

Theodor Spiro

Independent Researcher — cellular perception, aging biomarkers, and the comparative biology of learning systems

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Emergent Ventures grant recipient (2026)

PROFILE

Independent computational researcher with a biophysics background (Lomonosov Moscow State University). I work on substrate-independent organizing principles across cells, aging tissues, and neural networks — applying one statistical apparatus across biological and engineered systems. Current center of the work is **perceptome**, a framework and Python toolkit treating cellular signaling pathways as a perceptual repertoire. Alongside: cross-population aging biomarkers (ECG, EEG, transcriptome) and the comparative biology of neural networks (distribution of fitness effects, epistasis). Methodology inherited from experimental physics: preregistration, bitwise-reproducible pipelines, bootstrap uncertainty quantification, and honest negative results.

SOFTWARE & TOOLS

perceptome (2026) — Python toolkit for cellular perception analysis. 44 signaling modules; 9-PC eigenspace built from 154 Human Protein Atlas cell types; capacity-floor predictor; validity scorecard with three null controls; 8-cell cancer-attractor reference (11 cancers from 11 organ systems converge toward it during transformation, independently replicated on an external HCC cohort). Zenodo [10.5281/zenodo.20113468](https://zenodo.org/record/20113468) · 73/73 tests passing.

PUBLICATIONS & PREPRINTS

Preprints (arXiv / bioRxiv / Zenodo):

- **Spectral exponents of the twelve-lead ECG reveal the anatomy of cardiac conduction disorders and a bifurcation between aging and disease.** bioRxiv (submitted), 2026. 412,730 recordings across three continents; CLBBB vs CRBBB AUC ≈ 0.98 cross-population. Zenodo [10.5281/zenodo.19945065](https://zenodo.org/record/19945065).
- **Transcriptomic noise accumulates within tissue identity across human aging.** bioRxiv (post-review v4), 2026. GTEx v8 + Tabula Muris Senis + Calico rat + macaque atlas; aging as systemic noise, not selective accumulation. Zenodo [10.5281/zenodo.19944444](https://zenodo.org/record/19944444).
- **Universal statistical signatures of evolution in artificial intelligence architectures.** arXiv:2604.10571, 2026. 935 ablation experiments across 161 publications; substrate-independent heavy-tailed DFE.

Under review:

- **Waveform asymmetry as a biomarker of neural aging.** *Frontiers in Aging Neuroscience*, 2026. LEMON (N=215) + Dortmund Vital Study (N=608) + 208-subject 5-year longitudinal. Zenodo [10.5281/zenodo.19912202](https://zenodo.org/record/19912202).
- **Functional differentiation generates universal fitness-effect distributions in neural networks.** Under review, NeurIPS 2026 / ICML Mechanistic Interpretability Workshop 2026. Pythia 410M, 1,584 controlled ablations across 8 checkpoints.

Manuscripts in preparation:

- **Clonal crystallization as a shared signature of bone-marrow aging and neural-network training.** Cross-substrate (Gini, eff_N) framework; caloric restriction rescues 64% of the aging drift in rat bone marrow.
- **Temporal architecture of signaling oscillations predicts cancer gene function across pathways.** Rise/recovery temporal classification; OR = 27.5, $p = 3.6 \times 10^{-9}$ across 14 pathways.
- **Negative feedback loop architecture as a modular predictor of cancer vulnerability.** 128 NFLs from KEGG; 59-fold CGC enrichment ($p = 9 \times 10^{-44}$); Irreversible Authority metric ($\rho = 0.83$).

- **The Oracle's Fingerprint: correlated AI forecasting errors and the limits of bias transmission.** GPT-4o / Claude / Gemini error correlation $r = 0.78$ on 568 Metaculus forecasts.
- **21,000 attempts to think differently: a Russian adaptation of the Divergent Association Task.** $N = 21,159$; Cronbach's $\alpha = 0.899$; live instrument deployed.
- **Self-specific representations localize in emergent attention heads.** Pilot: 29 active meta-heads, all $\Delta_{self} > \Delta_{cross}$ (binomial $p < 10^{-8}$).

Technical reports:

- **EEG-based comprehension detection: a multi-dataset non-replication.** Honest negative result; 18 metrics, 5 datasets, 126 subjects.

RESEARCH EXPERIENCE

Independent Researcher — affiliated with Vaika Inc. · 2020 – present Independent computational research program across cellular perception, aging biomarkers, comparative biology of neural networks, and AI-collaborative research methodology. Recent concentration on the perceptome framework and on single-cell / transcriptomic analysis; earlier work in computational neuroscience (EEG) and systems biology. All projects preregistered where inferential; full code and data released on GitHub and Zenodo.

B.Sc. / M.Sc. research — Moscow State University, Faculty of Physics · 2018 – 2022 Supervisor: Prof. L. Yakovenko. Agent-based / cellular-automata modeling of the cellular response to pro-inflammatory stimuli (TLR4/TLR6 → NF- κ B → TNF → apoptosis), identifying key parameters of the innate-immunity signaling pathway. Presented at the Lomonosov-2021 Scientific Conference.

RESEARCH METHODOLOGY

Developer of an **AI-collaborative research methodology framework** (mool32.github.io/methodology) — preregistration discipline, sign-convention locks, locked-vs-working artifacts, reproducibility standards, and AI-friendly publishing — applied as worked examples across the portfolio.

EDUCATION

M.Sc. Biophysics (coursework completed) — Lomonosov Moscow State University, Faculty of Physics · 2021 – 2022 Computer simulation in biology; physics of biopolymers; physicochemical kinetics; magnetic radio-spectroscopy in biology and medicine. Thesis defense not completed due to relocation from Russia in 2022.

B.Sc. Biophysics — Lomonosov Moscow State University, Faculty of Physics · 2014 – 2021

Lyceum 1525, Physics & Mathematics — Moscow · 2010 – 2014

TEACHING

Eleven years teaching mathematics and physics (ages 11–25), including gifted and olympiad-oriented students, across selective international programs, online schools, and private practice.

- **Le Sallay Academy** — STEM Teacher & Curriculum Designer · 2025 – 2026. Selective international program for gifted students (France residential + online); designed and delivered the full mathematics, physics, and earth-science curriculum.
- **BrainyBara** — Co-Founder & Lead Teacher · 2022 – present. Mathematics, physics, and critical-thinking programs (Israel); Bagrut and Edexcel A-Level prep; built AI-powered teaching tools.
- **Foxford Online School** — Mathematics & Physics Teacher · 2015 – 2018 (Moscow). 12+ courses developed.
- **Moscow State University** — Instructor, Advanced Mathematics · 2018 – 2020.
- **Private tutoring & methodology** · 2014 – 2022.

PROFESSIONAL DEVELOPMENT

- Evidence-Based Teaching Practices — Harvard University BOK Center · 2022 – 2024
- Psychology of Development and Learning — MSUPE, Moscow · 2020
- Learning to Teach Online — University of New South Wales · 2020

GRANTS & HONORS

- **Emergent Ventures grant** — 2026

TECHNICAL SKILLS

- **Programming:** Python (NumPy, Pandas, SciPy, scikit-learn, matplotlib, PyTorch), Git, Bash, LaTeX, SQL basics
- **Methods:** preregistered experimental design, bootstrap uncertainty quantification, distribution fitting with AIC comparison, dimensionality reduction, time-series and signal analysis, agent-based modeling
- **Data domains:** single-cell & bulk RNA-seq, EEG / ECG signals, neural-network interpretability, large-scale forecasting data
- **AI-assisted research:** LLM-integrated analysis pipelines under an explicit preregistration / reproducibility framework

LANGUAGES

Russian (native) · English (C1; all research published in English) · Hebrew (B1)