

The lucidity trade-off.

V1.0 · OCTOBER 2026 · ARCAS DYNAMICS · HYPOTHESIS · NEUROSCIENCE

REM sleep is credited with loosening memory and aiding insight; lucid dreaming, with offering a place to practise. We propose that the two pull in opposite directions. If prefrontal re-engagement during lucid REM narrows associative sampling toward strong traces, lucidity should help the rehearsal of what is already known and hurt the recombination that insight depends on.

“Control helps a link only if that link is stronger than what is currently being sampled.”

Hypothesis and synthesis paper. No new experimental data are reported; every model output is an estimate under illustrative parameters, not a finding.

01

The argument.

From what REM sleep does to memory, to a prediction that can be tested within one person and one night.

01 REM is a low-control state

Prefrontal cortex is relatively quiet in REM sleep, and after REM awakenings weak associations are easier to reach than strong ones.

02 Lucidity may restore control

Lucid REM has shown more frontal gamma activity than non-lucid REM, although that evidence rests on very small samples.

03 Control narrows sampling

In the model, prefrontal control acts as an inverse temperature: as it rises, retrieval concentrates on the strongest associations.

04 A crossover

Lucidity should help the rehearsal of strong traces and hurt recombination that depends on weak links, within the same person and night.

02

Live model.

The paper's sampling model, live. Raise prefrontal control and watch where thirty draws from one cue land. The model runs in the browser at <https://arcasdynamics.com/research/lucidity-trade-off>.

Fig. 3a

One cue, fifty associations: a rehearsed trace, four strong links and forty-five weak ones, one of which solves an unsolved problem. At low control the draws scatter almost evenly; at high control they pile onto the rehearsed trace.

Fig. 3b

From $c = 0$ to $c = 1$, expected reactivations of the rehearsed trace rise from 0.60 to 14.77, and the chance of sampling the solution falls from 0.455 to 0.115.

Status

Model estimates under illustrative parameters. They resemble one small post hoc result but were not fitted to it.

03

The equations.

01 CONTROL SETS THE TEMPERATURE

$$\beta(c) = \beta_0 + (\beta_1 - \beta_0) c$$

c is near 0 in non-lucid REM and near 1 in lucid REM with active dream control.

02 SAMPLING AN ASSOCIATE

$$p_k(c) = \frac{\exp(\beta(c) s_k)}{\sum_j \exp(\beta(c) s_j)}$$

A low β samples almost uniformly; a high β concentrates on the strongest links.

03 REHEARSAL AND RECOMBINATION

$$R(c) = M p_{\text{rehearsed}}(c), \quad X(c) = 1 - (1 - q(c) p_{\text{solution}}(c))^M$$

Expected reactivations of the practised trace, and the chance that a weak solution link is sampled at least once.

$$\frac{\partial p_k}{\partial \beta} = p_k (s_k - E_p[s])$$

Raising control increases access to link k if, and only if, its strength exceeds the mean strength being sampled.

04

What it builds on.

What sleep research already shows, as the paper cites it. The evidence is thin, and the paper says so.

g $\approx$ -0.06

effect of memory cues delivered in REM sleep across 15 experiments, after two outliers were excluded: no reliable benefit

HU ET AL., 2020, PSYCHOLOGICAL BULLETIN · [HTTPS://DOI.ORG/10.1037/BUL0000223](https://doi.org/10.1037/BUL0000223)

About 40%

improvement on primed remote-associate problems in nap participants who reached REM

CAI ET AL., 2009, PNAS · [HTTPS://DOI.ORG/10.1073/PNAS.0900271106](https://doi.org/10.1073/PNAS.0900271106)

1 of 9

puzzles solved after lucid dreams of them, against 6 of 13 after non-lucid dreams; small, post hoc and unit-level

KONKOLY ET AL., 2026, NEUROSCIENCE OF CONSCIOUSNESS · [HTTPS://DOI.ORG/10.1093/NC/NIAF067](https://doi.org/10.1093/NC/NIAF067)

14 of 28

cued participants who reached signal-verified lucidity in a laboratory nap protocol

CARR ET AL., 2023, PSYCHOLOGY OF CONSCIOUSNESS · [HTTPS://DOI.ORG/10.1037/CNS0000227](https://doi.org/10.1037/CNS0000227)

05

Predictions.

Each one names the result that would refute it.

P1 Rehearsal improves

Refuted if items rehearsed in verified lucid REM are retained no better than items cued in non-lucid REM.

STATE: UNTESTED

P2 Recombination suffers

Refuted if once a puzzle enters a dream, the solve rate after lucid episodes is equal or higher.

STATE: UNTESTED

P3 Opposite directions

Refuted if lucidity moves rehearsal and recombination in the same direction.

STATE: UNTESTED

P4 Control, not awareness

Refuted if an instruction to direct or release the dream has no effect, or awareness alone carries the cost.

STATE: UNTESTED

P5 An associative signature

Refuted if the strong-to-weak priming ratio after lucid REM matches that after non-lucid REM.

STATE: UNTESTED

P6 A prefrontal index

Refuted if lucid and non-lucid REM show no difference in frontal engagement.

STATE: UNTESTED

06

How to test it.

First test: Within-person crossover

Three overnight sessions, with lucidity counted only when signalled by left-right eye movements during scored REM. Object locations are rehearsed and insight puzzles incubated in both states, with retests the next morning and a week later. About 51 recruits (model estimate).

TESTS P1, P2, P3, P6

Experiment 2: Direct or release

After a verified lucid signal, a randomised instruction either to direct the dream or to let it unfold, followed by strong and weak semantic primes and an anagram set on waking.

TESTS P4, P5

Experiment 3: Frontal stimulation

An exploratory arm: frontal 40 Hz stimulation or sham during cued REM, to test whether raising frontal engagement shifts outcomes toward rehearsal and away from recombination.

TESTS P6

07

Where it could be wrong.

Lucidity may not re-engage prefrontal cortex.

The premise rests on six participants and one case study. If Experiment 1 finds no frontal difference, the mechanism fails even if the crossover appears.

REM's role in memory is uncertain.

Suppressing REM with medication did not impair skill memory, so lucid rehearsal may be no different from rehearsal while awake.

Recombination gains are small.

Cueing in REM did not improve problem solving in two studies, which leaves little room to detect a cost of lucidity.

Lucid dreams are hard to produce.

Induction is unreliable, and only a minority of participants may contribute lucid episodes at all.

How to cite.

```
@misc{arcas2026lucidity,  
  author      = {Arcas Dynamics},  
  title       = {The lucidity trade-off},  
  year        = {2026},  
  month       = oct,  
  note        = {Hypothesis paper 03, version 1.0, CC BY 4.0},  
  howpublished = {\url{https://arcasdynamics.com/research/lucidity-trade-off}}  
}
```

© 2026 Arcas Dynamics. Licensed under Creative Commons Attribution 4.0 International (CC BY 4.0): <https://creativecommons.org/licenses/by/4.0/>

<https://arcasdynamics.com/research/lucidity-trade-off>

