Learned Spatiotemporal Sequence Recognition and Prediction in Primary Visual Cortex


-20161031 Journal Club-
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Learning Spatiotemporal Sequence

**a**

**b**

**c**

**d**

**e**

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Day 1 Day 2 Day 3 Day 4 Day 5

Train: ABCD (experimental) or scramble (control)

Test: ABCD, DCBA, ABCD_{300}

Experimental

A B C D

Control

B D C A

150 ms

1.5 s (gray screen)

One sequence presentation

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**Figure c:**

- Experimental
- Control

**Figure d:**

- ABCD_{300}

**Figure e:**

- Baseline
- ABCD
- DCBA
- ABCD_{300}
Learning Spatiotemporal Sequence

(a) 

(b) 

Day 1 Day 2 Day 3 Day 4 Day 5
Train: ABCD (experimental) or scramble (control)
Test: ABCD, DCBA, ABCD<sub>300</sub>

Experimental

Control

\[ \begin{array}{cccc}
A & B & C & D \\
\end{array} \quad \begin{array}{cccc}
A & B & C & D \\
\end{array} \quad \begin{array}{cccc}
D & A & B & C \\
\end{array} \]

\[ \begin{array}{cccc}
B & D & C & A \\
\end{array} \quad \begin{array}{cccc}
D & A & B & C \\
\end{array} \quad \begin{array}{cccc}
A & B & C & D \\
\end{array} \]

\[ \begin{array}{cccc}
\text{\(150\) ms} & \text{\(1.5\) s (gray screen)}
\end{array} \]

(f) 

(g)
Learning Temporal Signal

(a) Schematic representation of training and testing sequence with timing details. 
(b) Graphs showing the temporal signal extracted from different sequences.

Temporal signal extracted~
Learning Locally in V1
Learning Requires Muscarinic Receptors
Sequential Learning is Predictive

(a) Schedule of training and testing across five days.

(b) Graph showing three trials for each of the four trained sequences.

(c) Bar graph comparing magnitude across full sequences and second elements.
Multiple Cortical Layers Involved
Short Summary

• After repetitive entrainment, activity in V1 recognizes the sequential input
• Both spatial and temporal sequence are recognized
• Involves cholinergic input and locally in V1
• Prediction algorithm involve multiple cortical layers
• V1 is far more than a static detector. It can dynamically regulate response to input in time
**Predictive Coding in the Brain**


Detection and Prediction of Transient Patterns (in the retina)


Follow-up Studies

- Models

- Projections