A Lifetime’s Heartbeats Are Independent of Body Mass Only Because Two Powers Cancel

— If metabolic rate goes as body mass to the 0.75, heart rate goes as -0.25 and lifespan as $+0.25$, so their product goes as 0 and does not depend on mass — the separator is whether one asks per beat or per lifetime — [Paper 835]

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— From thinking to syncing. —

Abstract

It is said that every animal gets about the same number of heartbeats in a lifetime.This paper counts that this is a cancellation of two powers, and how easily that cancellation breaks.No new theorem or law is claimed. First, laid out, the exponents sum to zero——heart rate goes as mass to the -0.25, lifespan as $+0.25$, and the lifetime count as 0 (Section 2). **Second, and this is the core. “Constant” is the result of that cancellation, not an independent fact——with a residue of only 0.05, the lifetime count moves to 0.537159 of itself from mouse to elephant, about a 1.8616th** (Section 3). **Third, a small gap between exponents is magnified by the range of mass——Kleiber’s $3/4$ and the surface rule’s $2/3$ differ by only 0.083333, yet over 2.5×10^5 that becomes a factor of 2.817269** (Section 2). **Fourth, while the exponents match, the constants drop out of the answer——with constants fitted to a human, three animals all give 2.209032×10^9, a ratio of 1** (Section 3). **Fifth, the per-beat rate does move strongly with mass——each doubling of mass multiplies the heart rate by 0.840896** (Section 2). **Sixth, the separator is whether one asks per beat or per lifetime——the first moves strongly with mass, the second not at all while the exponents match** (Section 4). **Keywords**: Kleiber’s law, allometry, cancelling powers, heart rate, lifespan, model.

> **Scope of this paper (scope note)**: **No new theorem or law is claimed——Kleiber's law (metabolic rate as mass to the $3/4$), mass-specific metabolism going as $-1/4$, heart rate and lifespan going as opposite quarter powers, and their product being independent of mass, are all known.No real animal values are claimed——the constants are fitted so that 70 kg gives 60 beats per minute and 70 years; they are not measurements of species.The identity of the exponent is not discussed——why $3/4$ is not treated, and the vascular-network theories are not entered.No medical advice is given——it is not said that a slower heart makes a longer life.Between and within species are not mixed——what is varied here is mass across species, not individual differences within one.Relation to earlier papers**: **Paper 256 showed that the only scale at which dynamic similarity is exact is one, and its scope note placed Kleiber's law among the known——this paper sits in that seat, and there is no earlier occupant.Paper 372 showed that halving the area leaves 0.840896 of the species——the same 0.840896 appears here, but they do not share a root: there the $1/4$ is the exponent of an empirical species--area rule, here it is the metabolic power. By the criterion of Paper 300, a numerical coincidence alone is not a shared root.**What is added is **measuring that a residue of 0.05 gives a factor of 0.537159**, **measuring that the gap between $3/4$ and $2/3$ becomes 2.817269 over the range of mass**, **setting 0.840896 beside Paper 372 and calling them distinct roots**, and **placing the separator on per beat versus per lifetime**.

1. Notation and the Question

Setting: **let body mass be M, metabolic rate B, heart rate f, lifespan L, and write the metabolic exponent as b.**

$$B \propto M^{b}, \qquad \frac{B}{M} \propto M^{b-1}, \qquad f \propto M^{b-1}, \qquad L \propto M^{1-b}, \qquad fL \propto M^{(b-1)+(1-b)} = M^{0}$$

The heart rate is taken proportional to mass-specific metabolism, and the lifespan to its reciprocal.Both are how the model is placed.

Question: **what holds up the independence of the lifetime count?**

2. A Census of Exponents

Computation 2.1: **with $b = 0.75$, four exponents were laid out.**

quantity	exponent of mass
metabolic rate	$+0.7500$
mass-specific metabolism	-0.2500
heart rate	-0.2500
lifespan	$+0.2500$
lifetime heartbeats	$+0.0000$

> **Observation 2.2**
>
> **the final 0 is the sum of the two above it.The heart-rate and lifespan exponents are equal and opposite, so they vanish——replacing b by $2/3$ changes both exponents but the sum is still 0. What acts is not the value of b but that both are built from the same b.**

Computation 2.3: **the factor per doubling of mass, and the factor the exponent gap makes over the range of mass, were computed.**

measured	value
heart rate per doubling of mass	0.840896
range of mass, mouse to elephant	2.500000×10^{5}
gap between Kleiber's $3/4$ and the surface $2/3$	0.083333
what that gap makes over the range	2.817269

> **Observation 2.4**
>
> **an exponent gap is magnified by the range.A gap of $1/12$ becomes a factor of 2.817269 from mouse to elephant——which rule holds cannot be told from one animal, but can from a range.**

Observation 2.5

0.840896 appears for the third time in this corpus.In Paper 372 it was the share of species left after halving the area; in Paper 558 the diameter ratio that halves a spring constant——all three are $2^{-1/4}$, but the $1/4$ comes from three different places: an empirical species--area exponent, the fourth power of a wire diameter, and the metabolic power. By the criterion of Paper 300 they are not called a shared root.

3. How Easily the Cancellation Breaks

Computation 3.1: **with constants fitted to a human (70 kg, 60 beats per minute, 70 years), three masses were run.**

animal	heart rate (per min)	lifespan (years)	lifetime beats
mouse (0.02 kg)	461.4963	9.1008	2.209032×10^{9}
human (70 kg)	60.0000	70.0000	2.209032×10^{9}
elephant (5000 kg)	20.6387	203.5008	2.209032×10^{9}

Observation 3.2

that all three agree is trivial.The exponents were set to sum to 0, so the ratio can only be 1.000000000000 ——this table is not evidence that the count is constant; it is a check that “constant” follows from how the exponents were placed.

Computation 3.3: **the lifespan exponent alone was then moved off 0.25, to measure what the residue does to the lifetime count.**

lifespan exponent	residue	factor, mouse to elephant
0.25	0.00	1.000000
0.22	−0.03	0.688750
0.20	−0.05	0.537159
0.18	−0.07	0.418933
0.15	−0.10	0.288540

> **Observation 3.4**
>
> this is the core. A residue of 0.05 gives 0.537159.That is about a 1.8616th, a spread hard to call "independent of mass"——the word "constant" leans on two exponents agreeing to the second decimal place.

> **Observation 3.5**
>
> so the lifetime count is not a thing to be measured but an instrument for measuring the gap between two exponents.Flat means the gap is small; tilted means there is a gap——either way, what is read off is the gap.

4. The Separator

> **Observation 4.1**
>
> the separator is whether one asks per beat or per lifetime.Per beat, the rate moves by 0.840896 per doubling of mass; per lifetime, nothing moves while the exponents match——two questions about the same heart in the same animal return different answers.

Observation 4.2

sitting in the seat of Paper 256.256 showed that the only scale at which dynamic similarity is exact is one, and its scope note placed Kleiber's law among the known——there similarity broke with scale; here cancellation breaks with a shift in an exponent. Both count where something holds exactly.With Paper 372 this paper shares 0.840896 but not a root——by the criterion of Paper 300, a numerical coincidence alone is not a shared root.

Observation 4.3

what is not said.Real animal values, the identity of $3/4$, medical advice and within-species variation are not treated——what is shown is that "constant" is a cancellation of powers, not a fact that stands on its own.

5. Census and Closing

1. **metabolic rate $M^{+0.7500}$** (Computation 2.1): **Kleiber.**
2. **heart rate $M^{-0.2500}$, lifespan $M^{+0.2500}$** (Computation 2.1): **built from the same b.**
3. **lifetime beats $M^{+0.0000}$** (Computation 2.1): **the sum of the two.**
4. **0.840896 per doubling** (Computation 2.3): **per beat, it moves.**
5. **$3/4$ versus $2/3$ is 0.083333** (Computation 2.3): **small.**
6. **over the range, 2.817269** (Computation 2.3): **a range can tell.**
7. **three animals give 2.209032×10^{9}** (Computation 3.1): **ratio 1; trivially.**
8. **residue 0.05 gives 0.537159** (Computation 3.3): **the core.**
9. **0.840896 for the third time** (Observation 2.5): **Papers 372, 558; distinct roots.**
10. **per beat, or per lifetime** (Observation 4.1): **the separator; Papers 256, 300.**

Closing: **A lifetime's heartbeats are independent of body mass only because two powers cancel.If metabolic rate goes as mass to the 0.75, heart rate goes as -0.25 and lifespan as $+0.25$, and the two sum to 0——because both are built from the same b, so the value of b itself does not act.But the cancellation is fragile: with a lifespan exponent of 0.20, a residue of only 0.05, the lifetime count moves to 0.537159 of itself, about a 1.8616th, across the 2.5×10^{5} from mouse to elephant——because an exponent gap is magnified by the range of mass.By the same magnification, the 0.083333 between Kleiber's $3/4$ and the surface rule's $2/3$ becomes a factor of 2.817269.Placed among the earlier papers——sitting in the seat Paper 256 left open by placing Kleiber's law among the known, and calling the**

0.840896 shared with Paper 372 a distinct root by the criterion of Paper 300.To be honest——the constants are fitted model values, and the 2.209032×10^{9} of the three animals is not a measurement.

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