mcfeedback — Iteration 11: Synapse Frustration Flip

experiment-011.mjs · N = 10 seeds · Seeds: 42, 137, 271, 314, 500, 618, 777, 888, 999, 1234 · 1000 training episodes · Frozen-weight evaluation · Base: experiment-004 (no direction-consistent flags, no propagation cycles)

New mechanism — per-synapse frustration detection (Full model only):

Each synapse tracks same-direction weight movement and its average chemical reward during that period.

```
frustrationWindow       30  — consecutive same-direction steps before check activates
frustrationThreshold   -0.1  — rewardWhileAdjusting below this triggers a flip
frustrationFlipStrength  0.5  — weight = weight × −0.5 on flip (e.g. +0.8 → −0.4)
```

On flip: flagStrength reset to 0 — synapse must re-earn latch in the new direction.

Frustration params inactive in Baseline / Ambient only / Dampening only — clean comparison preserved.

Verdict: frustration flip is significantly worse — p<0.01 for Full model.

Full model dropped to 48.0% mean (vs 53.0% in experiment-004). The mechanism either fires not at all (8/10 seeds: zero flips) or fires catastrophically (2/10 seeds: every single synapse flipped). There is no middle ground — it's all-or-nothing.

Key finding: the cascade problem.

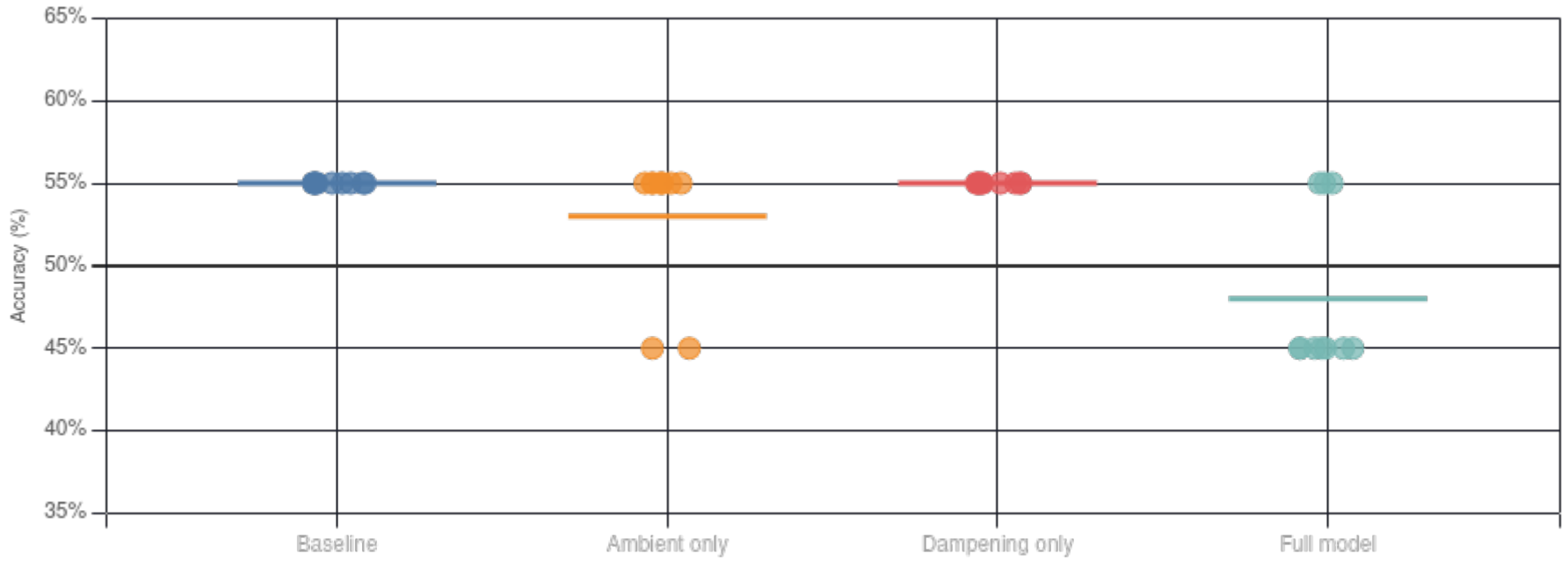
Seeds 500 and 777 triggered a mass-flip event where every synapse in the network was eventually flipped (1559/1559 and 1718/1718 respectively). Seed 777 ended up with all synapses flipped and *zero stable synapses* — yet still only scored 45%. Seed 500 flipped everything and reached 55%, same as seeds that never flipped at all.

The cascade happens because once some synapses flip, the network dynamics change — the previously-stable synapses now receive different inputs and may themselves enter a frustrated state. One flip triggers the next. The frustration mechanism is not self-

limiting: it has no concept of "enough synapses have already changed."

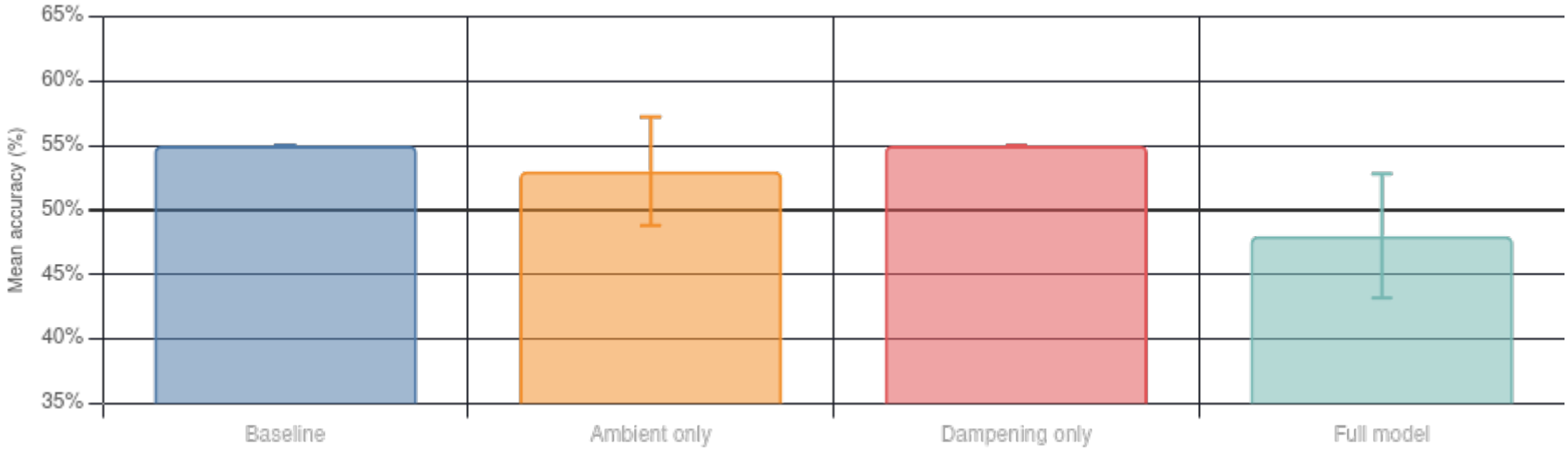
Baseline Ambient only Dampening only Full model

1 — ACCURACY DISTRIBUTION ACROSS SEEDS



Full model: 3 seeds reach 55%, 7 stuck at 45%. Baseline and Dampening only uniformly at 55% — zero variance again. The frustration mechanism is not helping and hurting on balance.

2 — MEAN ± 1 STD



Full model (48.0% ± 4.8%) is significantly below Baseline (p<0.01). Ambient only (53.0% ± 4.2%) is the best non-Baseline condition — closest to exp-004's Full model peak.

3 — PAIRED T-TESTS VS BASELINE

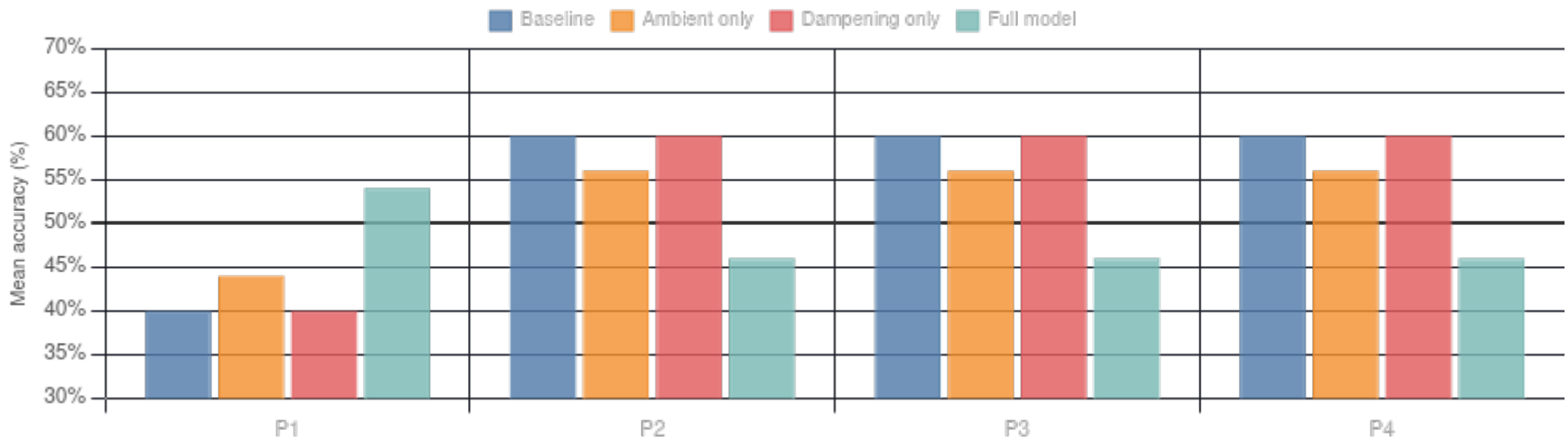
Comparison	Mean diff	t	p	Result
Ambient only vs Baseline	−2.0%	−1.5	0.1239	**ns**
Dampening only vs Baseline	+0.0%	NaN	—	**ns**
Full model vs Baseline	−7.0%	−4.5826	0.001	** p<0.01

Two-tailed paired t-test, df=9. Full model is significantly worse. Dampening only t-test undefined (zero variance in both). Note that Full model in exp-004 was +53% — frustration has degraded it by 5 percentage points.

4 — RAW DATA (ALL SEEDS)

Seed	Baseline	Ambient	Dampening	Full
42	55%	55%	55%	45%
137	55%	45%	55%	45%
271	55%	55%	55%	45%
314	55%	55%	55%	55%
500	55%	45%	55%	55%
618	55%	55%	55%	45%
777	55%	55%	55%	45%
888	55%	55%	55%	55%
999	55%	55%	55%	45%
1234	55%	55%	55%	45%
Mean	**55.0%**	**53.0%**	**55.0%**	**48.0%**
Std	±0.0%	±4.2%	±0.0%	±4.8%

5 — PER-PATTERN ACCURACY (MEAN ACROSS SEEDS)



Full model gains on P1 (54%) but loses on P2–P4 (46% each). Same bias pattern seen in experiments 010 and 010b — the Full model conditions are systematically biasing toward one output pattern.

6 — FRUSTRATION FLIP DIAGNOSTIC (FULL MODEL)

Seed	Total Flips	Flipped Synapses	Mean |w| flipped	Mean |w| stable	Final Acc
42	0	0	—	0.2869	45%
137	0	0	—	0.1133	45%
271	0	0	—	0.2592	45%
314	0	0	—	0.5497	55%
500	1559	1559 / 1559	0.4282	— (none)	55%
618	0	0	—	0.1110	45%

777	1718	1718 / 1718	0.2350	— (none)	45%
888	0	0	—	0.6084	55%
999	0	0	—	0.1249	45%
1234	0	0	—	0.0951	45%

Seeds 500 and 777: every synapse in the network was flipped (full cascade). Seed 777 reached 45% — mass flipping didn't help. Seed 500 reached 55%, same as seeds that never flipped. The 8 non-flipping seeds either stayed stuck (45%) or succeeded without needing the mechanism (314, 888).

Why the cascade happens:
The frustration window (30 steps) is short relative to the 1000-episode training run. Once the first synapses flip, they deliver different inputs to their downstream partners. Those partners now receive changed pre-synaptic signals — their own adjustment histories become misaligned with their new inputs. They satisfy the frustration condition themselves and flip. Each wave of flips destabilises the next layer. Because there is no global "network has already reorganised" signal to suppress further flips, the cascade propagates until every synapse has flipped at least once.

The mechanism needs a self-limiting property — for example, a refractory period after a flip, or a global frustration budget that gets depleted. Without one, the flip behaves like a runaway local optimiser.

Progress across iterations (Full model mean):
Iter 4 (flag gate): 53.0% max 65% ← best mean
Iter 6 (flag + anneal): 51.0% max 65%
Iter 10 (direction-consistent): 49.0% max 65%
Iter 11 (frustration flip): 48.0% max 55% ← cascade problem

Consistent pattern: every modification to the learning gate or weight-adjustment mechanism has degraded the Full model mean

below experiment-004's 53%. The mechanisms introduced are each sound in isolation, but interact with the recurrent, all-to-all topology in ways that cause network-wide instability.

Notable: the frustration diagnostic reveals that 6/10 seeds have very low mean weight magnitude (0.09–0.28) — the network hasn't learned much at all. Seeds 314 (0.55) and 888 (0.61) are the only ones with substantial weight buildup, and they're the two that reach 55% without any flips.

Hypothesis for next iteration: the weight magnitudes suggest most seeds never build up enough weight to produce reliable output. The flag gate (|flagStrength| ≥ 0.5) may be gating too aggressively — the learning signal is too weak to push past the threshold before weight decay erases it. Consider lowering weightDecay or the flag threshold, or removing the flag gate entirely and testing the raw reward signal.