

A Human Episodic Memory Primer: Seeking a Functional Specification

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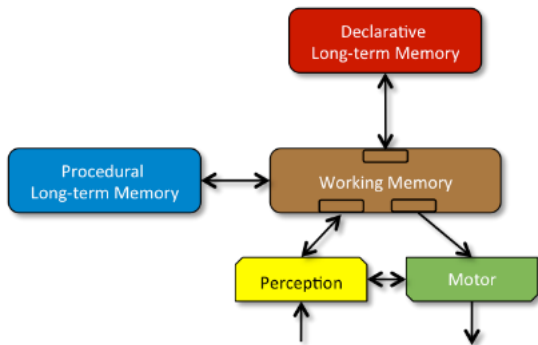
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Overview

- 1 Episodic Memory?
- 2 Towards Additional Specification
 - 6 Properties for Temporal Memory

Episodic Memory?



Semantic/Episodic Distinction

Semantic

- What you know

Episodic

- What you remember

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Episodic

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 - When was the first time you saw a firetruck?

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 - Firetrucks are generally which color?
 - Where do you normally park your car?

Episodic

- What you remember
 - When was the first time you saw a firetruck?
 - Where did you last park your car?

(Nuxoll & Laird 2012) Episodic Memory Specification

Property

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same functionality provided across different tasks

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Architectural	same functionality provided across different tasks
Automatic	does not depend on agent action to function
Autonoetic	memories distinct from current setting
Temporally-indexed	conveys a sense of relative ordering for episodes

Towards Additional Specification

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 - 6 Properties for Temporal Memory

How do I identify properties for Episodic Memory?

- Clarify properties present in human episodic memory.
- Reason out which properties must be present for any “rational” episodic memory.

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The hippocampus and the cortex

(Episodic Memory needs both.)

Hippocampus

- (Mostly) required to store and retrieve autobiographical memory.
 - HM, a famous hippocampal lesion case

Cortex

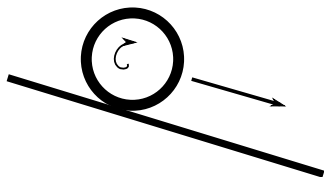
- Seems to store representation which is activated by hippocampus.
 - Old memories sometimes still can be recalled even with hippocampal lesion.

Non-exhaustive Selection of Theories on Episodic Memory or Temporally-extended Memories

- Complimentary Learning Systems (McClelland, McNaughton, O'Reilly 1995)
- Event Segmentation Theory (Zacks 2007)
- Hippocampal Indexing Theory (Teyler & DiScenna 1986)
- Hierarchical Temporal Memory (Hawkins 2004; George 2008)
- Thalamocortical circuits (Rodriguez, Whitson, Granger 2004)

Property 1: Temporally-extended memory elements

There is a type of memory element which itself represents the state or changes to the state across an extended period of time, not only at an instant.

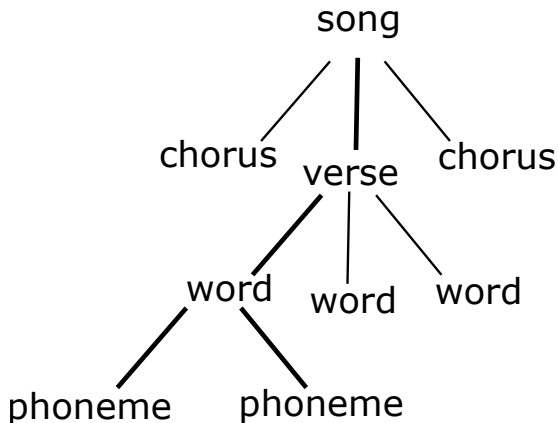


(a rolling ball)

“Jingle bells, jingle bells, ...”

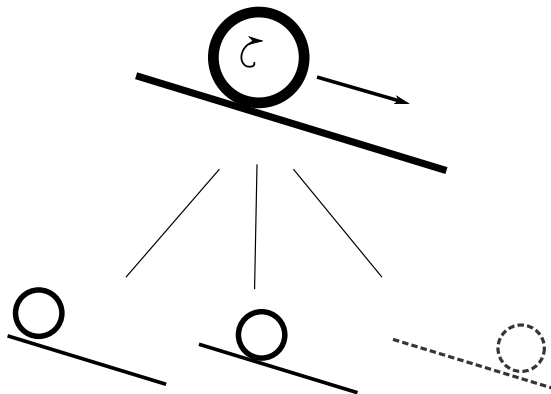
Property 2: Hierarchical storage and encoding

These temporally-extended memory elements describe different timescales with some at longer timescales entirely subsuming others that have more specific information or detail at shorter timescales.



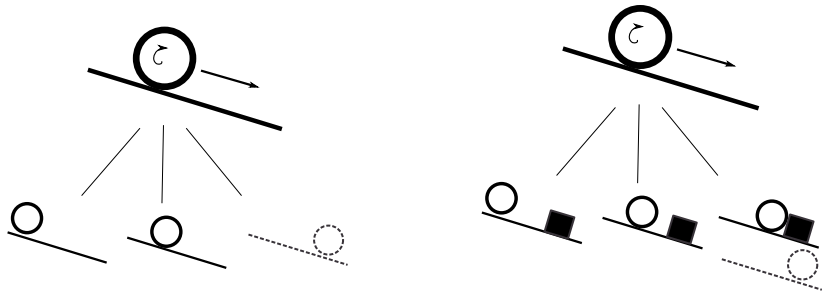
Property 3: Predictive Retrieval

In a familiar situation, recognition of a temporally-extended memory element in the environment constitutes a prediction for the unobserved remainder of the recognized sequence.



Property 4: Prediction-based encoding

When there is a misprediction, this event of misprediction is taken as a signal to log a significant event.

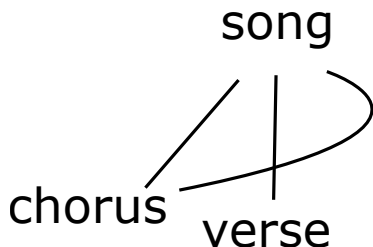


Property 5: Reconstruction-based retrieval for episodes

Episodic memories themselves only need to be stored in a manner sufficient for reconstruction, not wholly specified.

Property 6: Overlapping encoding

Temporally-extended memory elements for events have overlapping underlying representations from encoding new events in terms of previously-encoded events.



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Episodic Memory as Special Case

- “top” of hierarchy
- represents single autobiographical sequence
- depicts entire state
- rapidly acquired
- orthogonalization/pattern-separation for distinct similar cues

Nuggets and Coal

Nuggets

Coal

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Nuggets

- extended set of properties to draw from helps constrain set of algorithms which could perform similarly to humans

Coal

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- unclear when/whether some properties are “rational”

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Nuggets

- extended set of properties to draw from helps constrain set of algorithms which could perform similarly to humans

Coal

- unclear when/whether some properties are “rational”
- still unclear which algorithms/methods to employ