stage design builds on findings from Phase 0 and Phase 1 and incorporates a core cohort, deep phenotyping subgroup, and exploratory subgroup to optimise feasibility, data quality, and interpretability.

Layer	Domain	Measure	Method / Partner Tech	Timing	Expected Direction (↑ ↓ ↔)	Interpretation
Exposure	Social exposome	JoyScore EMA (connection, joy, meaning, purpose, recovery)	Rejuve.ai	Baseline; during; immediate post; optional repeated follow-up	↑	Core psychosocial exposure and flourishing index
Exposure	Context / confounds	Sleep, caffeine, alcohol, substances, hydration, illness	EMA tags + logs	Daily / pre-session	—	Controls confounding exposome inputs
Exposure	Sensory context	Music block, tempo band, sound/light environment	Event logging + protocol timestamps	Continuous during exposure	State-dependent	Designed sensory exposure for synchrony and recovery modelling
Exposure	Behavioural engagement	Movement intensity / activity load	IMU + wearable-derived activity	Continuous during exposure	↔	Quantifies exertion and behavioural participation
Mediator	Neural state	EEG spectral dynamics (alpha, theta, beta)	AWEAR	During music and synchrony modules	State-dependent	Neural responsivity to designed exposures
Mediator	Neural state validation	Frontal asymmetry, alpha/theta state profiling	Muse2 (deep phenotyping subgroup)	Pre; during selected blocks; post	State-dependent	Higher-resolution neural state characterisation
Mediator	Neural entrainment	Beat- and rhythm-related neural entrainment	AWEAR + Muse2	During structured music blocks	↑	Brain–music coupling and temporal alignment

Mediator	Inter-brain synchrony	ISC / ITPC or related synchrony metrics	EEG subgroup; optional validation layer	During shared exposure	↑	Shared neural processing during collective experience
Mediator	Cardiac state	HR, RR intervals, ECG-derived HRV (including RMSSD)	Polar ECG	Pre; continuous peri-event; post	↑ recovery / ↔ state-dependent	Autonomic regulation and recovery capacity
Mediator	Cardiac synchrony	Inter-subject cardiac coupling / coherence	Polar ECG	During shared exposure	↑	Co-regulation and physiological synchrony
Mediator	Recovery dynamics	HRV recovery slope	Polar ECG	Immediate post; early recovery; overnight where available	↑	Short-term autonomic resilience
Mediator	Movement synchrony	Phase-locking / synchrony indices (e.g. PLV)	IMU-based movement sensing	During shared exposure	↑	Embodied synchrony and collective coordination
Mediator	Respiration (optional)	Breathing rate / respiratory coherence	Optional respiration monitoring	Pre; during; post	↑ coherence	Complementary autonomic regulation signal
Mediator	Electrodermal activity (optional)	Skin conductance / arousal dynamics	Optional EDA wearable	During selected blocks	State-dependent	Complementary sympathetic arousal signal
Mediator	Neuroendocrine stress / recovery	Cortisol	Salivary biomarker partner	Pre; post; optional repeated recovery sampling	↓	Primary biochemical index of stress–recovery dynamics
Mediator	Sympathetic activation	Alpha-amylase	Salivary biomarker partner	Pre; post	↔ / context-dependent	Supporting index of sympathetic activation
Mediator	Immune / exploratory	sIgA; oxytocin (exploratory only)	Salivary biomarker partner	Optional subset	Exploratory	Ancillary immune / social salience measures; interpreted conservatively
Mediator	Mitochondrial stress	GDF15	Mitra DBS + lab partner	Baseline; post-event; optional repeated follow-up	↓	Stress–recovery load
Mediator	Metabolic resilience	Urine amino-acid metabolomics	Deleón Omics	Repeated over 4–6 weeks	Normalisation	Biochemical response to psychosocial exposure
Mediator	Recovery dynamics	Recovery Margin; clearance constants	Deleón Omics (wearable-fused)	Weekly model outputs	↑	Personalised recovery capacity
Mediator	Epigenetic ageing	Biological Age (epigenetic clock)	AgeRate	Baseline + end; optional follow-up	↓	Long-horizon anchor reflecting cumulative exposure history; used to validate JoyScore trajectories rather than detect acute intervention effects
Mediator	Preventative health profile	Functional longevity panel	Eveda	Baseline + end	↑	Contextualised resilience pathways

Mediator	Glycomic ageing	GlycanAge Score & Glycan Age Index	GlycanAge	Baseline + end; optional follow-up	↓	Immune and inflammatory ageing signature
Outcome proxy	Psychological flourishing	Meaning / purpose; vitality; hope; belonging	EMA + validated scales	Daily / weekly / post-session	↑	Joie de vivre and psychosocial resilience
Outcome proxy	Acute recovery	Emotional recovery rating	EMA	Immediate post; delayed post	↑	Subjective recovery following stimulation
Outcome proxy	Sleep and autonomic recovery	Sleep architecture; resting HRV RMSSD	Wearables (agnostic) + Polar where available	Nightly / overnight	↑	Physiological recovery proxy
Outcome proxy	Functional state	Mood and energy scales (e.g. POMS subscales)	Validated brief scales	Pre; post	↑	Short-term functional response
Outcome proxy	Composite resilience index	Integrated multimodal score	Analytic synthesis	Programme duration	↑	Cross-domain adaptation signal

Note: "Expected direction" arrows refer to hypothesised beneficial change (e.g. ↓ stress load; ↑ joy, synchrony, and resilience). All interpretive statements are phrased conservatively to reflect research aims, not clinical claims. Measures collected in subgroups are used to enhance mechanistic inference while limiting participant burden. This is consistent with the Phase 2 tiered design described in the latest proposal.

APPENDIX

IRB Executive Summary

Study Title

The JoyScore Experiment: Measuring Joy, Meaning, and Social Connection as Components of the Human Exposome

Purpose and Scientific Rationale

The JoyScore Experiment investigates whether joy, meaning, social connection, synchrony, and emotional recovery can be reliably measured as components of the human exposome, and whether these experiential states are associated with markers of resilience and healthy ageing. Social disconnection and chronic stress are established risk factors for morbidity and mortality; however, there is currently no validated metric that quantifies positive psychosocial exposures such as joy, belonging, and purpose in a way that is measurable, repeatable, and biologically interpretable. This study aims to validate JoyScore as a multidimensional measure of psychosocial wellbeing and to examine its relationship with neural, autonomic, behavioural, and biochemical indicators, with longer-horizon biological anchors included in selected participants.

Study Design

This is a non-interventional, observational, within-subject study incorporating repeated measures. Participants will take part in structured experiential sessions, including music-based collective

experiences and comparator conditions where applicable, and will complete ecological momentary assessments (EMA). Data collection includes self-report measures, wearable-based neural and cardiac recordings, movement synchrony measures, minimally invasive salivary and dried blood microsampling in subgroups, and optional longitudinal follow-up. The study is designed to distinguish measurement validation from exploratory association testing and does not make clinical or therapeutic claims.

Tiered Measurement Design

To optimise feasibility, data quality, and participant compliance, the study employs a tiered measurement architecture**:**

Tier 1 — Core Cohort (all participants)
Participants contribute ecological momentary assessment (EMA; JoyScore), movement synchrony measures, cardiac measures derived from wearable devices, sleep and recovery metrics, and contextual exposure logging.

Tier 2 — Deep Phenotyping Subgroup
A subset of participants contributes wearable EEG data using AWEAR and Muse2, ECG data using Polar devices, salivary biomarkers including cortisol and alpha-amylase, and optional respiration and electrodermal activity measures.

Tier 3 — Exploratory Subgroup
A further subset contributes dried blood microsampling (for example GDF15 and exploratory analytes), advanced metabolomics and recovery modelling, and extended longitudinal follow-up including biological ageing anchors where feasible.

Participants
Participants are adults aged 18 years or older who are capable of providing informed consent. Exclusion criteria include acute illness, inability to comply with study procedures, or contraindications to wearable sensors or biological sampling procedures. Participation is voluntary, and participants may withdraw at any time without penalty. Individuals will only be enrolled into those measurement tiers for which they have provided explicit consent.

Participants will provide tier-specific informed consent, allowing them to opt into or decline deeper phenotyping components without affecting participation in the core study.

Procedures and Data Collected
Participants will complete the following procedures, depending on measurement tier:

Psychosocial assessment
Repeated ecological momentary assessments (EMA) measuring joy, positive affect, belonging, meaning/purpose, emotional recovery, and contextual variables including sleep, hydration, caffeine, alcohol, and illness.

Neural measurements
Non-invasive EEG recordings using single-ear and multi-sensor wearable devices during selected experiential sessions. EEG analyses will focus on spectral dynamics, neural entrainment to rhythmic stimuli, and, in selected subgroups, inter-brain synchrony.

Cardiac and autonomic measurements
Wearable ECG-based cardiac recordings, including continuous RR interval capture and derived HRV measures, will be used to assess autonomic state, recovery dynamics, and inter-subject cardiac synchrony during shared experiences.

Movement synchrony
Wearable inertial measurement units (IMUs) or equivalent motion-sensing devices will be used to quantify movement intensity, phase alignment, and collective coordination.

Salivary biomarkers
Saliva samples will be collected in a subgroup to assess cortisol as a primary stress–recovery biomarker and alpha-amylase as a supporting index of sympathetic activation. Optional exploratory markers such as secretory IgA and oxytocin may be included where analytically feasible and will be interpreted conservatively.

Dried blood microsampling and other exploratory biosamples
A subset of participants will provide dried blood microsamples for GDF15 and other exploratory analytes, as well as urine or related biospecimens for metabolomic analyses where applicable.

Longitudinal biological anchors
Selected participants may undergo longer-horizon biological assessments, including epigenetic and glycomic measures, to examine associations between cumulative JoyScore trajectories and biological resilience proxies over time. These measures are not expected to change acutely from a single session.

<u>Temporal Structure</u>
Measures are organised around three time windows:

Pre-event (baseline)
Baseline EMA, resting cardiac measures, resting neural state in EEG subgroups, and baseline saliva sampling in relevant participants.

Peri-event (exposure)
Continuous ECG recording, EEG during structured music blocks in subgroups, movement synchrony measurement, and time-stamped alignment with music tempo and exposure structure.

Post-event (recovery)
Immediate post-session EMA, HRV recovery slope estimation, post-event EEG in subgroups, repeated saliva sampling in relevant participants, and sleep / overnight recovery tracking where available.

Risks and Risk Mitigation

Risks are minimal and include mild discomfort or inconvenience associated with wearable devices, adhesive sensors, or biological sample collection. There is a small risk of fatigue, transient overstimulation, or emotional discomfort during experiential sessions. Risk mitigation includes trained staff oversight, optional breaks, conservative interpretation of exploratory biomarkers, clear withdrawal rights, and exclusion of participants for whom the procedures would be inappropriate. No psychoactive substances are administered or encouraged as part of the study.

Benefits

Participants may gain insight into their wellbeing and recovery patterns and contribute to research aimed at understanding positive psychosocial factors in health and ageing. There is no guarantee of direct personal benefit. Findings are intended for research and model development rather than diagnosis or treatment.

Data Protection and Confidentiality

All data will be pseudonymised and stored on secure, access-controlled systems. Identifiable information will be kept separate from research data. Multimodal data streams, including wearable, self-report, and biospecimen-derived data, will be linked using study identifiers only. Data will be used for research purposes and handled in accordance with applicable data protection regulations.

Ethical Considerations

This study adheres to the principles of respect for persons, beneficence, and justice. The protocol focuses on observation and measurement rather than intervention. All analyses are pre-specified to reduce bias and will be interpreted conservatively. Findings will be reported in aggregate to protect participant privacy. Subgroup biomarker and deep-phenotyping components are included to improve mechanistic inference while limiting participant burden.

Summary

The JoyScore Experiment is a low-risk, ethically grounded study designed to validate a novel psychosocial measurement framework and examine its relationship to resilience, synchrony, recovery, and healthy ageing. The Phase 2 protocol uses a tiered multimodal design that integrates psychosocial, neural, cardiac, behavioural, and biochemical measures while preserving feasibility, participant safety, and scientific rigor.

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