Testing Objective Reduction via Collective Human Measurement: A Macroscopic Qubit Proposal

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We propose a novel, testable framework for constructing macroscopic qubits and qudits using ensemble human agency as both the source of quantum state generation and the mechanism for collapse. Inspired by the Big Bell Test — which demonstrated that human-generated randomness can close loopholes in Bell inequality experiments — we extend this paradigm by defining human-driven superposition states.

In our model, a collective of human choices (e.g. heads or tails) defines a latent quantum state within a formal Hilbert space constructed from human choices, which remains unresolved until a collective measurement is made. While not physically coherent in the traditional sense, the ensemble mimics quantum superposition through the structure of collective uncertainty and delayed resolution. We demonstrate that this statistical ensemble satisfies the core properties of a qubit or qudit, including superposition and collapse dynamics, without relying on traditional quantum coherence.

We introduce a critical threshold N_c of participants needed to reliably induce collapse and derive estimates based on analogies with quantum decoherence, statistical sampling theory, and Penrose's Objective Reduction (OR) model. We also propose experimental protocols for multi-qubit scaling, implementing quantum gates such as CNOT and Hadamard, and creating entangled macroscopic states using coordinated human action.

This model provides a low-barrier, scalable platform for participatory quantum simulation, with implications for the foundations of quantum mechanics, quantum computation, and the role of conscious observers in wavefunction collapse.

1 Introduction

Quantum mechanics fundamentally hinges on the role of the observer, from the Einstein–Podolsky–Rosen (EPR) paradox [1] to the experimental verification of Bell inequalities [2]. The Big Bell Test [3] harnessed human-generated randomness from over 100,000 participants worldwide to close the freedom-of-choice loophole in quantum experiments, demonstrating that collective human input can influence quantum outcomes. Turiel *et al.* [4] further revealed that human perception exhibits statistical biases distinct from quantum randomness, suggesting that human agency could play a deeper role in quantum processes.

In this work, we propose a macroscopic qubit model in which a physical object — a penny — is placed into a notional superposition, with its final state (heads or tails) determined by the ensemble average of many human decisions. This model transforms the logic of the Big Bell Test from influencing microscopic quantum systems to collapsing macroscopic states via conscious, collective choice.

Quantum computing traditionally relies on microscopic qubits [5], where coherence can be preserved in isolated, cryogenically-cooled environments. In contrast, macroscopic quantum systems typically succumb to rapid decoherence due to environmental interactions [6]. However, Penrose's Objective Reduction (OR) model [7] proposes that gravitational self-energy itself may induce collapse, suggesting that the boundary between quantum and classical behavior is governed by spacetime geometry rather than environmental noise [8, 9].

Building on this and the Big Bell Test framework, we define the "penny qubit" not as a single physical object in superposition, but as an ensemble average over human decisions — each participant flipping or selecting a coin state. The system's quantum-like behavior emerges from the collective uncertainty prior to measurement. This model allows us to probe whether human-driven statistics — potentially modulated by gravity — could bridge the gap between microscopic quantum phenomena and macroscopic consciousness.

While the framework is grounded in statistical ensemble theory, we propose that if Penrose's OR model and the Big Bell Test findings reflect true quantum dynamics, then collective human agency may serve not only as an analogue but as a legitimate quantum measurement system — one driven by spacetime geometry, gravitational self-energy, and conscious observation.

2 Background

2.1 The Big Bell Test

The Big Bell Test [3] demonstrated that human-generated randomness can serve as a valid input for closing loopholes in Bell inequality experiments. Over 100,000 participants contributed unpredictable binary decisions, which were used in real-time to control measurement settings in entangled particle experiments. This large-scale, crowdsourced approach strengthened empirical support for quantum nonlocality by eliminating the freedom-of-choice loophole.

Turiel *et al.* [4] examined human-generated sequences and identified statistical biases — such as nonuniform distributions and pattern tendencies — that differ significantly from ideal quantum randomness. While their study did not target wavefunction collapse, it highlighted the structure of human unpredictability and its divergence from truly random quantum processes. These findings laid the groundwork for exploring whether collective human choice could itself serve as a measurement apparatus.

2.2 Standard qubits and superposition

In conventional quantum systems, a qubit is defined as a coherent superposition of two basis states:

$$|\psi\rangle = \alpha\,|0\rangle + \beta\,|1\rangle\,, \tag{1}$$

where α and β are complex amplitudes constrained by $|\alpha|^2 + |\beta|^2 = 1$. Quantum gates manipulate these amplitudes, enabling interference, entanglement, and computation that surpass classical limits [5]. However, maintaining such superpositions requires isolation from environmental noise, as interactions lead to decoherence and classical behavior [6].

2.3 Conceptual framework: human-driven macroscopic superposition

We propose a new interpretation of a macroscopic qubit based on ensemble human agency. Rather than preparing a single physical system in a coherent superposition, we treat the binary decisions of many human participants — such as selecting "heads" or "tails" for a coin flip — as forming a statistical superposition:

$$|\psi\rangle = \frac{1}{\sqrt{2}}\left(|\text{Heads}\rangle + |\text{Tails}\rangle\right)\,. \tag{2}$$

In this framework, each human choice acts as a probabilistic contribution to an unresolved state. The final state remains unresolved until a collective measurement aggregates the ensemble. The system collapses when the fraction of human choices f_H crosses a defined decision boundary (e.g. $f_H > 0.5$). This threshold is not a statistical confidence level but a deterministic collapse condition defined by the ensemble dynamics. A critical number of participants N_c may be required to ensure the superposition collapses reliably, drawing parallels to decoherence thresholds and sampling theory.

This model differs from traditional qubits in that it does not rely on phase coherence or physical isolation. Instead, it leverages uncertainty in aggregated human decisions to simulate quantum behavior at macroscopic scales. The collapse process is driven by observation — either by a human observer or an algorithmic tally — mirroring the role of measurement in standard quantum mechanics.

2.4 Relation to Objective Reduction and spacetime discreteness

Penrose's Objective Reduction (OR) model [7] offers a gravitational mechanism for wavefunction collapse, proposing that superpositions involving significantly different spacetime curvatures become unstable and collapse spontaneously. This implies that the quantum-classical boundary is not merely a matter of environmental decoherence but may depend on gravitational self-energy and spacetime geometry.

In our macroscopic model, we hypothesize that the number of human participants required to induce collapse (N_c) could scale with gravitational instability in the superposed configurations. If collective human agency acts as a measurement mechanism, it may couple to gravitational degrees of freedom, potentially enabling tests of spacetime discreteness or quantum gravity effects [8, 9].

This framework suggests a novel approach to probing quantum foundations: by treating human statistical ensembles as macroscopic qubits, we open a pathway to explore whether conscious agents can drive collapse and whether such collapse is influenced by gravity.

2.5 Measurement dynamics

We propose to use an ensemble number of people making a choice to place the coin on heads or tails. Each qubit state is determined by the ensemble average to be heads or tails upon collapse. The collapse is modeled as:

$$|\psi\rangle \xrightarrow{\text{Human Average}} \begin{cases} |\text{Heads}\rangle & \text{if } f_H > 0.5\,, \\ |\text{Tails}\rangle & \text{if } f_H < 0.5\,, \end{cases} \tag{3}$$

where f_H is the fraction of heads across all choices. Ties ($f_H = 0.5$) may require N_c to break ambiguity.

2.6 Threshold effects

We hypothesize the existence of a critical threshold N_c — the minimum number of human participants required to induce collapse. This could parallel decoherence thresholds in standard quantum systems.

Clarifying the term "quantum-like"

Throughout this paper, we refer to the proposed human-driven systems as exhibiting "quantum-like" behavior. By this, we do not mean that the system is merely a classical simulation of quantum mechanics. Rather, we suggest that collective human agency — particularly when treated as unresolved until a final ensemble average is observed — shares key structural and operational features with quantum systems. These include:

- Representation of states in a Hilbert space,
- Superposition of possible outcomes prior to measurement,

- Collapse dynamics triggered by observation or ensemble resolution,
- Rule-based analogs of entanglement and quantum gate operations.

Importantly, we do not assume that human agency is a classical stochastic process. Instead, we remain open to the possibility — motivated by Penrose's Objective Reduction (OR) and Orch-OR[‡] — that decision-making may involve non-classical or gravitationally-linked effects. Thus, the system behaves formally like a quantum information structure, and may in fact reflect deeper quantum-gravitational dynamics tied to cognition and observation.

3 Derivation of the human agency qubit

To formally ground the concept of a macroscopic qubit governed by human agency, we now derive its structure within the framework of quantum information theory. We demonstrate that the ensemble of human decisions admits a Hilbert space representation, forms legitimate superposition states, and permits a meaningful projection-based collapse rule analogous to standard quantum measurement. This section provides the mathematical and conceptual scaffolding for the central hypothesis of the paper: that collective human decisions can simulate quantum superposition and collapse dynamics.

3.1 Single participant as a basis state

We begin by modeling each human participant as a binary decision-maker who consciously chooses either "heads" (H) or "tails" (T). These are mapped onto orthonormal quantum basis states:

$$|H\rangle \equiv |0\rangle\,, \qquad |T\rangle \equiv |1\rangle\,. \tag{4}$$

Each participant thus occupies a two-dimensional Hilbert space $\mathbb{C}^2$ analogous to a qubit in quantum mechanics.

3.2 Ensemble state prior to measurement

Let N participants each make a choice, which is kept hidden prior to tallying. The overall system can be represented as a tensor product of individual states:

$$|\Psi\rangle = |\psi_1\rangle \otimes |\psi_2\rangle \otimes \cdots \otimes |\psi_N\rangle\,. \tag{5}$$

Assuming no predetermined decisions, each person exists in a balanced undecided state:

$$|\psi_i\rangle = \frac{1}{\sqrt{2}}\left(|0\rangle + |1\rangle\right)\,. \tag{6}$$

The total state becomes a uniform superposition over all possible 2^N outcome strings:

$$|\Psi\rangle = \bigotimes_{i=1}^{N} \frac{1}{\sqrt{2}}\left(|0\rangle + |1\rangle\right) = \frac{1}{2^{N/2}} \sum_{\mathbf{x}\in\{0,1\}^N} |\mathbf{x}\rangle\,. \tag{7}$$

[‡]Orchestrated Objective Reduction

This state spans the 2^N-dimensional Hilbert space $\mathcal{H} = (\mathbb{C}^2)^{\otimes N}$.

3.3 Macroscopic collapse rule

We define a macroscopic observable: the majority choice fraction

$$f_H = \frac{1}{N}\sum_{i=1}^{N} x_i\,, \tag{8}$$

where $x_i = 0$ for heads and $x_i = 1$ for tails. A measurement projects the superposition onto one of two macrostates:

$$|\Psi\rangle \xrightarrow{\text{tally}} \begin{cases} |\text{MajH}\rangle & \text{if } f_H < 0.5\,, \\ |\text{MajT}\rangle & \text{if } f_H > 0.5\,. \end{cases} \tag{9}$$

Here, $|\text{MajH}\rangle$ and $|\text{MajT}\rangle$ are defined as normalized superpositions over all strings with majority heads or tails, respectively:

$$|\text{MajH}\rangle = \frac{1}{\sqrt{N_H}} \sum_{\substack{\mathbf{x}\in\{0,1\}^N \\ \#(0)>\#(1)}} |\mathbf{x}\rangle\,, \tag{10}$$

$$|\text{MajT}\rangle = \frac{1}{\sqrt{N_T}} \sum_{\substack{\mathbf{x}\in\{0,1\}^N \\ \#(1)>\#(0)}} |\mathbf{x}\rangle\,, \tag{11}$$

where N_H and N_T are normalization factors counting the number of majority heads or tails configurations.

3.4 Hilbert space structure and interpretation

This derivation confirms that the system of N human decisions admits a quantum-like structure:

- Each participant is a 2-state quantum object.
- The ensemble spans a Hilbert space $\mathcal{H} = (\mathbb{C}^2)^{\otimes N}$.
- Prior to tallying, the system resides in a uniform superposition over 2^N microstates.
- Measurement projects onto macrostates based on the majority decision, simulating a quantum collapse.

This framework underpins the proposed human agency qubit and supports its use in defining higher-order quantum gates and algorithms in subsequent sections.

4 The macroscopic qubit proposal

Building upon the formal derivation in §3, we now shift from theoretical structure to practical implementation. The macroscopic qubit defined by human agency exists as a distributed ensemble across multiple conscious agents, each of whom selects between two defined basis states: "heads" or "tails". This collective system resides in a quantum-like unresolved state until measurement — here defined as the aggregation of all participant decisions — is performed. This section outlines how such macroscopic qubits can be constructed, collapsed, and manipulated in both physical and virtual settings.

4.1 Operational representation and collapse rule

The macroscopic qubit exists in a latent state until a majority decision among N participants is tallied. The state is interpreted as:

$$|\psi\rangle = \frac{1}{\sqrt{2}} \left(|\text{Heads}\rangle + |\text{Tails}\rangle\right) , \tag{12}$$

where "heads" and "tails" are collective macrostates defined by a statistical majority. Collapse occurs through measurement of the ensemble average:

$$|\psi\rangle \xrightarrow{\text{Tally}} \begin{cases} |\text{Heads}\rangle & \text{if } f_H > 0.5 \,, \\ |\text{Tails}\rangle & \text{if } f_H < 0.5 \,, \end{cases} \tag{13}$$

with f_H denoting the fraction of participants who selected "heads". A perfect tie (i.e. $f_H = 0.5$) may require an external tiebreaker, a re-measurement, or a minimum threshold N_c to resolve ambiguity.

4.2 Interpretation of superposition

Unlike microscopic qubits, which maintain quantum phase coherence across superposed basis states, the macroscopic qubit's superposition is epistemic — rooted in the unresolved knowledge of the ensemble rather than a physical quantum state. Nevertheless, as shown in §3, the system's collective Hilbert space structure and projection-based measurement rules replicate the algebraic and statistical behavior of genuine quantum states.

4.3 Physical vs. virtual implementation

There are multiple modalities for realizing macroscopic qubits in practice:

- **Physical implementation:** Each participant chooses heads or tails with a real coin and records the outcome privately. Results are then aggregated to determine the collapsed state. The coin acts as a symbolic mediator rather than a literal superposed system.
- **Virtual implementation:** Participants use an online interface or app to select a value (heads or tails), with the results aggregated in real-time. This enables scalable, synchronous experiments with thousands of global participants — similar to the infrastructure of the Big Bell Test [3].

In both cases, it is critical that the outcome is hidden until the final tally, preserving the ensemble's unresolved state and ensuring authentic collapse behavior.

4.4 Measurement and observer role

Measurement is not performed on each participant's individual choice but on the aggregated majority. This aggregate observation fulfills the quantum role of "collapse" from a system-wide perspective. The observer in this context may be human (e.g. a coordinator) or algorithmic (e.g. a tallying server), but in both cases the tally marks the point of transition from superposition to resolved classical state.

4.5 Robustness to environmental noise

Because macroscopic qubits in this model do not rely on maintaining quantum phase coherence, they are naturally robust against decoherence in the traditional sense. Instead, errors arise from incomplete data, human indecision, or measurement bias, which can be handled through classical redundancy, majority voting, or sampling corrections. This suggests a new paradigm of quantum-like computation where resilience arises from statistical mechanics rather than cryogenic isolation.

4.6 Implications for qubit scaling

This framework permits large-scale implementation of qubits without the technological burdens of traditional quantum systems. Assuming a critical number of participants N_c (further explored in §6) is available per qubit, a multi-qubit system can be constructed with $M \times N_c$ participants, enabling simulation of quantum algorithms on crowdsourced platforms.

4.7 Link to Objective Reduction and cognitive measurement

As with Penrose's OR model, the macroscopic qubit collapse may reflect deeper links between spacetime geometry and measurement. If the decision and measurement processes are mediated through conscious observation, then human agency might act as a gravitationally relevant component of collapse — especially in large-scale ensembles. This motivates experimental tests not only of collapse thresholds but also of possible correlations with gravitational self-energy or spatial configuration.

5 Building a macroscopic quantum computer

5.1 Scaling to multiple qubits

Assuming a critical threshold N_c participants can control a single macroscopic qubit, we propose constructing a 10-qubit system using $10 \times N_c$ participants as discussed in §2.

This could be implemented in reality with N individuals taking turns choosing with one coin or many choosing with multiple coins. The end resulting ensemble average is the qubit's final state. This could also be done virtually on a computer.

5.2 Entanglement and quantum gates

To perform quantum computation, qubits must be entangled and manipulated through quantum gates. Participants would coordinate their choices across qubits to implement entangling operations like the CNOT gate. For example, a control group could synchronize their decisions based on the state of another qubit, enabling conditional logic between pennies.

To demonstrate the Einstein-Podolsky-Rosen (EPR) experiment [1], we propose entangling two macroscopic penny qubits. Participants controlling each qubit would coordinate their choices to maintain entanglement. Measurements on one penny would instantaneously influence the state of the other, showcasing nonlocal correlations. By varying the measurement bases chosen by the participants, we could observe violations of Bell inequalities, providing macroscopic evidence of quantum entanglement.

The protocol for the EPR demonstration involves:

1. Preparing two penny qubits in a maximally entangled Bell state.
2. Assigning separate groups of participants to each qubit.
3. Instructing participants to randomly select measurement bases.
4. Recording outcomes to analyze correlations and test Bell inequalities.

This experiment would serve as a proof-of-concept for the macroscopic quantum computer's ability to simulate fundamental quantum phenomena.

5.2.1 Actions required by qubit participants for gate operations

In the macroscopic quantum computer, human participants will perform specific actions to emulate quantum gate operations. Below are the required actions for each gate:

Hadamard gate (H) The Hadamard gate creates a superposition from a basis state. Participants representing a qubit apply the Hadamard by randomly deciding between "heads" and "tails" for the penny, ensuring a 50/50 probability for each outcome. This random choice simulates the creation of a superposition state:

$$|0\rangle \xrightarrow{H} \frac{1}{\sqrt{2}}\left(|0\rangle + |1\rangle\right) . \tag{14}$$

CNOT gate The CNOT gate entangles two qubits. Participants controlling the control qubit observe its state first. If the control qubit is in the "heads" state, participants managing the target qubit flip its state (from heads to tails or vice versa). If the control qubit is "tails", no action is taken on the target qubit. This action implements the CNOT operation:

$$|c, t\rangle \xrightarrow{CNOT} |c, t \oplus c\rangle . \tag{15}$$

Pauli-X gate (NOT gate) To perform a Pauli-X gate, participants flip the state of the penny. If the penny shows heads, they flip it to tails, and vice versa. This simulates the quantum NOT operation:

$$|0\rangle \xrightarrow{X} |1\rangle , \quad |1\rangle \xrightarrow{X} |0\rangle . \tag{16}$$

Measurement For measurement, participants agree on a basis (e.g. Z-basis or X-basis). They then observe the penny and record the outcome. In experiments like the EPR test, different participant groups will select measurement bases at random to ensure the integrity of Bell inequality testing.

These collective human-driven actions enable the execution of quantum gate operations in the macroscopic quantum computer, mirroring traditional quantum computations.

5.2.2 Programming the macroscopic quantum computer for EPR using Qiskit

To program our macroscopic quantum computer to demonstrate the EPR experiment, we can utilize Qiskit as a framework to design and visualize the quantum circuit [11]. The outcome of the EPR experiment can be coded and implemented on the IBM quantum computer for comparison. Below is an example Qiskit code to create a Bell state and perform measurements in varying bases:

```
from qiskit import QuantumCircuit, Aer, execute
from qiskit.visualization import plot_histogram

qc = QuantumCircuit(2, 2)
qc.h(0)qc.cx(0,1)
qc.measure([0,1], [0,1])

simulator = Aer.get_backend('qasm_simulator')
result = execute(qc, simulator, shots=1024).result()
counts = result.get_counts(qc)
plot_histogram(counts)
```

Fig. 1: Qiskit code to generate and measure an EPR Bell state.

Participants would emulate these operations by making choices corresponding to the gates and measurements in the Qiskit code. The Hadamard gate creates superposition, the CNOT entangles the qubits, and the measurement step collapses the system, mirroring the behavior of the programmed circuit.

This experiment would serve as a proof-of-concept for the macroscopic quantum computer's ability to simulate fundamental quantum phenomena.

5.2.3 Circuit diagram and gate descriptions

The quantum circuit for the EPR (Bell) experiment consists of the following gates applied sequentially:

- **Hadamard gate (H):** Applied to the first qubit to create a superposition state.
- **CNOT gate:** Entangles the first qubit (control) with the second qubit (target).
- **Measurement:** Both qubits are measured in the computational basis.

The following matrix representations describe the gates used:

Hadamard gate (H):

$$H = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix} \tag{17}$$

CNOT gate:

$$\text{CNOT} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \end{bmatrix} \tag{18}$$

The **CNOT gate** uses a control qubit and a target qubit:

- A solid dot indicates the control qubit.
- A circle with a plus sign (+) marks the target qubit.
- If the control qubit is in state $|1\rangle$, the target qubit undergoes a NOT (X) operation.

The full circuit is depicted in Fig. 2.

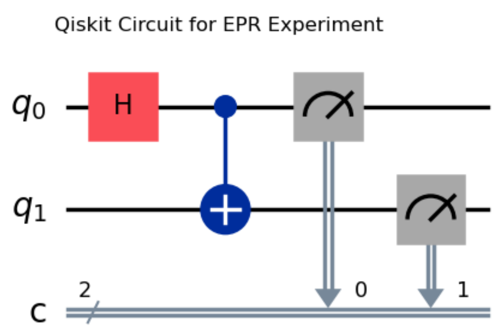

Fig. 2: EPR (Bell) State Circuit with labeled Hadamard, CNOT, and Measurement gates.

5.2.4 Mathematical framework and Bell inequality calculations

The EPR experiment relies on creating a Bell state [2]:

$$|\Psi^+\rangle = \frac{1}{\sqrt{2}} (|01\rangle + |10\rangle) \ . \tag{19}$$

Measurements on this state in different bases can reveal violations of Bell inequalities. The CHSH (Clauser-Horne-Shimony-Holt) inequality provides a testable framework [10]:

$$S = |E(a,b) + E(a',b) + E(a,b') - E(a',b')| \leqslant 2\,, \tag{20}$$

where $E(a,b)$ is the correlation coefficient between measurement settings a and b.

Quantum mechanics predicts violations up to $S = 2\sqrt{2}$ for appropriately chosen settings.

The correlation coefficient is computed as:

$$E(a,b) = P_{00}(a,b) + P_{11}(a,b) - P_{01}(a,b) - P_{10}(a,b)\,, \tag{21}$$

where $P_{ij}(a,b)$ is the probability of measuring outcomes i and j for settings a and b.

Participants would select measurement settings corresponding to a, a', b, b' and record outcomes, enabling the calculation of S and verification of Bell inequality violations.

5.3 Quantum circuit implementation

Participants could follow predefined quantum circuits, choosing heads or tails to enact specific gate operations. This human-driven approach would allow for the construction of complex quantum algorithms, with collective human agency serving as the mechanism for both superposition collapse and qubit manipulation.

5.4 Error correction and stability

Given the macroscopic nature of the system and human involvement, error correction protocols would be essential. Majority voting among participants, redundancy in group assignments, and error-checking procedures could help maintain computational integrity.

6 Determining the critical threshold N_c

The critical threshold N_c represents the minimum number of human participants required to reliably induce the collapse of a macroscopic superposition defined by collective choice. We propose that N_c can be estimated through multiple complementary approaches, all suggesting that collapse is a function of collective information processing, statistical precision, and gravitational instability. This section unifies these approaches and derives the scaling behavior of N_c in a single framework.

6.1 Unified collapse framework: decoherence, statistics, and gravity

We consolidate four perspectives into a common scaling framework for N_c:

- **Decoherence analogy:** Human choices act as an environment. Collapse occurs when decoherence time τ_D becomes shorter than system coherence time.
- **Statistical sampling:** Ensemble averaging must resolve a decision with confidence level ϵ, following binomial error bounds.
- **Percolation thresholds:** Collapse requires a critical number of interconnected participants to exceed a decision percolation threshold.
- **Gravitational Objective Reduction (OR):** Collapse is driven by the gravitational self-energy ΔE_G of the superposed macrostates, as proposed by Penrose.

These perspectives all imply a threshold N_c that determines when resolution occurs. In the OR framework, this collapse is objective and gravitational; in the ensemble model, it is probabilistic and informational. We treat both as complementary.

6.2 Key scaling relations

We present the collapse framework in a unified mathematical block:

(1) Gravitational self-energy:

$$\Delta E_G = \frac{G}{2} \int\int \frac{[\rho(\mathbf{r}) - \rho'(\mathbf{r})]\,[\rho(\mathbf{r}') - \rho'(\mathbf{r}')]}{|\mathbf{r} - \mathbf{r}'|}\, d^3r\, d^3r' \quad (22)$$

(2) OR collapse time:

$$\tau \approx \frac{\hbar}{\Delta E_G} \quad (23)$$

(3) Human collapse timescale:

$$\tau_H \propto \frac{1}{N_c} \quad (24)$$

(4) Threshold scaling:

$$N_c \propto \frac{\Delta E_G}{\hbar} \quad (25)$$

Eq. (25) encapsulates the central hypothesis: greater gravitational self-energy between superposed states reduces the number of participants required for collapse. This provides a bridge between observer-driven and objective collapse mechanisms.

6.3 Statistical estimation of N_c

Independent of gravity, we can estimate N_c based on the confidence level required to distinguish two ensemble outcomes. Treating human decisions as a binomial process with probability $p = 0.5$, the standard error is:

$$\mathrm{SE} = \sqrt{\frac{p(1-p)}{N}} = \frac{1}{2\sqrt{N}}\,. \quad (26)$$

To achieve confidence ϵ, we solve:

$$Z \cdot \mathrm{SE} \leqslant \epsilon \quad \Rightarrow \quad N_c \geqslant \left(\frac{Z}{2\epsilon}\right)^2. \quad (27)$$

Here, Z is the Z-score corresponding to the desired confidence level of the decision threshold — for example, $Z = 1.96$ for a 95% confidence interval. This ensures that the ensemble average deviates from 50% by more than ϵ with the specified level of certainty.

This gives a statistical lower bound on N_c, which can be adjusted upward if gravitational effects weaken the ensemble's collapse influence.

6.4 Percolation and network collapse analogy

If participants are modeled as nodes in a network, collapse may only occur when the connectivity of decision alignment percolates. For a 2D lattice, the percolation threshold is around $p_c \approx 0.59$. This suggests that a critical fraction of participants must reach coherence before the system-wide state can resolve. This provides a geometrical or network-theoretic perspective on N_c, complementary to both statistical and gravitational models.

6.5 Distance and spatial separation effects

From Penrose's model, the self-energy ΔE_G increases with spatial separation d between superposed states of mass m. In simple cases:

$$\Delta E_G \propto \frac{Gm^2}{d} \quad \Rightarrow \quad N_c \propto \frac{1}{\Delta E_G} \propto \frac{d}{Gm^2}\,. \quad (28)$$

Thus, increasing the spatial separation between superposed configurations (e.g. the location of a "heads" vs. "tails" penny) increases the gravitational instability, decreasing the required number of human agents to induce collapse. Conversely, minimal displacement requires larger N_c.

6.6 Summary and experimental implications

These models converge on the idea that N_c is a tunable parameter reflecting the interplay of statistical certainty, observer participation, and gravitational geometry. Experiments varying:

- The mass m and displacement d of superposed macrostates,
- The number of participants N,
- The spatial distribution and timing of decisions,

can be used to test which collapse mechanism dominates, and to empirically validate or constrain the proposed scaling of N_c. §5.2.4 applies this framework to entangled macroscopic qubits and spatial separation effects.

7 Extending to qudits: human-driven collapse beyond binary

While the macroscopic qubit model focuses on binary choices (heads or tails), the framework can be naturally extended to *qudits* — quantum systems with d discrete levels — by increasing the number of available outcomes. In this extended model, each participant chooses an integer value from a predefined set, such as $\{1, 2, \ldots, 10\}$ for a 10-dimensional qudit.

Participants would no longer act as binary agents, but as selectors from a d-level Hilbert space:

$$|\psi\rangle = \frac{1}{\sqrt{d}} \sum_{k=1}^{d} |k\rangle\,, \quad (29)$$

representing an equal superposition over d outcomes. The system remains in superposition until the collective human choices are measured and tallied.

Virtual die analogy One practical implementation is to present participants with a virtual 10-sided die and ask them to consciously select a number between 1 and 10. The final collapsed state of the qudit is the statistically dominant outcome across the ensemble. This approach preserves the role of human agency while expanding the dimensionality of the macroscopic quantum system.

Measurement dynamics Let f_k be the fraction of participants who chose outcome k. The system collapses to the state $|k^*\rangle$ corresponding to the outcome with the highest frequency:

$$|\psi\rangle \xrightarrow{\text{Human Choice}} |k^*\rangle\,, \quad \text{where } k^* = \arg\max_k f_k\,. \tag{30}$$

Applications and scalability Using qudits enables more compact encoding of quantum information, reduces the number of participant groups needed for certain algorithms, and opens the door to simulating higher-dimensional quantum gates. Human-driven implementations of qutrits ($d = 3$) or higher-dimensional logic gates could expand the scope of the macroscopic quantum computer beyond what binary ensembles allow.

Future studies could explore the threshold number $N_c^{(d)}$ required for qudit-level collapse, as well as investigate the impact of perceptual biases in number selection (e.g. preference for round numbers) on statistical coherence in high-dimensional spaces.

8 Scaling to a giant macroscopic quantum computer

8.1 Inspiration from the three-body problem

The concept of using human agency as computational elements draws inspiration from Liu Cixin's *The Three-Body Problem*, where an army of soldiers forms a massive human-based computer to solve complex problems [12]. In that fictional scenario, each soldier acts as a simple logic gate or bit, with coordination enabling large-scale computation.

Adapting this idea to quantum computing, we propose extending the macroscopic qubit model to create a vast human-driven quantum computer, where *armies* of participants collectively perform quantum operations. Unlike classical bits, which hold definitive states of 0 or 1, macroscopic qubits embody superpositions, entanglement, and collapse dynamics, enabling powerful quantum computations on a human scale.

8.2 Human-driven quantum architecture

8.2.1 Participant organization

In a giant macroscopic quantum computer, participants are organized hierarchically:

- **Qubit groups:** Each macroscopic qubit is controlled by a group of N_c participants responsible for inducing collapse through collective choices, as outlined in previous sections of this paper.
- **Gate operation teams:** Specialized groups coordinate between qubit groups to implement entangling gates (e.g. CNOT) and single-qubit operations (e.g. Hadamard, Pauli-X).
- **Measurement collectives:** Designated participants record and analyze outcomes, maintaining the system's coherence and consistency.

There would have to be specialty groups trained to perform the tasks assigned to the group. There would be Hadamard Gate groups, for example trained to only operate as a Hadamard Gate with known inputs giving known outputs. Likewise, all of the quantum computing components would require specialty trained participants.

8.2.2 Quantum circuit execution

The execution of complex quantum algorithms, such as Shor's or Grover's algorithms, would involve:

1. **Preparation:** Participants initialize macroscopic qubits in defined states, possibly using shared visual cues or symbolic objects (e.g. pennies, cards) to represent qubit states.
2. **Gate application:** Coordinated groups execute gate operations, ensuring phase coherence and entanglement are preserved. Timing synchronization becomes crucial, possibly managed via visual or auditory signals.
3. **Measurement and readout:** Upon completing the computation, participants collectively measure qubit states, collapsing the superpositions and yielding the final result.

8.3 Scaling challenges and error correction

Scaling to thousands or millions of participants introduces significant challenges:

- **Decoherence and synchronization:** Ensuring all participants act within coherent timeframes is critical. Decoherence could be modeled as human-induced "noise" leading to erroneous operations.
- **Error correction:** Implementing quantum error correction codes (e.g. Shor's or Steane codes) would require additional participant groups dedicated to detecting and correcting mistakes.
- **Communication overhead:** Managing coordination between thousands of individuals introduces latency and complexity, echoing issues in distributed quantum systems.

8.4 Emergent quantum phenomena and philosophical reflections

Collective human choices might yield emergent phenomena, echoing Orch-OR [13] and quantum consciousness models

[14]. The quantum-classical boundary could shift with scale, probing discreteness effects [15]. A giant human-driven quantum computer invites philosophical considerations:

- **Collective consciousness:** Could collective human choices, entangled across macroscopic qubits, create emergent cognitive phenomena? This echoes questions from Penrose and Hameroff's Orch-OR model [13].
- **Quantum-classical boundary:** Scaling to a vast number of participants blurs the line between quantum and classical behavior, offering an experimental platform to probe the quantum-to-classical transition.
- **Ethics and agency:** Involving human participants as computational agents raises ethical considerations, especially regarding agency, consent, and cognitive load.

8.5 Symbolic parallels: quantum computing and the kabbalistic tree of life

To illustrate the intersection of abstract computation and symbolic meaning, Fig. 3 presents a side-by-side comparison of a quantum logic board game diagram [18] and the Kabbalistic Tree of Life [19].

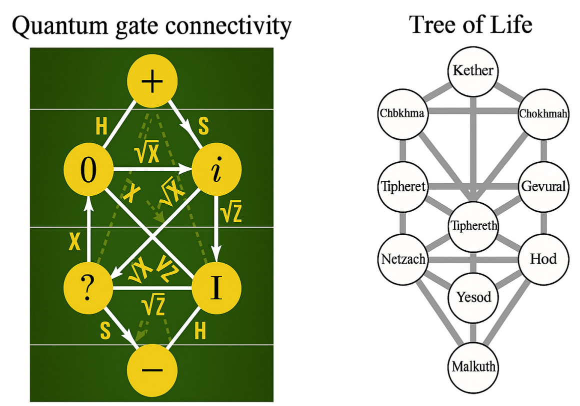

Fig. 3: Left: A tabletop quantum computing game. Right: The Kabbalistic Tree of Life.

While the two images emerge from vastly different traditions — one scientific, the other esoteric — they share striking structural similarities: nodes connected by pathways, representing possible transformations or flows of information. In the quantum circuit model, these nodes are qubit states manipulated by unitary gates. In the *Tree of Life*, they represent spiritual emanations (Sefirot) connected by paths of experience and causality.

This visual juxtaposition is not intended to suggest that quantum computing is mystical or that Kabbalah is scientific, but rather to acknowledge that both systems organize complex, interconnected structures of transformation. The board game formalism provides an intuitive, tangible version of quantum algorithms; the *Tree of Life* offers a metaphysical map of potential states of being. Both can serve as cognitive scaffolds for reasoning about multidimensional processes — whether physical or philosophical.

As this project touches on the role of collective human agency in quantum collapse, it is useful to consider how ancient symbolic systems might resonate with emerging quantum paradigms. The idea that observers (or agents) move through pathways of decision and transformation is not new — it is only now that it may be quantified and tested.

8.6 Diagram: macroscopic human agency quantum computer

As shown in Fig. 4, the system architecture consists of distributed participant groups, synchronization protocols, and symbolic entanglement layers designed to simulate quantum operations.

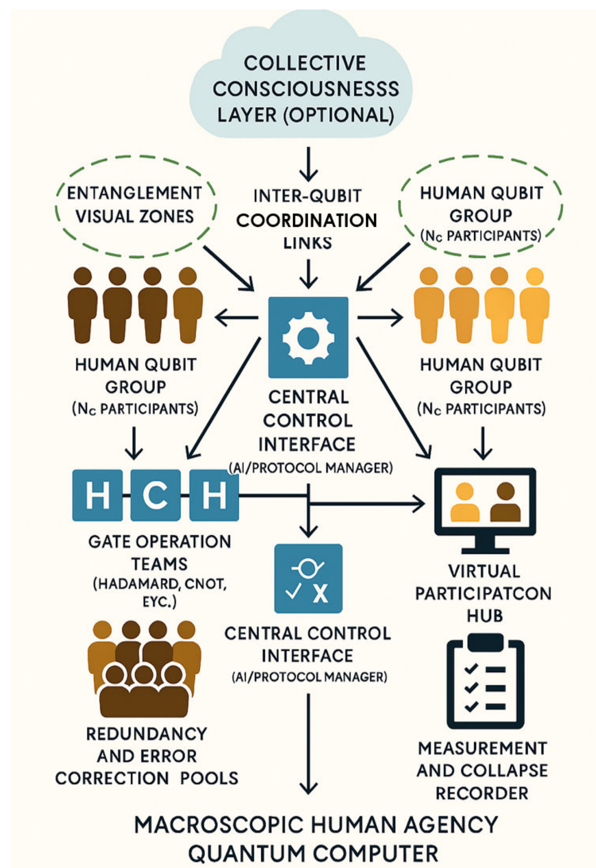

Fig. 4: A schematic of the Macroscopic Human Agency Quantum Computer.

Component descriptions and intentions

1. **Human qubit group (N_c participants):** These groups form the core computational units, analogous to qubits in standard quantum computers. Each contains a critical number of human participants N_c whose collective decisions statistically determine the state of a macroscopic qubit (e.g. heads or tails). The unresolved state

prior to tallying represents a human-induced superposition.

2. **Inter-qubit coordination links:** These represent synchronized decision protocols or communication pathways between qubit groups. They enable the simulation of quantum entanglement and conditional logic, such as CNOT operations, through coordinated human action.
3. **Gate operation teams (Hadamard, CNOT, etc.):** Specialized participant teams implement quantum gates by directing how qubit groups make decisions. For example, Hadamard groups introduce randomized choices, while CNOT groups conditionally flip a target qubit based on the state of a control qubit.
4. **Central control interface (AI/protocol manager):** This system ensures coherence across the macroscopic quantum network by managing timing, sequence of operations, and synchronization between participant groups. It functions like a classical clock or control bus in digital computers but mediates human-based gate execution.
5. **Measurement and collapse recorder:** At the end of each computation, this module collects the aggregated choices of each qubit group to collapse their superposition states. It may be a physical tally, a digital computation, or a symbolic reveal, serving as the observer in quantum measurement theory.
6. **Redundancy and error correction pools:** These backup participants or decision-checking algorithms emulate quantum error correction by mitigating errors in human decision-making. Majority voting, parity checks, or redundant encoding strategies ensure consistency in macroscopic qubit behavior.
7. **Virtual participation hub:** This represents the distributed nature of the platform, allowing participants to contribute from remote locations via a digital interface. Inspired by the Big Bell Test, it scales participation globally and democratically, transforming computation into a crowdsourced quantum simulation.
8. **Entanglement visual zones:** Symbolic areas denoting nonlocal correlations between qubit groups. These highlight how group outcomes may statistically influence or mirror each other despite spatial separation, simulating Bell-type entanglement in a macroscopic context.
9. **Collective consciousness layer:** An abstract representation of the hypothesis that coordinated human intention may itself be a source of quantum-like coherence. While speculative, it aligns with theories such as Orch-OR and invites philosophical exploration into the relationship between consciousness and quantum collapse.

8.7 Potential experimental realizations

While a fully operational giant macroscopic quantum computer remains speculative, smaller-scale prototypes could be tested:

- **Crowdsourced experiments:** Leveraging online platforms to coordinate thousands of participants globally, similar to the Big Bell Test [3].
- **Physical assemblies:** Large-scale gatherings (e.g. stadiums) where participants physically represent qubits and gates, following choreographed routines to execute quantum circuits.
- **Hybrid systems:** Combining human-driven elements with classical computational assistance to manage coordination and error correction.

8.8 Implications and future directions

Constructing a giant macroscopic quantum computer challenges conventional paradigms of computation, observation, and agency. It bridges quantum physics, consciousness studies, and complex systems, offering a unique platform to explore the intersection of physical laws and human cognition.

Future research could focus on:

- Formalizing models of large-scale human-driven quantum systems.
- Developing protocols for error correction and synchronization in macroscopic qubit networks.
- Exploring philosophical and cognitive implications of collective quantum computation.

9 Implications and future work

This proposal redefines the quantum-classical divide by positing human agency as a collapse mechanism for macroscopic qubits, where a penny's state emerges not from a single quantum superposition but from the statistical average of collective human flips. Unlike traditional qubits confined to microscopic scales by decoherence [6], this ensemble approach sidesteps physical coherence challenges, suggesting that macroscopic quantum phenomena might hinge on observer-driven statistics rather than isolated systems. If validated, this could imply that quantumness scales with collective intent, potentially echoing Penrose's Objective Reduction (OR) [7] where gravitational effects amplify with participant number, or even hinting at spacetime discreteness shaping statistical outcomes [8, 9].

The implications span physics, computation, and philosophy. Physically, it challenges the notion that quantum effects vanish at macroscopic scales, offering a testbed for theories like OR or quantum cognition [14] — could human decisions, aggregated over thousands, mirror quantum processes in the brain? Computationally, a human-driven quantum computer could democratize quantum technology, trading cryogenic labs for crowdsourced networks, though at the cost of precision and speed compared to silicon-based qubits [5]. Philosophically, it blurs the line between observer and system, raising questions about free will, collective consciousness, and the nature of reality: if N_c humans collapse a qubit, does their agency entangle with the cosmos?

Future work will prioritize three areas:

1. **Formalizing collapse dynamics**: Develop a rigorous statistical model for the ensemble qubit, refining N_c with binomial distributions. For N flips with $p = 0.5$, the standard error $\mathrm{SE} = \sqrt{p(1-p)/N}$ suggests $N_c \approx 10^4$ for a 95% confidence interval ($\mathrm{SE} < 0.005$), but gravitational or network effects (e.g. percolation [16]) could shift this. Simulations will test if ΔE_G scales meaningfully with N, probing Penrose's hypothesis.
2. **Experimental realizations**: Launch a pilot with 1,000 participants choosing heads or tails online, measuring f_H convergence rates and Bell correlations across two groups. A 10-qubit prototype will follow, using AI to sync $10 \times N_c$ flips, targeting a simple algorithm (e.g. Deutsch's) to benchmark against Qiskit simulators [11]. Physical gatherings (e.g. stadium-scale) could explore real-time dynamics.
3. **Scaling beyond 10 qubits**: Scale to millions via phased recruitment, leveraging cloud platforms and AI-driven signals for gate execution and error correction. Each qubit's state, an average over N_c flips, requires robust protocols — e.g. majority voting or Steane codes adapted for human noise. A "giant" system might compute Shor's algorithm, testing if human ensembles rival quantum hardware.

This framework's scalability hinges on technology and human coordination. A 10-qubit system with $N_c \approx 10^4$ demands 100,000 participants, manageable via global crowdsourcing, while millions could push macroscopic quantumness to unprecedented scales. AI will be key, predicting flip patterns to minimize latency and decoherence-like errors from misaligned choices. Success could redefine quantum computing as a participatory science, merging human cognition with fundamental physics, and invite radical questions: does collective will imprint on spacetime, as discreteness models suggest [17]? Future experiments will chase these horizons, blending empirical rigor with speculative wonder.

10 Conclusion

In this paper, we have proposed a novel framework for constructing macroscopic qubits driven by human agency, exploring the intersection of quantum mechanics, consciousness, and gravitational effects. Drawing inspiration from the Big Bell Test, we extended the notion of observer-induced collapse to a macroscopic scale, using human choices as a direct mechanism for collapsing a superposition state.

We outlined the conceptual basis for using simple macroscopic objects, such as pennies, as qubits and examined how collective human choices could act as a measurement apparatus. Through the exploration of entanglement possibilities and quantum gate operations, we proposed the construction of a human-driven macroscopic quantum computer capable of demonstrating complex quantum phenomena, including the Einstein-Podolsky-Rosen (EPR) experiment and violations of Bell inequalities.

A critical component of this study was the investigation into the threshold number of participants (N_c) required to induce collapse. By examining analogies with quantum decoherence, statistical sampling, percolation theory, and Penrose's Objective Reduction (OR) model, we provided multiple pathways to estimate N_c. The integration of Penrose's OR theory introduced a gravitational dimension to the collapse process, suggesting that mass distribution and spatial separation could influence collapse dynamics and potentially reduce the human effort needed for macroscopic quantum control.

This interdisciplinary approach challenges conventional boundaries between quantum and classical systems, offering insights into the nature of consciousness, observation, and reality. While speculative, this framework opens new avenues for experimental validation, especially in testing gravitational influences on quantum systems and the role of human agency in quantum measurements. While the framework is speculative and metaphorical in parts, its purpose is to probe the intersection of quantum mechanics, human cognition, and observer-based collapse in novel ways. Empirical tests will be critical to validate or falsify these claims.

Future work will focus on refining the theoretical models for N_c, designing experimental setups to test gravitationally-influenced collapse, and scaling the human-driven quantum computer beyond the proposed 10-qubit system. Additionally, deeper exploration into the relationship between consciousness and quantum mechanics, as suggested by the Orch-OR model, could offer profound insights into the nature of reality itself.

This study represents a first step in reimagining quantum systems not just as abstract mathematical constructs, but as entities deeply intertwined with human experience and fundamental spacetime structures.

Acknowledgements

We thank the participants of the Big Bell Test for their pioneering work in integrating human choice into quantum experiments.

Received on April 18, 2025

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