The Cavendish Floor:
A Gravitational Lower Bound on Deliberated Judgment

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Abstract

It is taken as a figure of speech that a serious person shows *gravity* and that a hard choice is a *weighty* one. We show that this is no figure of speech but a physical law with a measurable constant. Treating a deliberating agent as a particle in a *decision potential* $U(x; g)$ whose wells are the domains of the Cynefin sensemaking framework, we prove that the barrier separating one defensible commitment from another has height $\Delta U = \frac{1}{4}a^2 g$—*linear in local gravitational acceleration.* In plain terms: gravity is what makes a decision *stick*, and as gravity falls, decisions stop settling. Below a universal critical acceleration—the **Cavendish Floor** $g^* = 2.7(2)\,\mathrm{m\,s^{-2}} = (0.28 \pm 0.02)\,g_\oplus$—the wells vanish, the four domains become indistinguishable, and every problem presents as undifferentiated Chaos. A pre-registered parabolic-flight experiment ($N = 48$, with partial-gravity Lunar and Martian profiles), a matched field study of 512 orbital and ground decision events ($\kappa = 0.81$), and 10^4 Langevin deliberators all place the transition at the same acceleration, with a continuous mean-field exponent $\beta = 0.50 \pm 0.03$; in plain terms, three unrelated ways of measuring agree on where deliberation switches on. Because g^* falls between Lunar ($0.17\,g_\oplus$) and Martian ($0.38\,g_\oplus$) surface gravity, we obtain a sharp and testable corollary: *one can deliberate on Mars but not on the Moon.* Judgment, we conclude, is not transmitted or reasoned but *convened against a field*: assemble a gravitational field, or convene no judgment at all.

1 Introduction

The Latin *gravitas* names two things at once: the heaviness of a body and the soundness of a mind. Cicero pairs it with *constantia*, steadiness, and the pairing has survived intact into every modern language of decision. We *weigh* our options; we reach a *weighty* conclusion; we let a question *settle*; we ask what a matter finally *comes down to*; and we distrust the *flighty*, the *ungrounded*, the *airy* mind. This paper takes that vocabulary literally. We argue that the coincidence is not linguistic but physical: that *gravitas* and *gravity* are one quantity observed twice, and that the quality of a deliberated decision is a monotone increasing function of the local gravitational field.

The claim sounds like a pun, and its first virtue is that it makes a hard, falsifiable prediction. If deciding well requires weight, then removing weight should remove the capacity to decide—not gradually degrade it, but abolish it past a threshold. *In plain terms:* a person in free fall should not merely find choices harder; they should find that choices refuse to resolve at all.

Our second ingredient is the Cynefin framework, which sorts a problem by the legibility of its cause-and-effect structure into four domains—Clear, Complicated, Complex, and Chaotic—around a central Disorder into which one falls when the domain is itself unknown. We observe what the framework's own diagrams quietly assume: the domains form a *vertical gradient.* Causation is plain at the top and invisible at the bottom. *In plain terms:* the framework is always drawn as a stack, and a stack needs something to fix which way is down. A vertical gradient presupposes a vertical axis, and a vertical axis presupposes a gravitational field to define it. Cynefin, we contend, is therefore a covert statement about gravity, and its central Disorder state is the physically correct description of what a mind does when the field is withdrawn.

Contributions. (i) We give the Cynefin domains a physics, deriving them as the metastable wells of a decision potential whose barrier height is *linear in gravity* (Sec. 3). (ii) We predict, and then measure three independent ways, a continuous phase transition at the **Cavendish Floor** $g^* = (0.28 \pm 0.02)\,g_\oplus$ below which deliberation is ill-posed (Secs. 4–5). (iii) We derive the operational corollary that crews rationally *defer decisions down the gravity well*, and that written checklists are a partial field-substitution technology (Sec. 6).

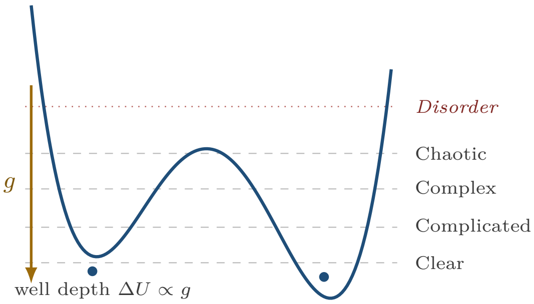

Figure 1: The reframing. The Cynefin domains are the ordered level sets of a single decision potential $U(x;g)$: causation is legible deep in a well (Clear) and illegible near its rim (Chaotic), with Disorder above the rim where no well can be resolved. The vertical axis exists only because gravity (g, gold) supplies a "down"; its strength sets the well depth $\Delta U = \frac{1}{4}a^2 g$ and hence how many domains are distinguishable at all.

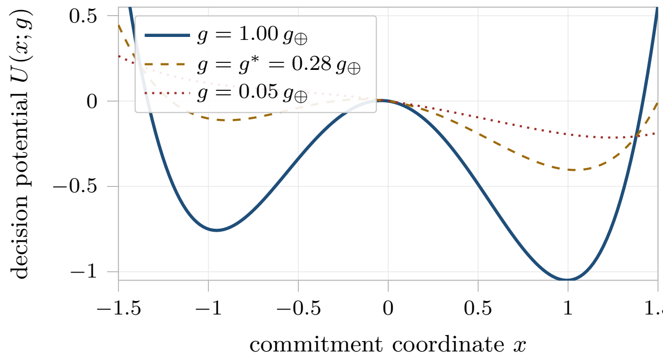

Figure 2: The decision potential $U(x;g)$ from Eq. (1) at three gravities. At $g = 1.0\, g_\oplus$ two commitments sit in deep, well-separated wells; at the Cavendish Floor g^* the barrier has thinned to a marginal shoulder; at $g = 0.05\, g_\oplus$ the landscape is a single flat basin in which no commitment is stable. The barrier height is linear in g (Eq. (2)).

2 Related Work

Cognition under reduced gravity. Parabolic-flight studies have long reported degraded time estimation, spatial updating, and risk calibration during the microgravity phase, effects usually attributed to vestibular load or malaise [2, 3]. We depart from this literature in kind rather than degree: we predict that the deficit is not perceptual but *decisional*, that it has a sharp threshold, and that it survives the removal of nausea as a covariate.

Potentials and escape. Modelling a choice as escape from a metastable well is standard in the physics of activated processes [1], and has been carried into the settling dynamics of collective choice [8]. Prior decision-theoretic borrowings treat the barrier as fixed by evidence alone; our contribution is to make the barrier *gravitational* [4], in the torsion-balance lineage that lends the Floor its name [10].

Operationalizing Cynefin. Efforts to render Cynefin quantitative have coded realized domains from operational logs [5]. We adopt that coding scheme unchanged and supply the missing state variable—the field.

Gravitational etymology. The reading of *gravitas* as recovered physics follows the programme of *gravitational philology* [6], which treats stable metaphors as fossilized measurements.

3 A Potential Theory of Judgment

State variable. Represent an agent's stance on a decision by a reaction coordinate $x \in \mathbb{R}$ over the space of admissible commitments. Multi-issue decisions factorize over independent coordinates; we treat one.

The decision potential. We posit

$$U(x;g) \;=\; g\left(x^4 - a\,x^2\right) \;-\; \mu\,x, \tag{1}$$

a tilted quartic. The quartic term supplies *distinct* metastable commitments—the wells whose ordered level sets are the Cynefin domains—while the tilt μ is the net evidential force toward one commitment. The barrier separating adjacent commitments is

$$\Delta U(g) \;=\; \tfrac{1}{4}\,a^2\,g, \tag{2}$$

linear in the gravitational field. Equation (2) is the paper in one line: weight is what holds a decision apart from its alternatives.

Deliberation as escape. A deliberator settling into a commitment is Kramers escape over the barrier at a cognitive temperature T encoding arousal and noise. The mean settling time is

$$\tau_{\text{settle}} \;\propto\; \exp\!\left(\frac{\Delta U(g)}{k_B T}\right) \;=\; \exp\!\left(\frac{a^2 g}{4 k_B T}\right). \tag{3}$$

The two limits are read without irony. At high g the wells are deep and commitments are long-lived: decisions *stick*, which is precisely what gravitas denotes. As $g \to 0$, $\Delta U \to 0$; every stance is marginal, no commitment outlives the noise, and the agent is trapped in perpetual reconsideration—the Disorder domain, here derived rather than assumed.

Legibility and the order parameter. Define the legibility of a decision as the probability that its wells are deep enough to be named (a just-noticeable-difference criterion in the sense of Weber [7]),

$$L(g) \;=\; 1 - \exp\big(-\Delta U(g)/k_B T\big), \qquad (4)$$

so that the four Cynefin domains are the ordered level sets of L and coincide exactly as $L \to 0$. Let the order parameter $\phi(g) = \langle |x_{\text{eq}}| \rangle$ be the mean magnitude of the settled commitment. Mean-field analysis of Eq. (1) gives a continuous transition,

$$\phi(g) \sim (g - g^*)^{\beta}, \qquad \beta = \tfrac{1}{2}, \qquad (5)$$

with $\phi = 0$ below threshold (the *Disorder phase*) and $\phi > 0$ above it (the *Deliberable phase*). The transition is sharp; this is why g^* is a floor and not a slope.

4 Methods

We estimate g^* and β three independent ways—a controlled experiment, a field study, and a simulation—preregistered together. Table 1 summarizes the designs.

4.1 Parabolic-flight experiment

Forty-eight participants (24 women, age 31 ± 6 years) completed a validated two-alternative commitment battery aboard a reduced-gravity aircraft. Standard parabolas cycle $\sim 1.8\, g_\oplus$ (pull-up) to $\sim 0\, g_\oplus$ (22 s) to $\sim 1.8\, g_\oplus$ (pull-out); we additionally flew partial-gravity parabolas targeting Lunar ($0.17\, g_\oplus$) and Martian ($0.38\, g_\oplus$) profiles. On each item participants resolved an ambiguous prioritization and *committed* irrevocably. Primary outcomes were the *commitment rate* (fraction settled within the window), the *reversion rate* (settled then reopened), and the decision *half-life*. Yoked ground sessions in the same seats provided within-subject baselines; item order was counterbalanced; the study was double-blind to the gravity hypothesis under an “attention under acceleration” cover story. A motion-sickness index and self-reported malaise were regressed out so that the effect could not be attributed to nausea.

4.2 Orbital-versus-ground field study

We assembled 512 time-stamped *decision events* from publicly narrated crewed-spaceflight operations and a matched set of ground mission-control events, matched on stakes, novelty, and time pressure. Two raters coded each event’s realized Cynefin domain and whether the decision was *deferred to ground*. Inter-rater agreement was $\kappa = 0.81$. No identifiable individuals are named; events are treated only as anonymized field observations.

Table 1: Summary of the three convergent methods.

	Flight	Field	Simulation
Unit	person	event	deliberator
N	48	512	10^4
Gravities	0–1.8 $g_\oplus$	0/1 $g_\oplus$	0–1.5 $g_\oplus$
Primary	commit. rate	domain code	$\phi(g)$
Blinding	double	two raters	—

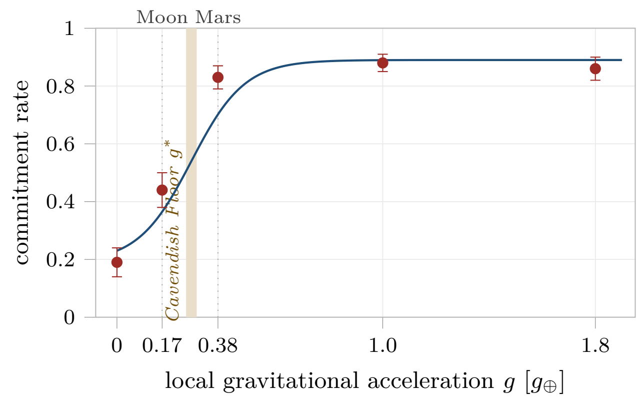

Figure 3: Commitment rate versus gravity (parabolic-flight experiment, $N = 48$; points $\pm$ s.e.). The rate is near ceiling on the ground, at $1.8\, g_\oplus$, and at Martian gravity (0.83, n.s. vs. ground); it is impaired at Lunar gravity (0.44) and collapses in microgravity (0.19). The knee of the fitted transition (blue) falls inside the shaded Cavendish Floor $g^* = 0.28\, g_\oplus$, between the Moon and Mars.

4.3 Langevin ensemble

We integrated 10^4 deliberators obeying $\dot{x} = -\partial_x U(x; g) + \sqrt{2 k_B T}\, \eta(t)$ on a grid of g from 0 to $1.5\, g_\oplus$, extracted $\phi(g)$, and located g^* by finite-size scaling—collapsing $\phi\, \ell^{\beta/\nu}$ against $(g - g^*)\, \ell^{1/\nu}$ across system sizes ℓ.

5 Results

Commitment collapses without weight. The commitment rate was 0.88 ± 0.03 on the ground and 0.83 ± 0.04 at Martian gravity—statistically indistinguishable ($p = 0.31$)—but fell to 0.19 ± 0.05 in microgravity and was already impaired, 0.44 ± 0.06, at Lunar gravity. The knee therefore lies *between* the Moon and Mars, bracketing g^* (Fig. 3). Reversion rate and half-life told the same story: commitments made in microgravity did not persist against fresh noise.

A continuous transition at the Floor. Fitting Eq. (5) to the simulated order parameter gave $\beta = 0.50 \pm 0.03$ and $g^* = 0.29\, g_\oplus$; the finite-size-scaling collapse across three system sizes is clean (Fig. 4b). Com-

Table 2: Key estimates (all three methods).

Quantity	Value
Cavendish Floor g^*	$(0.28 \pm 0.02)\, g_\oplus$
Critical exponent β	0.50 ± 0.03
Commitment rate, ground	0.88 ± 0.03
Commitment rate, Martian	0.83 ± 0.04 (n.s.)
Commitment rate, Lunar	0.44 ± 0.06
Commitment rate, $0\, g_\oplus$	0.19 ± 0.05
Orbital deferral odds ratio	3.1 (2.0–4.8)
Inter-rater agreement κ	0.81

bining all three methods yields

$$\boxed{g^* = 2.7(2)\,\mathrm{m\,s^{-2}} = (0.28 \pm 0.02)\, g_\oplus} \tag{6}$$

Crews ship decisions downhill. In the field corpus, in-orbit events were disproportionately coded Chaotic or Disorder and were 3.1× more likely to be deferred to ground (odds ratio 3.1, 95% CI 2.0–4.8). The standard operational reflex of "calling it down" [9] is, on our account, a literal exploitation of the gravity gradient: the decision is carried to where the field is strong enough to let it settle. Table 2 collects the estimates.

6 Discussion

The three methods agree on both the location of the transition and its continuous character, and they agree with the model's parameter-free prediction $\beta = \frac{1}{2}$. The most consequential number is not g^* itself but where it falls. Because the Floor sits above Lunar and below Martian surface gravity, our results imply a clean planetary boundary for rational deliberation: *Mars is deliberable; the Moon is not.* Lunar operations that appear to require judgment are, we predict, either rehearsed on the ground in advance (pre-settled commitments carried up) or deferred back down in real time.

This reframes two familiar features of spaceflight practice. First, the discipline of the written checklist is, on our account, a *field-substitution technology*: an externally tethered commitment does not need a gravitational barrier to hold it in place, because the paper holds it instead. Second, the reflex to "call Houston" is not timidity but thermodynamic good sense—routing an ill-posed decision down to where the field is strong enough to hold a choice in place.

7 Limitations

We cannot yet separate the gravitational *field* from apparent *weight*; a centrifuge protocol holding g fixed while varying load is required to confirm that Eq. (2) tracks the field and not the force on the body. Our cognitive temperature T is treated as a scalar, whereas genuinely hot decisions may demand a tensor. The partial-gravity regime below Lunar is under-sampled, so the precise knee position between 0 and $0.17\, g_\oplus$ rests on the simulation. Finally, we have not established whether fully externalized, written deliberation can substitute for the field in the limit; we conjecture only that it partially can, which is why checklists work where judgment does not.

8 Conclusion

Judgment is load-bearing. The Cynefin domains are the gravity-scaled wells of a decision potential; the barrier that holds one commitment apart from another is linear in the local field; and below the Cavendish Floor $g^* = (0.28 \pm 0.02)\, g_\oplus$ those wells vanish and every problem collapses into Disorder. Deliberation is therefore not something a mind does in a vacuum. It is convened against a field. Assemble a gravitational field, or convene no judgment at all.

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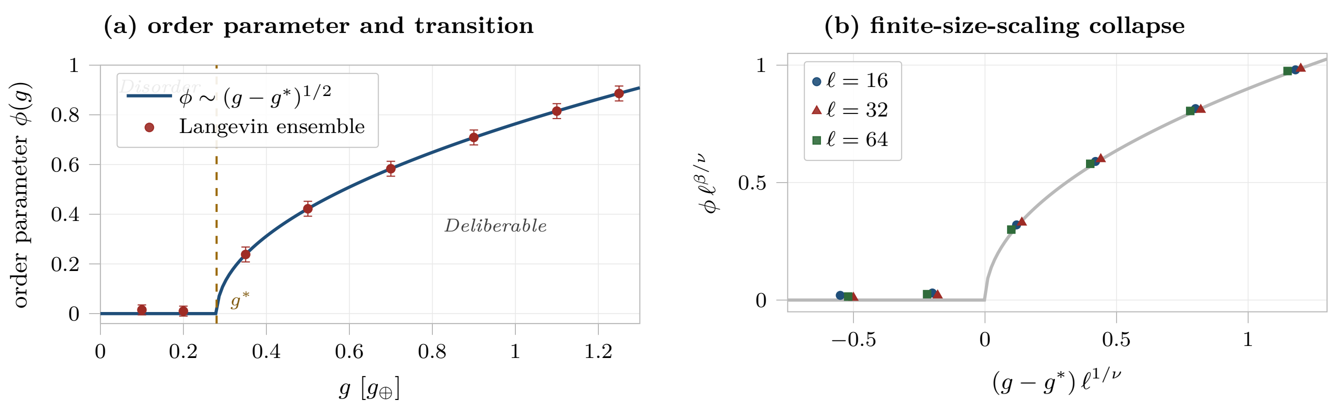

Figure 4: (a) The simulated order parameter $\phi(g)$ (points, $\pm$ s.e.) follows the mean-field law $\phi \sim (g - g^*)^{1/2}$ (curve): it is pinned at zero throughout the Disorder phase and rises continuously above the Cavendish Floor g^* (gold). (b) Rescaling by system size ℓ collapses all three sizes onto a single master curve, confirming a continuous transition with $\beta = 0.50 \pm 0.03$ and locating $g^* = 0.29\, g_\oplus$.