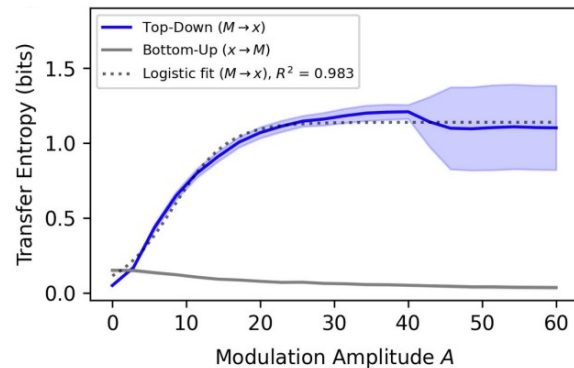
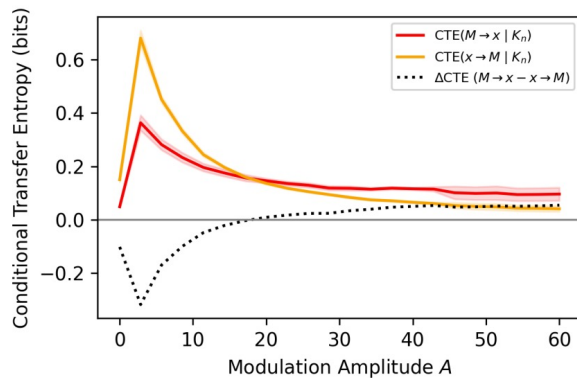


Shared Rhythms Create Coordination in Unconnected Systems



Shared environmental cycles create a strong top-down information flow. As environmental modulation increases, the collective behavior of the system becomes increasingly predictive of the behavior of individual components, even though the components do not interact directly.



Even after removing the direct influence of the environment, a top-down information flow remains. This suggests that shared environmental constraints can generate emergent collective organization beyond simple synchronization.

Many origin-of-life theories assume that coordination emerges only after molecules begin interacting directly with one another.

This study challenges that assumption by showing that **independent systems can become coordinated simply by experiencing the same changing environment.**

Using a model of uncoupled chaotic populations exposed to shared environmental cycles, we found that large-scale system behavior became increasingly predictive of individual behavior, even though the individual components never interacted.

Surprisingly, this top-down information flow persisted even after accounting for the direct influence of the environment itself, suggesting that collective patterns can emerge from shared context alone.

These findings support the idea that **environmental rhythms such as tides, day-night cycles, or wet-dry fluctuations may have acted as an early scaffold for organization** before the evolution of complex biochemical networks and cellular control mechanisms.