CAFFEVOLVE™ · RESEARCH BRIEF

How Caffeine Actually Works

The mechanism the Caffevolve™ Platform is built to act on.

Caffeine's effect is a curve, not a quantity

Most caffeine guidance treats the substance as a simple lever: more cups, more alertness, until some vague point where you've had "too much." The research describes something more precise — and more useful. Caffeine's effect on cognitive performance does not rise in a straight line with dose. It follows an inverted-U, the relationship first described by psychologists Robert Yerkes and John Dodson in 1908 and since one of the most replicated findings in cognitive science.[1] Performance climbs as stimulation increases, reaches an optimal peak, and then declines as overstimulation takes hold. The same active caffeine level that sharpens attention at one point on the curve fragments it a little further along. That gives caffeine *two* boundaries, not one.

> **The shape of that curve is established science.** *The names for its critical points — floor, Peak Zone, Wake Hours Ceiling, Bedtime Ceiling — are Caffevolve's own vocabulary, not terms drawn from any single study. The curve and the thresholds below are the research; the names, and the milligram cut-points attached to them, are the Platform's.*

The floor. Below roughly 40–60 mg of active caffeine in the system, caffeine's cognitive effects are negligible — present in the bloodstream but producing no meaningful change in focus or energy. Nehlig (2010) places the onset of meaningful cognitive activation in this range;[2] Fredholm et al. (1999) document low-dose benefits — reduced fatigue, sharper alertness — beginning around 40–60 mg for most adults;[3] Smith (2002) finds performance enhancement emerging from as little as 32–75 mg depending on the task and the individual.[4] Below the floor, caffeine is underleveraged.

The Peak Zone. Above the floor lies the band where caffeine does what people actually want it to: focus sharpens, thinking deepens, output quality peaks. This is the *Peak Zone* — not a single number but a personal range, bounded below by the floor and above by the point where the curve turns.

The Wake Hours Ceiling. That upper turn is where arousal exceeds optimal stimulation and additional caffeine begins to subtract rather than add. The result is familiar to every regular coffee drinker: restlessness, irritability, a racing quality that reads as energy but fragments attention, and the jitteriness that signals the nervous system has had enough. This is the *Wake Hours Ceiling* — the daytime boundary above which the same substance that was an asset becomes a liability.

Why "one rule for everyone" fails

> Caffeine metabolism varies widely between individuals — driven by the **CYP1A2** enzyme, and further shifted by smoking, pregnancy, medication, and age — which is why population averages fail and why Caffevolve™ calibrates to the individual.

The location of these boundaries is not universal, and the spread between people is wide. Caffeine clearance is governed chiefly by the liver enzyme CYP1A2, which performs roughly 90–95% of caffeine's primary metabolism; a common variant in the CYP1A2 gene — the −163C>A polymorphism — sorts people broadly into faster and slower metabolizers.[5,6] But genetics is only the baseline. CYP1A2 activity is shifted further, often substantially, by smoking — a potent enzyme inducer that can roughly halve caffeine's half-life — as well as by pregnancy, oral contraceptives and certain medications, age, and liver function.[7] The practical result is a genuinely large range: one person may clear caffeine in a few hours while another still carries an active load past midnight.

This is why population-level rules such as "no caffeine after 2 p.m." are blunt instruments — far too conservative for some drinkers, not nearly conservative enough for others. The science does not point toward a better universal rule; it points toward calibrating to the individual. That is precisely the case for Caffevolve's approach: rather than sorting users by population average, the Platform derives each person's boundaries from their own reported behavior, in which the combined effect of all these factors already shows up — no genotype test, and no assumptions, required.

Two boundaries, two different shapes

The Wake Hours Ceiling governs the day, and it is a *curve* — a performance relationship with a slope and a peak. The night is governed by a boundary of a different shape: the *Bedtime Ceiling*, the residual caffeine level above which sleep clearance is compromised. That one is not a curve but a flat threshold — above it, sleep is disrupted; below it, rest is possible; there is no optimization on either side, only a binary outcome. A complete account of caffeine has to manage both at once: the curve that governs waking performance and the threshold that governs sleep.

From mechanism to capability

None of these variables is visible by feel. Most people have no reliable way to know how much caffeine is active in their body at a given moment, let alone where a new cup will place them relative to either boundary — and by the time the jitters arrive, the ceiling has already been crossed.

This is the gap the Caffevolve™ Platform is built to close. The system maintains a continuous model of active caffeine across a rolling 24-hour window and projects where a given brew will land on the curve before it is made, then puts that information in front of the user. The boundaries begin as research-informed defaults and are refined over time through the user's own reported outcomes, so the thresholds increasingly reflect that individual's physiology rather than population averages. *The system recommends; the user decides; the machine always brews.*

Research-informed default boundaries

STARTING SENSITIVITY	PEAK ZONE FLOOR	WAKE HOURS CEILING	BEDTIME CEILING	RESEARCH BASIS
Higher	~40 mg	200 mg	20 mg at bedtime	Nehlig (2010); Fredholm et al. (1999)
Moderate	~40 mg	300 mg	50 mg at bedtime	Smith (2002); Nehlig (2010)
Lower	~60 mg	400 mg	75 mg at bedtime	Smith (2002); FDA (2023)

These are population starting points, not fixed assignments. For Guest profiles, the three sensitivity tiers serve as a deliberately conservative shortcut. For resident users, they are only where the system begins: Caffevolve derives each individual's Peak Zone floor, Wake Hours Ceiling, and personal caffeine decay rate from their own behavioral inputs and reported outcomes over time. The floor is fixed per starting tier; the Wake Hours Ceiling personalizes as the system learns.

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