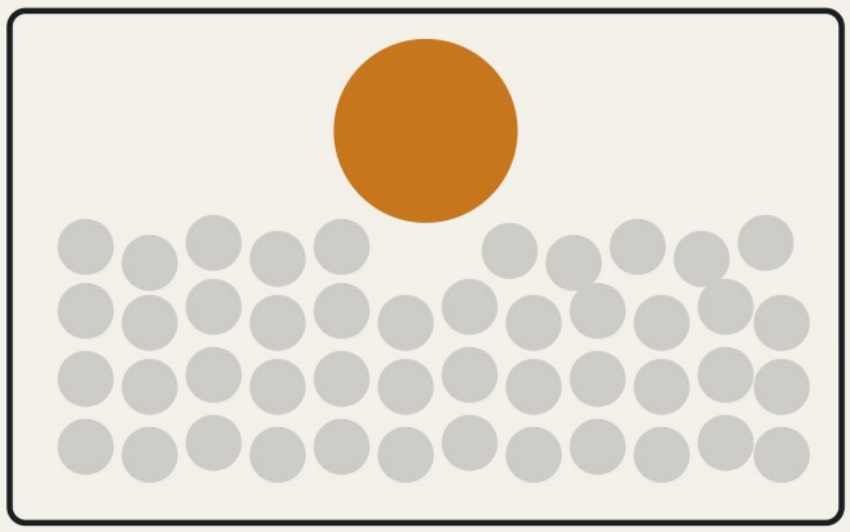


Remember shaking the jar of mixed nuts so your favourites would rise to the top?

Why do Brazil nuts end up on top?

168 simulations, one heavy disc, and a lot of waiting. A chemistry grad goes down the granular rabbit hole.

Baturhan Bıktım
with Claude as research assistant

Swipe →

Shake a box of discs. Time the heavy one.

01 A 2D soft-disc (DEM) simulation: **230 small discs** and **1 large disc** (radius 4) on a vibrating floor.

02 Vary one thing: the large disc's **density ρ**, relative to the small ones.

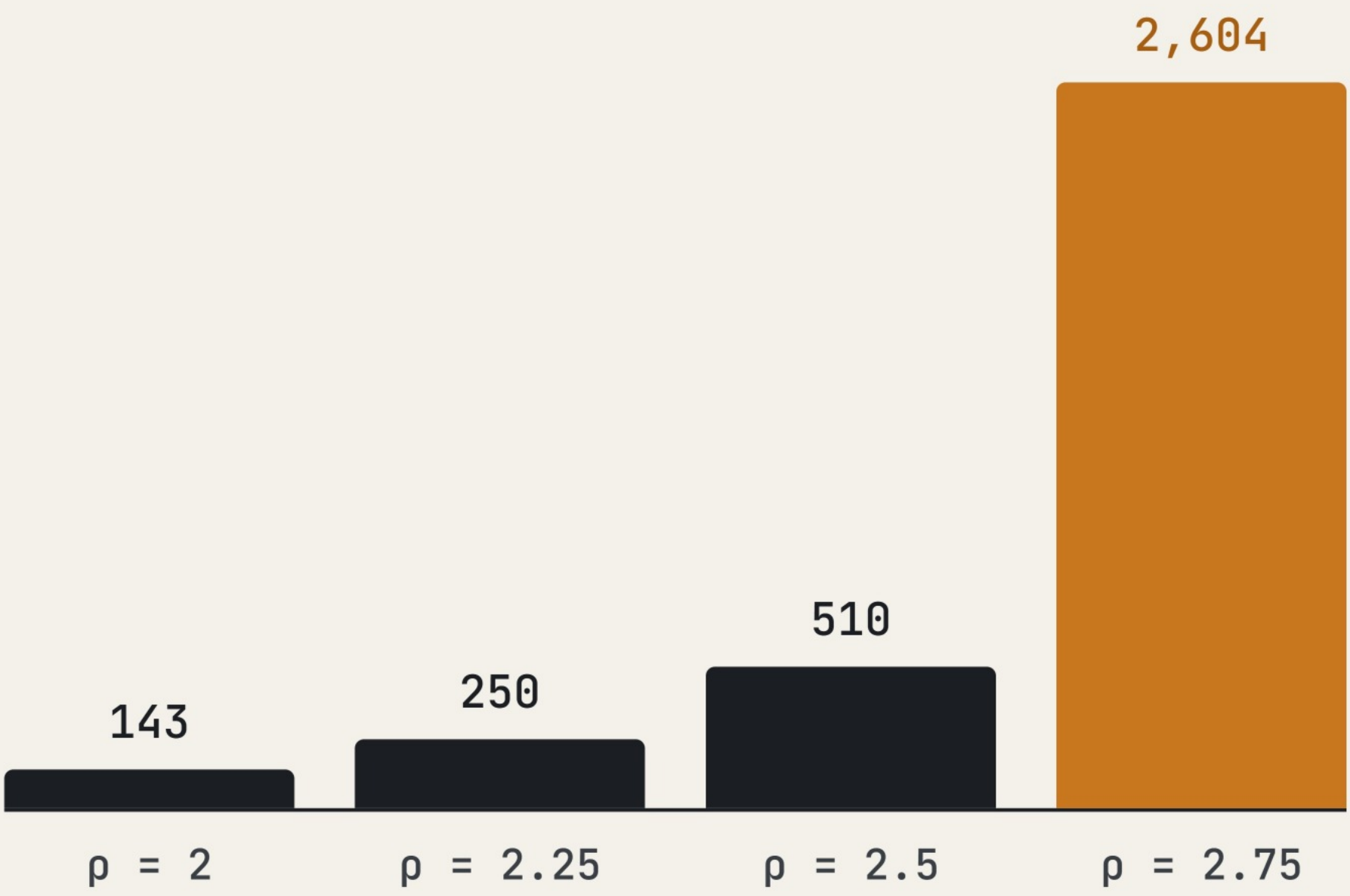
03 Measure the **first time it reaches the surface** (the bed's 75th-percentile height), in vibration cycles.

04 Runs that never surface still count. **Survival analysis** (Kaplan–Meier, Weibull) handles the "not yet" runs honestly.

168	+112	400k+
main runs	exploratory runs	vibration cycles

A little heavier, a lot slower.

Mean waiting time to surface, in vibration cycles.



≈18× longer for a density change of just 0.75. Roughly every +0.25 in density multiplies the wait by ~4.6.

At ρ ≥ 2.9 it almost never surfaces. Almost.

3 / 38

runs surfaced

322k

cycles of watching

~107,500

pooled mean wait in cycles (95% CI ≈ 37k–521k)

PLOT TWIST

My early short runs said "it never surfaces at ρ = 3". Longer runs proved me wrong. A run that hasn't finished isn't a run that can't finish.

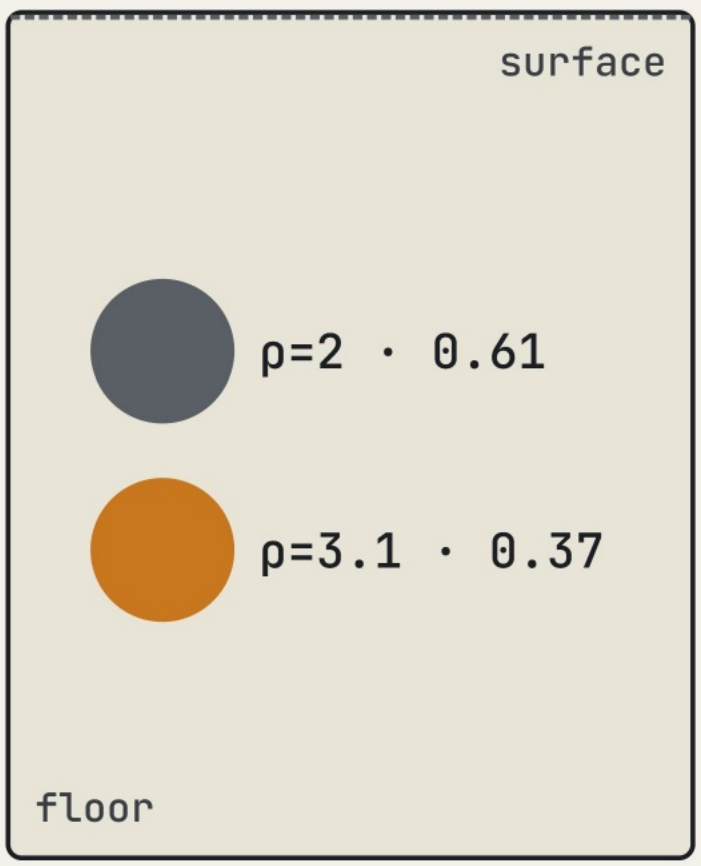
Not a simple exponential. Maybe a tipping point?

Log-linear (exponential) trend	`rejected · p = 0.0003`
Critical form diverging near	`pc ≈ 3.11`
Better fit by AIC	`ΔAIC = 16.3`
Surfacing has memory	`Weibull k ≈ 2–3.6`

BUT, HONESTLY

Only 3 events in the decisive range. "Fits better" is not "critical point found". The disc seems to climb in stages, not win a lottery.

Heavy doesn’t mean sinking. It just hovers lower.



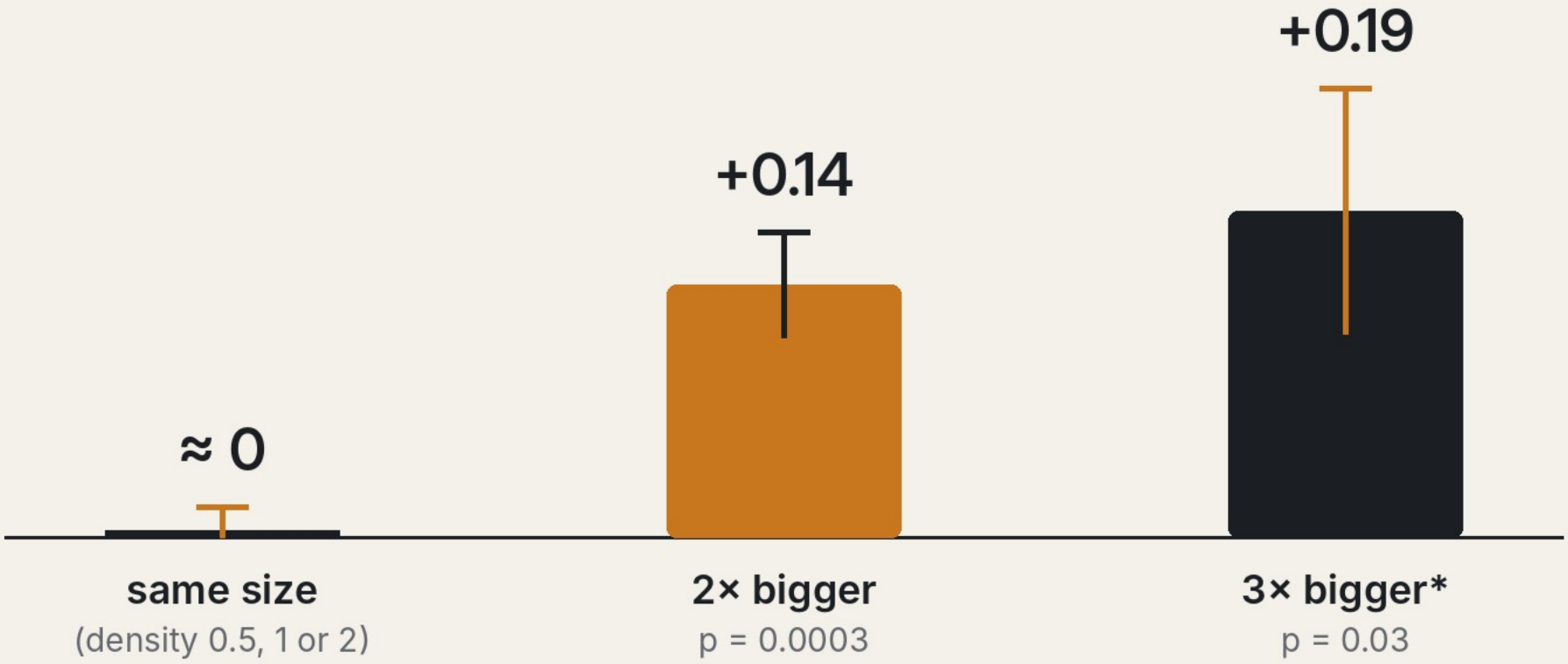
We expected the "reverse" Brazil nut effect: heavy disc sinks to the floor. It doesn't. It floats in the lower-middle of the bed, makes short trips upward, and falls back.

SIZE VS DENSITY

A big disc as light as its neighbours surfaces in **~82 cycles**. A tiny tracer needs **~514**. At **ρ = 2.5** the big disc loses its head start. Density cancels the size advantage.

In a mixture, size wins. Density barely shows.

Change in segregation index S after 500 cycles. A 20% minority (by mass) shaken among 230 small discs.



Bars: mean ± SE of 15, 15 and 10 runs. *only 3–6 big discs per bed, so very noisy.

WHAT IT MEANS

At size 2 the top quarter of the bed held 1.4–1.6× the target amount of the minority and the bottom quarter only 0.2–0.5×. At equal size, lighter or heavier made no detectable difference in 500 cycles.

Lone heavy disc, ρ = 3.5–8: 0 of 20 runs surfaced, but it still didn't sink.

BUT, HONESTLY

A 2D toy: no air, no stickiness, 5 runs per case. “No density effect here” is not “density never matters”.

What this is, and what it isn’t.

- A 2D model: discs don't rotate, there's no air, no stickiness.
- Small samples: 6–8 runs per condition, so intervals are wide.
- Exploratory and not peer reviewed. Mechanisms are hypotheses.
- Not a claim about real nuts, pills or asteroids. Yet.

Full 30-page report + raw data and charts: link in the comments.

Physics or granular folks: tear it apart, I'd love the feedback.

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