

Task representations in neural networks trained to perform many cognitive tasks

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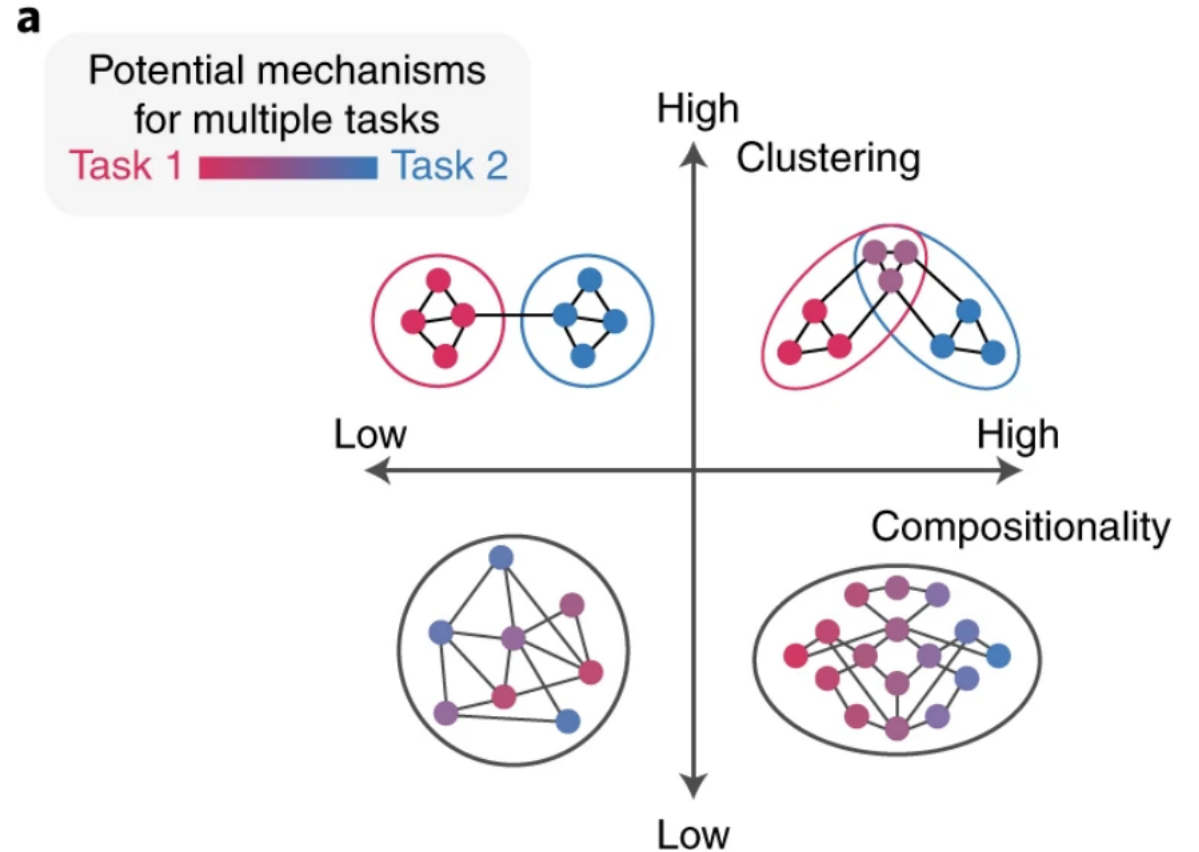
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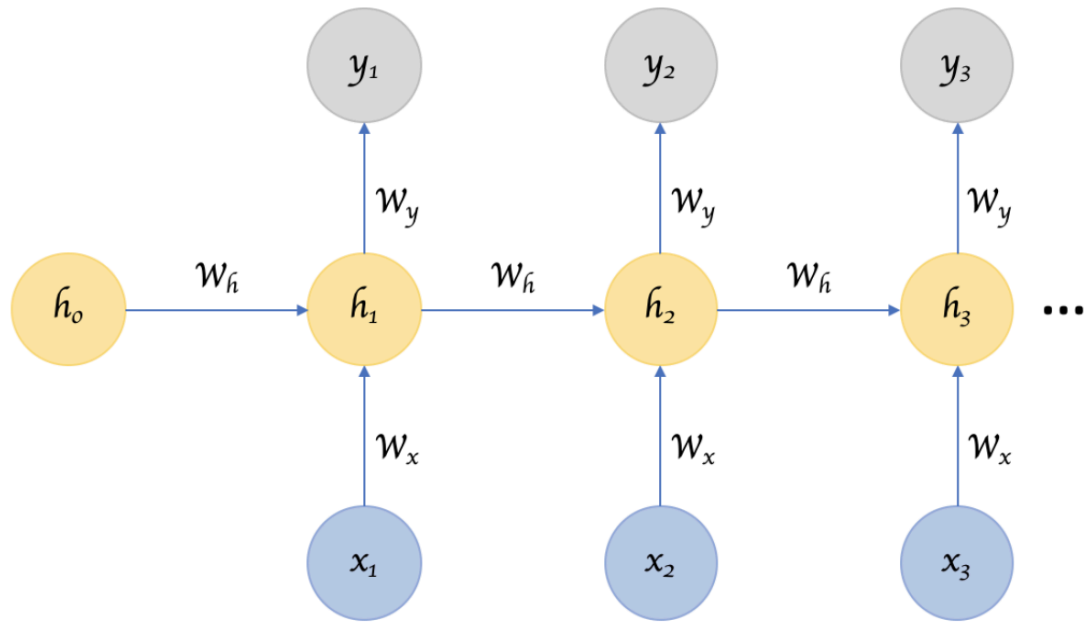
Research Goals

Do two related tasks use a shared cluster of neurons?

Can compositional task structures emerge in simple neural networks?

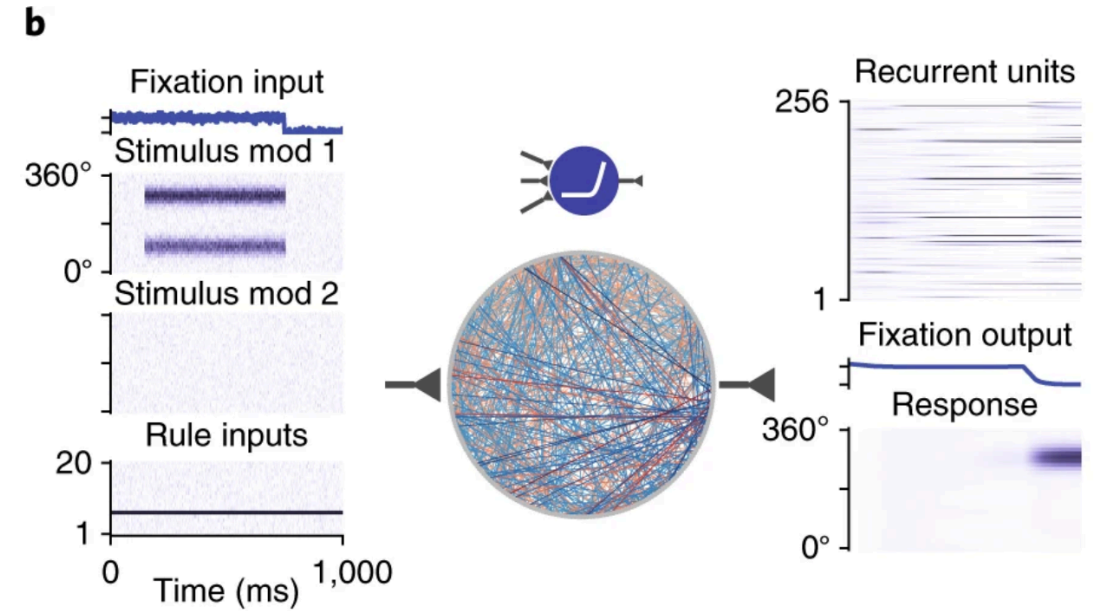
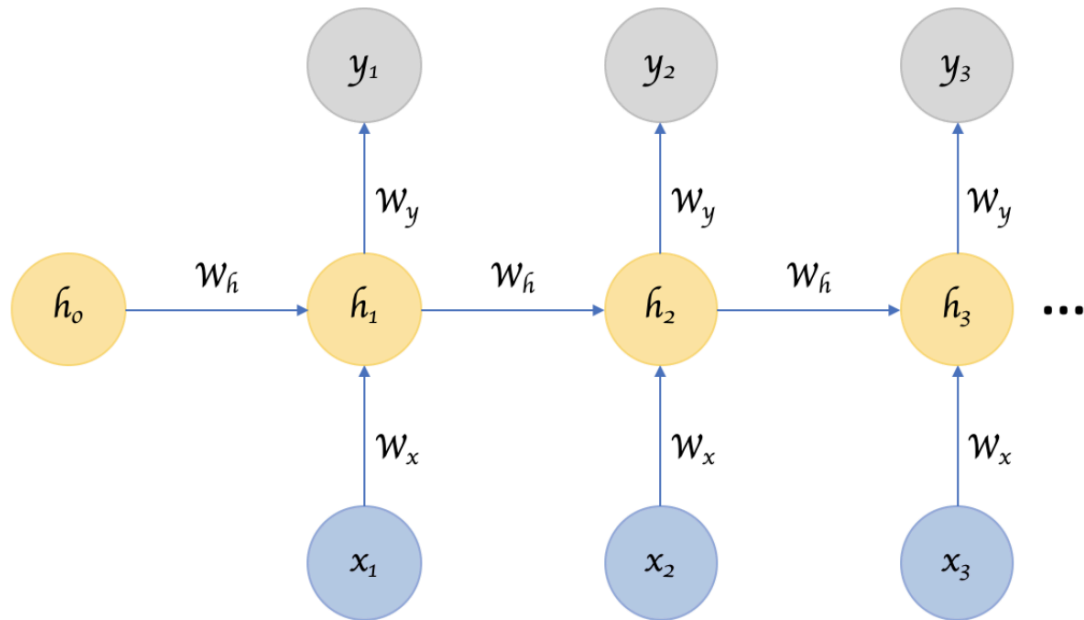


RNN architecture



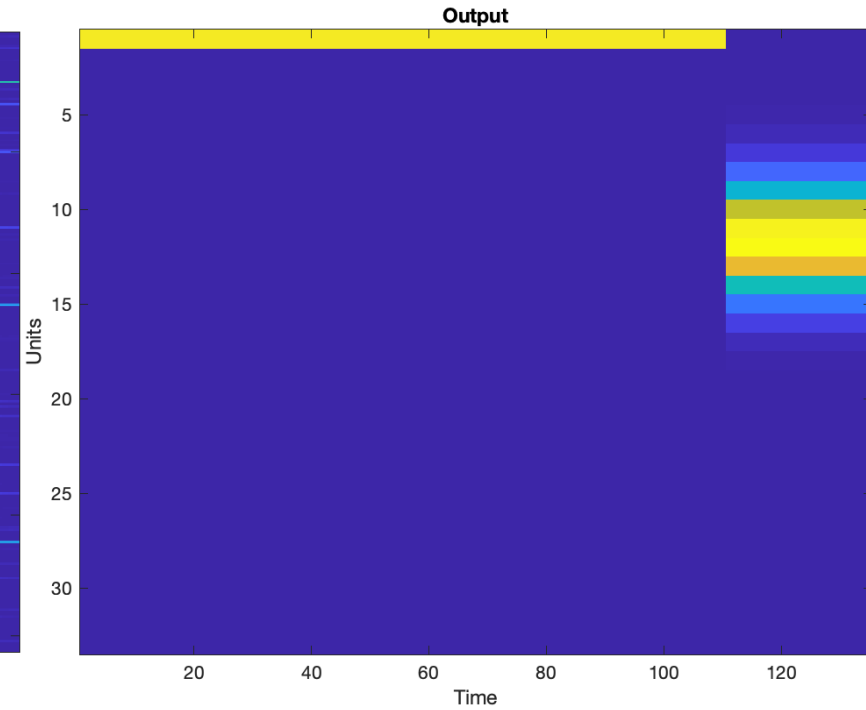
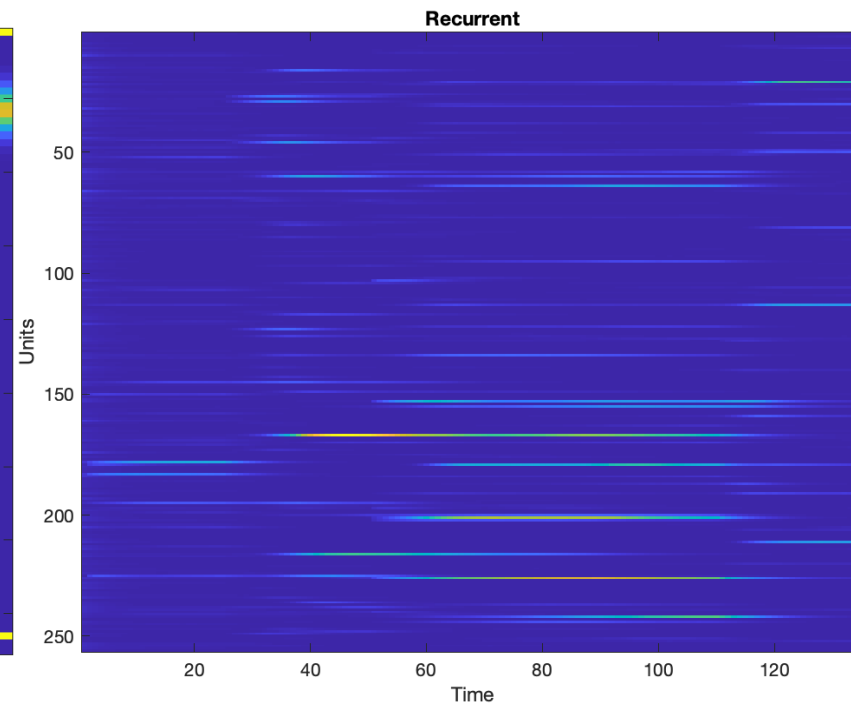
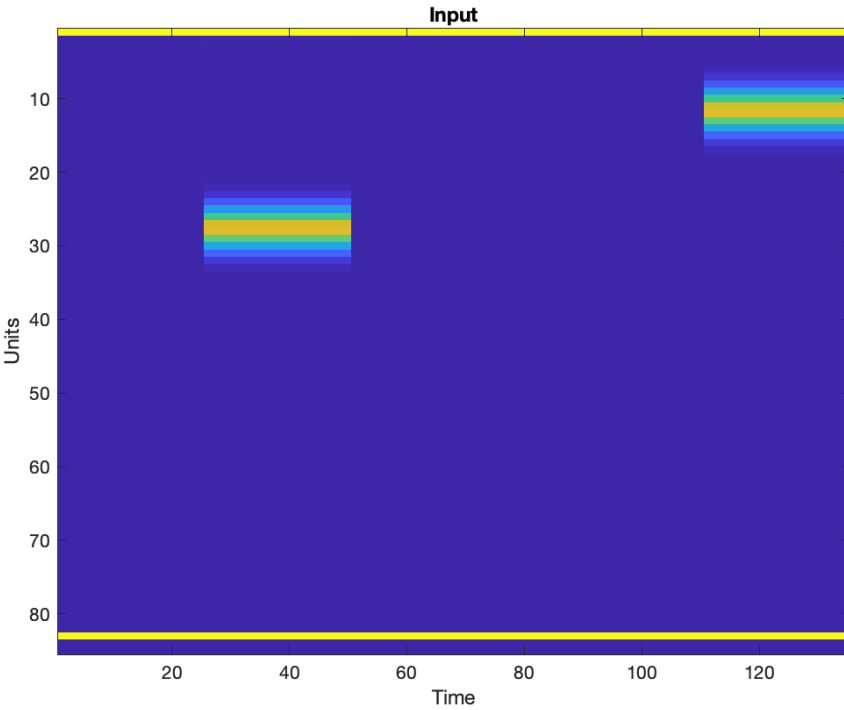
Gao, Miao & Shi, Guoyou & Li, Shuang. (2018). Online Prediction of Ship Behavior with Automatic Identification System Sensor Data Using Bidirectional Long Short-Term Memory Recurrent Neural Network. Sensors.

RNN architecture



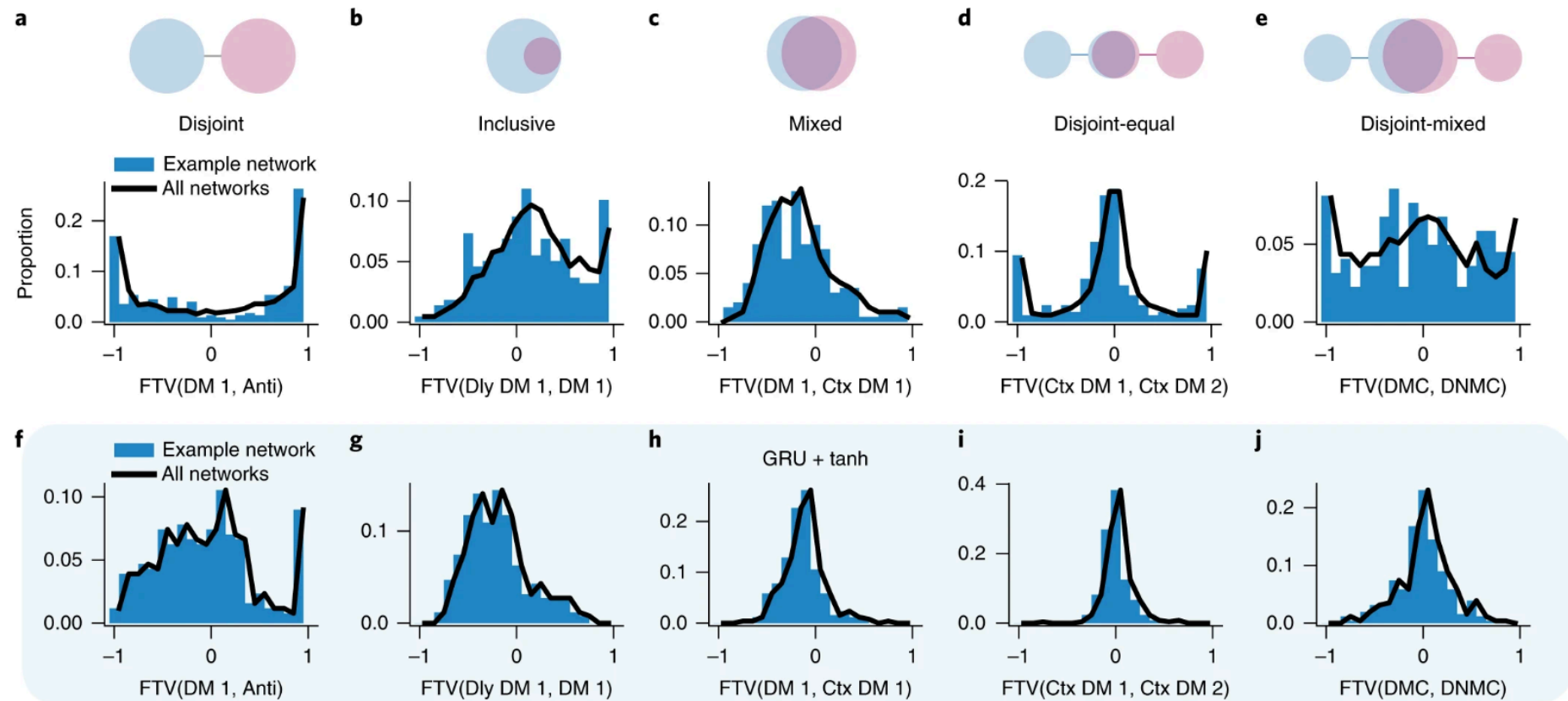
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Delay Non-Match Sample (DNMS) Task



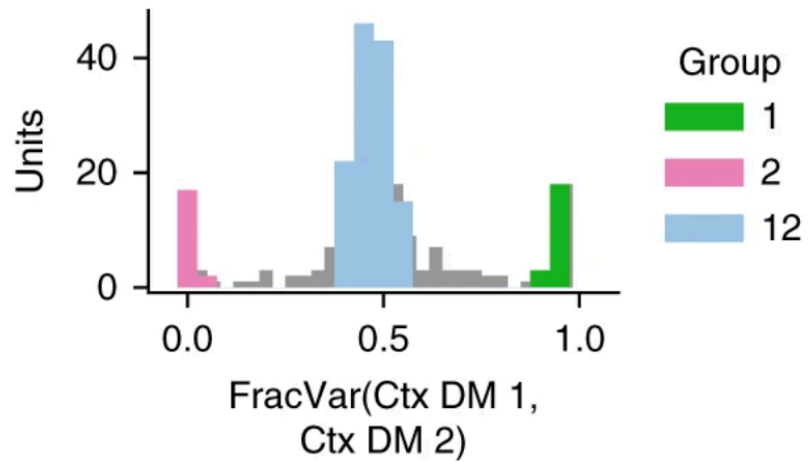
Relationships between neural representations of pairs of tasks

$$FTV_i(A, B) = \frac{TV_i(A) - TV_i(B)}{TV_i(A) + TV_i(B)}$$

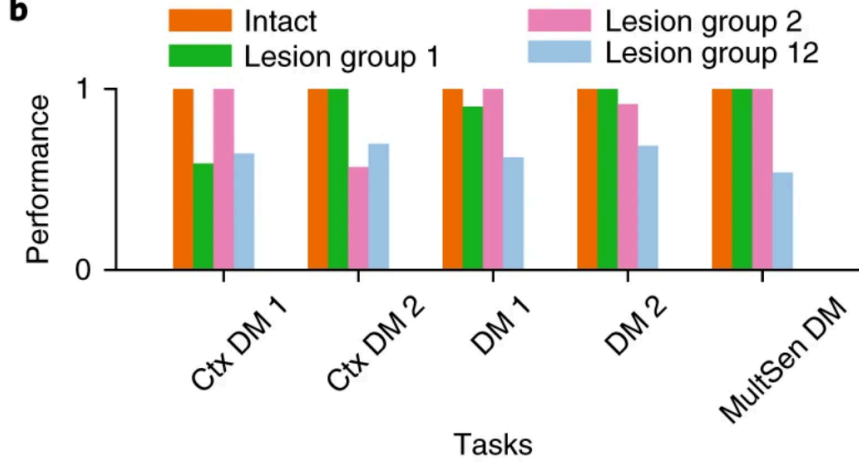


Functional clusters encode subsets of tasks

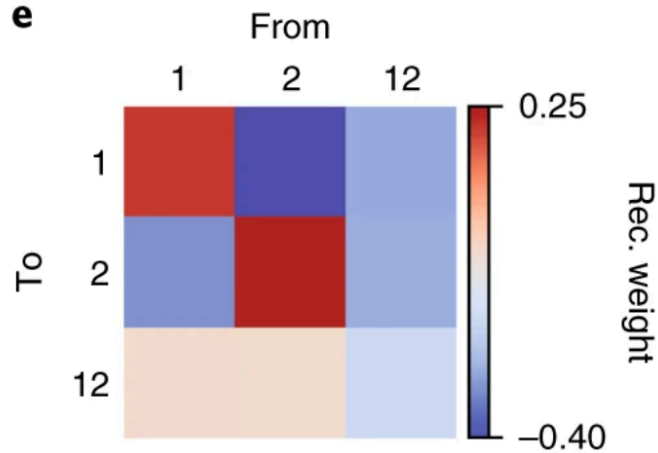
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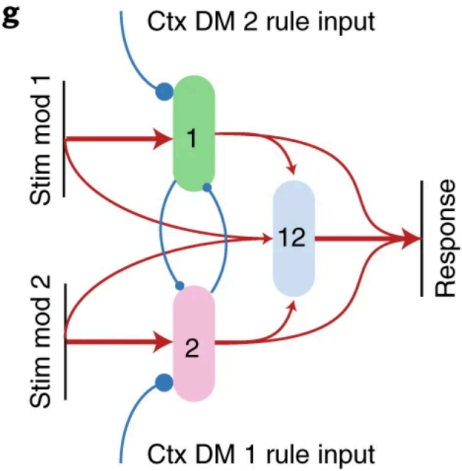
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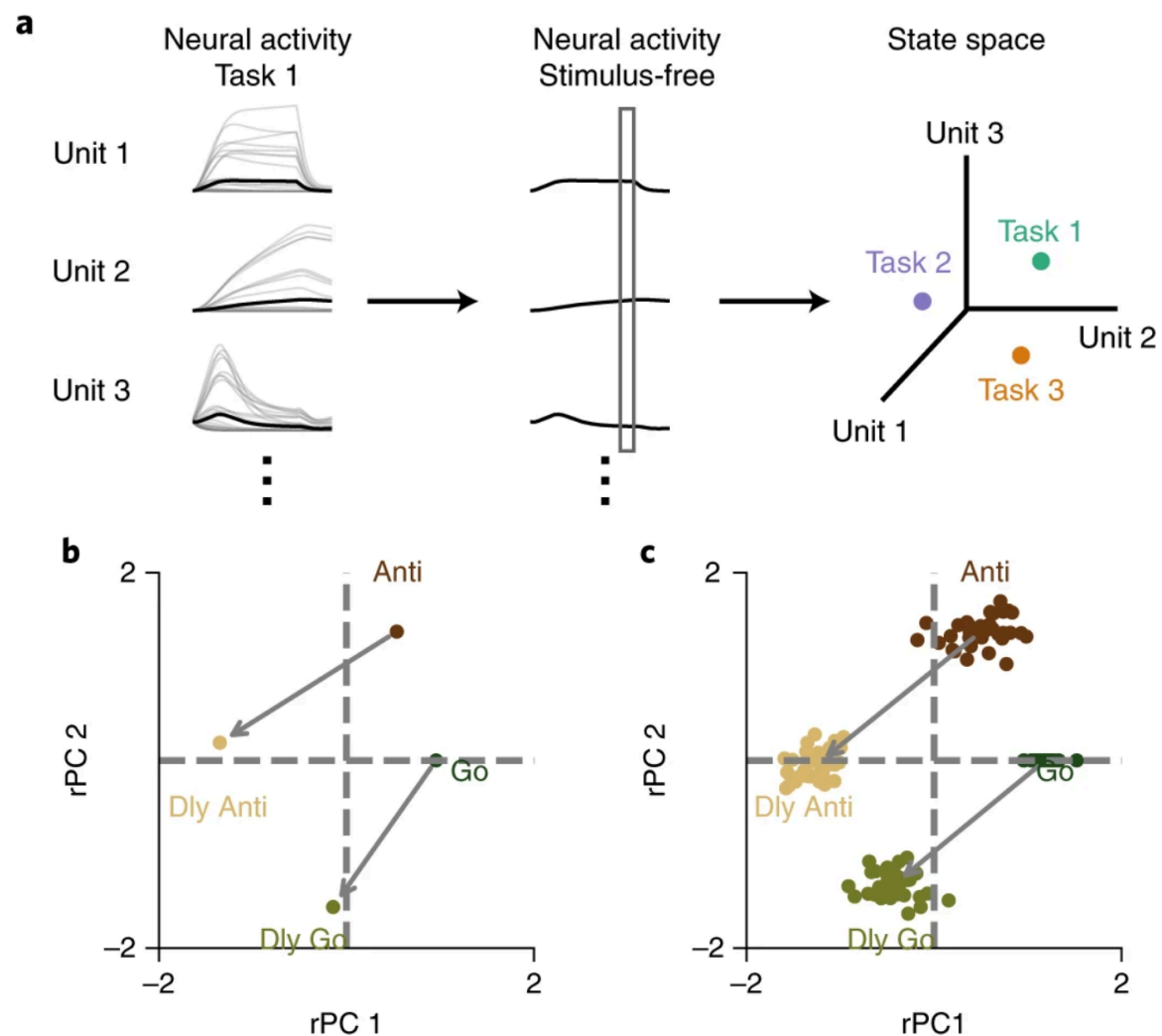
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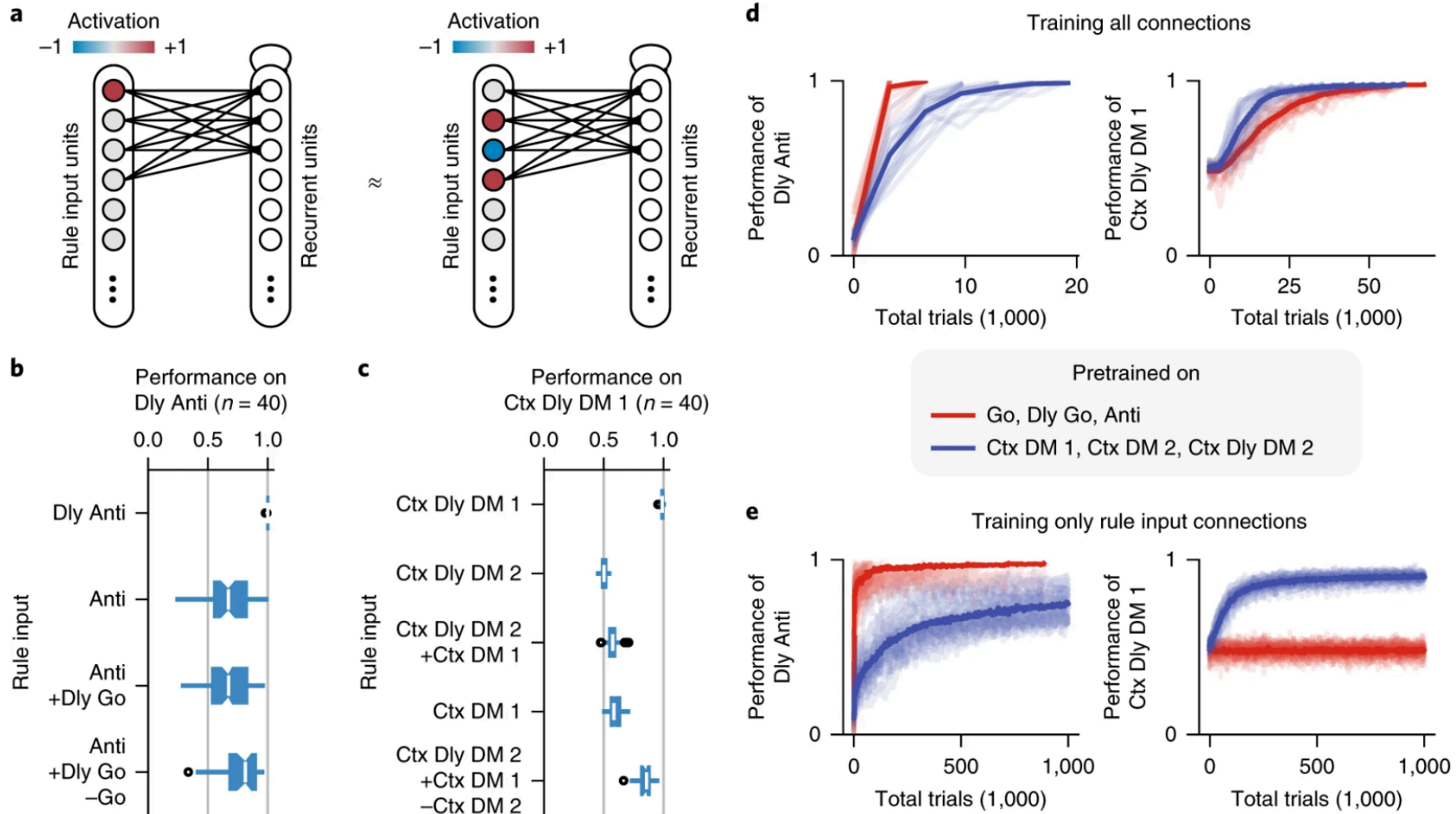
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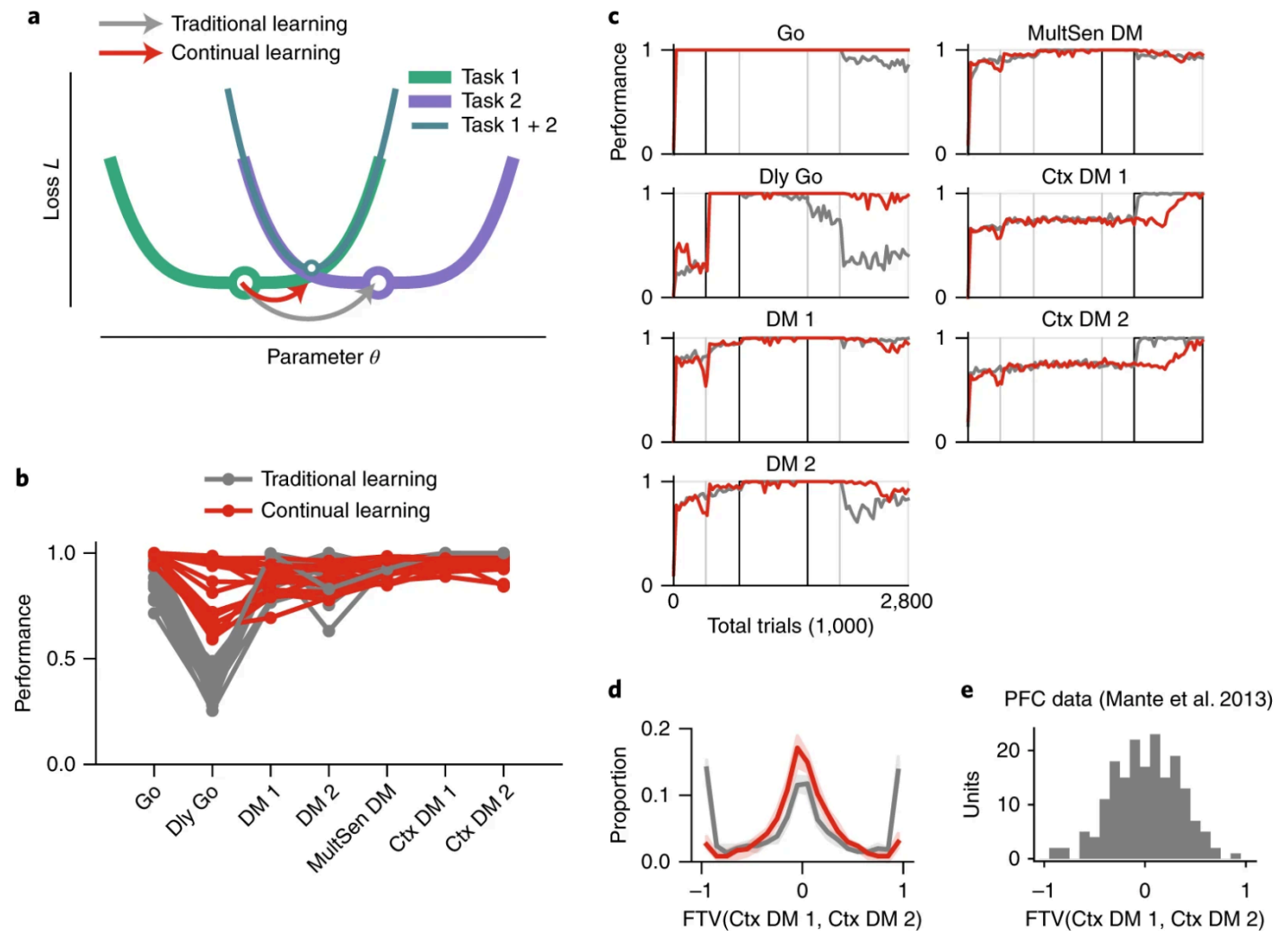
Compositional representation of tasks in state-space



Performing tasks with algebraically composite rule inputs



Continual learning versus traditional learning



Summary of the Results

- Each cluster is specialized for a subset of tasks
- Network showed a form of compositionality, but it could not perform all tasks with algebraically composite rule inputs
- Network successfully learned many tasks sequentially using a continual learning technique