

# Rumination as State Inference



Rachel L Bedder – 06/11



Workshop on *Repetitive Negative Thinking and Simulation in Natural and Artificial Cognition* @ RLDM 2022

*Why do I feel so awful?*

*Why do I always feel so awful?*

*Why do I always get so stressed about things?*

*What does it mean about me that I'm always getting so worked up?*

# What is Rumination?

- “...thoughts that focus one’s attention on one’s depressive symptoms and on the implications of these symptoms”  
*Nolen-Hoeksema (1991)*
- Repetitive; past orientated, negative and overly abstract *Watkins (2008)*
- Tendency to rumination predicts **severity of depression** and **repeated episodes** *Just & Alloy (1997), Nolen - Hoeksema & Davis (1999)*
- Most kinds of rumination are unconstructive - *You cannot ruminate yourself out of ruminating!*
- A ruminative episode cannot be directly observed

*Why do people do it?*

# Why do People Rumininate?

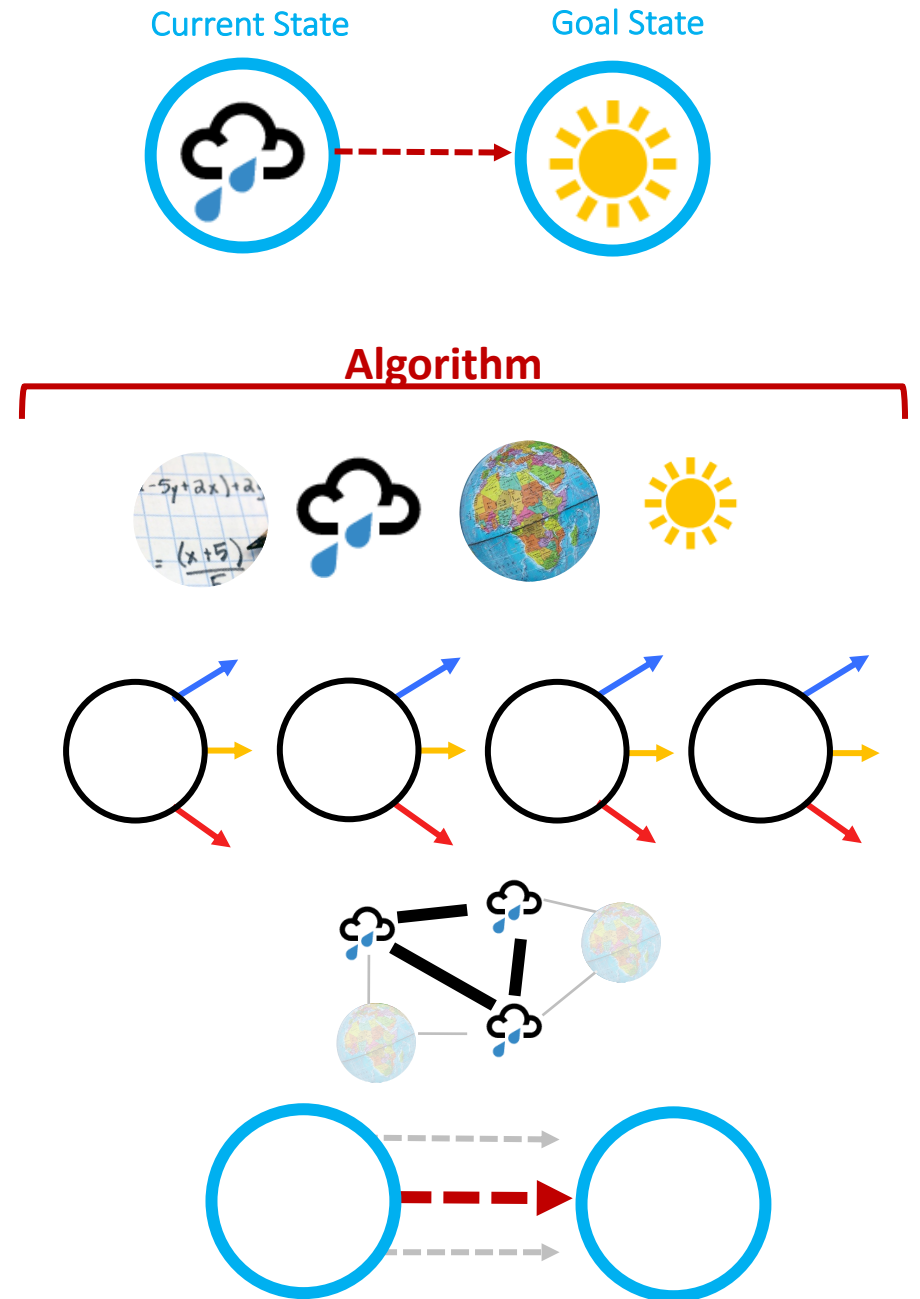
- Rumination is an **algorithm** selected in order to **choose an action**
- **Sample from previous experience** to identify relevant features of current experience

What to sample?

How long to sample for?

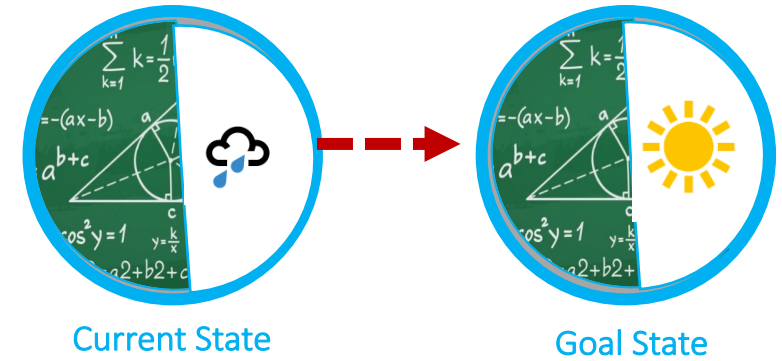
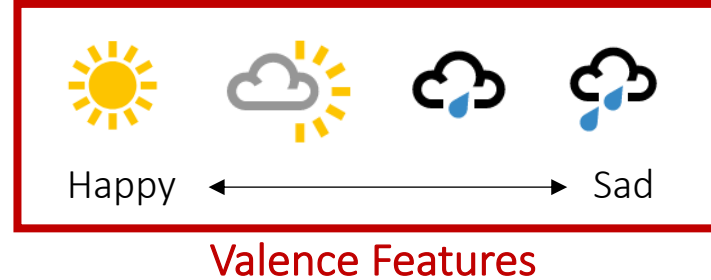
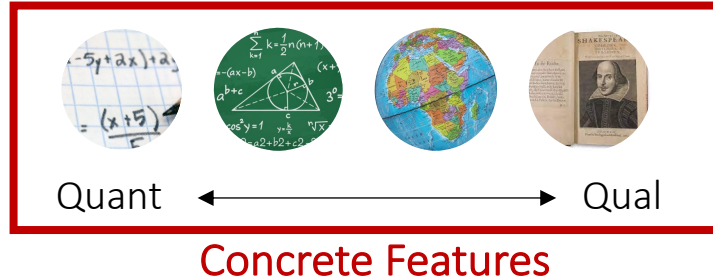
Can sampling **change** the state space?

Why do rumination episodes **repeat**?

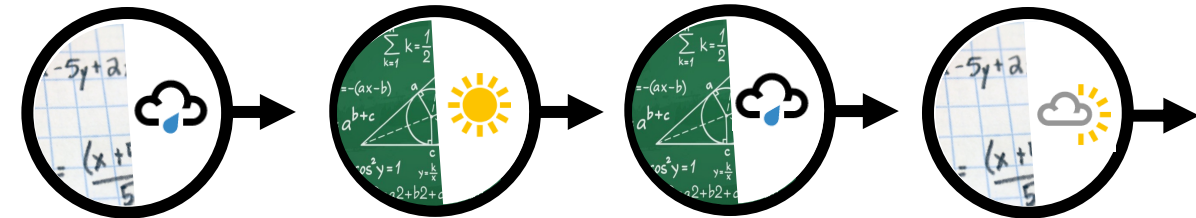


# What to sample?

- Studying for a physics exam – *why do I always get so stressed about these things?*

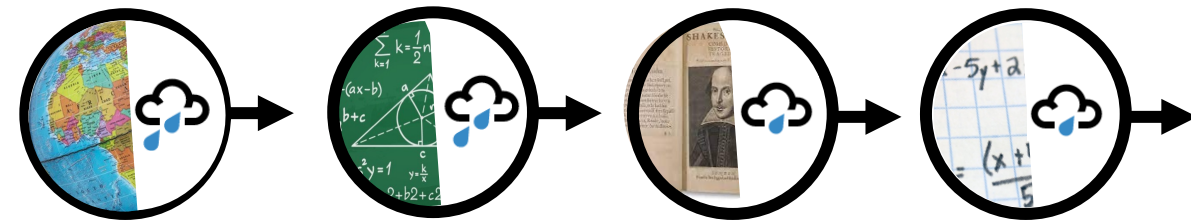


- Sample based on similar concrete features (with similar policies)



- High trait ruminators are less able to inhibit negative information  
e.g. Zetsche et al (2012)

- Sample based on valenced features (different policies)

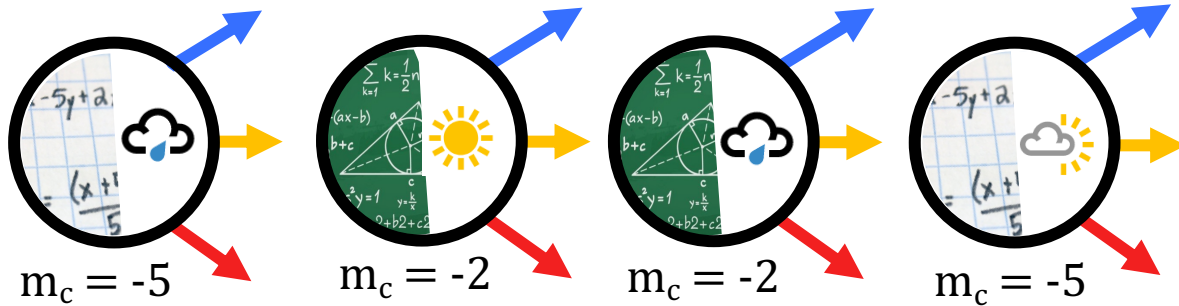


Rumination is a sequence of negatively biased memories (states)

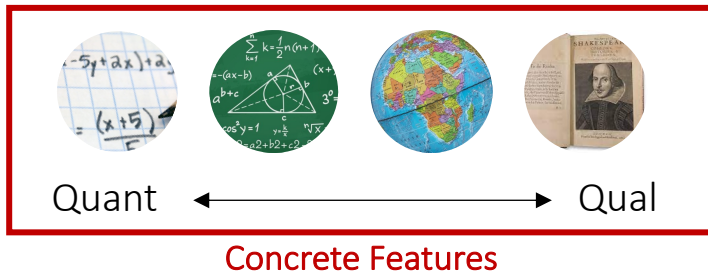
# How long to sample for?



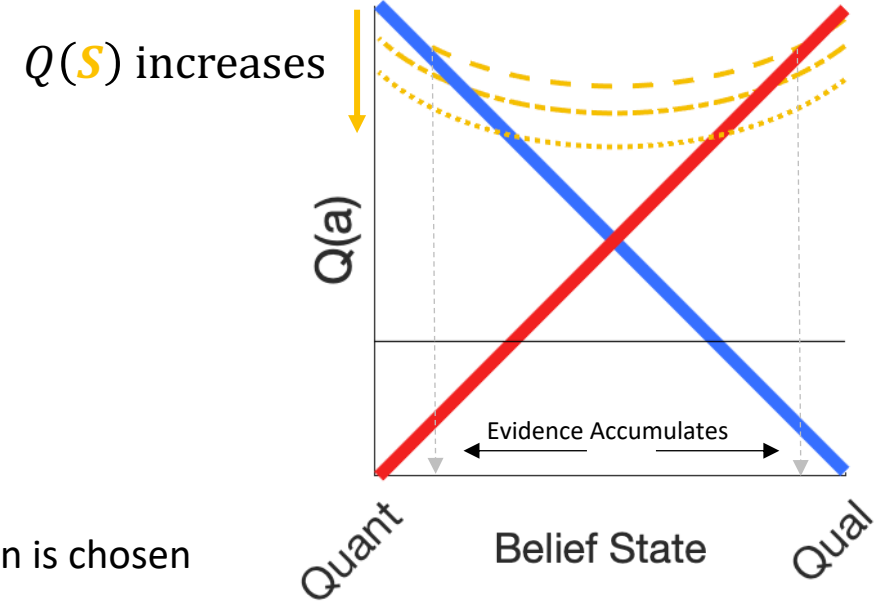
- The accumulation of evidence from memory (cues) helps identify the latent state in order to plan an action.



$Q(\text{Library})$   
 $Q(\text{Run})$        $Q(\text{Sample})$   
 $m_{c,i}$  = feature value



$Q(\text{L}, \text{Quant}) = +5$   
 $Q(\text{R}, \text{Quant}) = -2$   
 $Q(\text{L}, \text{Qual}) = -2$   
 $Q(\text{R}, \text{Qual}) = +5$   
 $Q(\text{S}) = [-0.1, -0.5, -1]$



- Low cost to sampling** means **belief state certainty** must be **higher** before an action is chosen
- Sampling** based on **action irrelevant feature** (valenced) causes belief state to remain uncertain

Model based on Dayan & Daw (2008)

Rumination can be maintained by low costs to sampling

# Can sampling change the state space?

- Reactivation of episodes from **memory** could act as a mechanism for **identifying statistical regularities** and **consolidating into more general memories**. Tompary & Davachi (2017), McClelland et al (1995).
- **Spontaneous thought** could be a mechanism for this Mildner & Tamir (2019)
- People with **depression** tend to show more **general autobiographical memory** Williams et al., (1996)

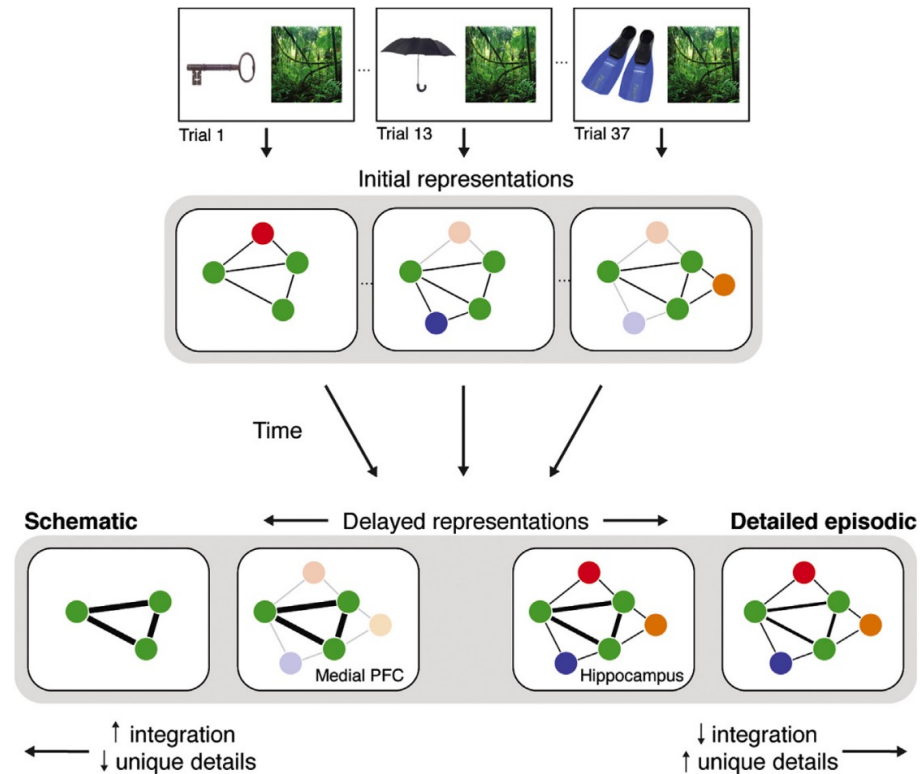
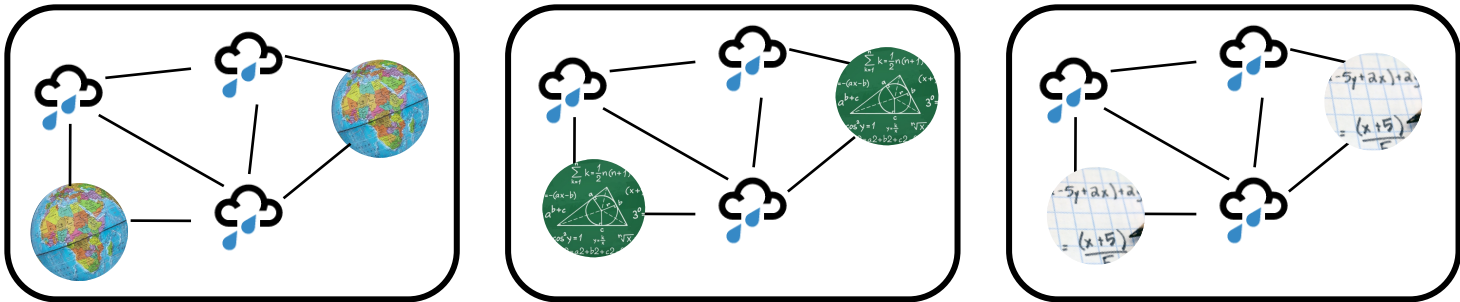


Figure from Tompary & Davachi (2017) *Consolidation promotes the emergence of representational overlap in the hippocampus and medial prefrontal cortex*

# Can sampling change the state space?

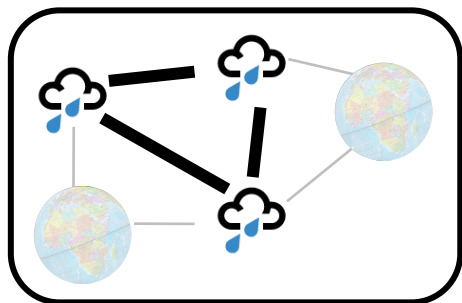
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Initial representations



Schematic representation after time

↑ integration  
↓ unique details



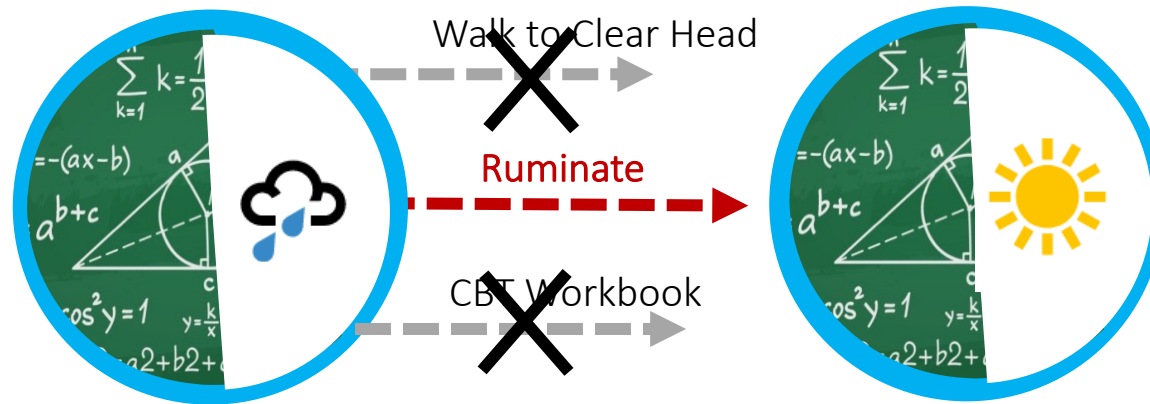
- Representations made up of shared negative features could be experienced as higher-level beliefs  
e.g. *I will also fail at challenging things*  
*I am stupid and everyone knows it*

Rumination integrates negative valenced features to create negative beliefs about the self



# Why do rumination episodes repeat?

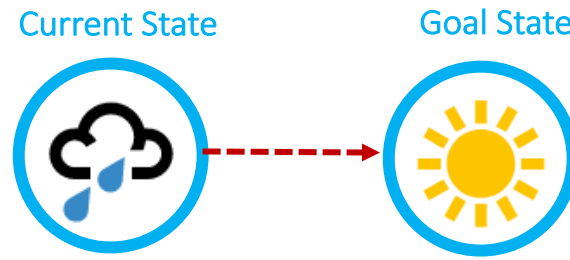
- **Abstract thinking** increases tendency to **over-generalize** successes & failures to the self *Van Lier et al (2015)*



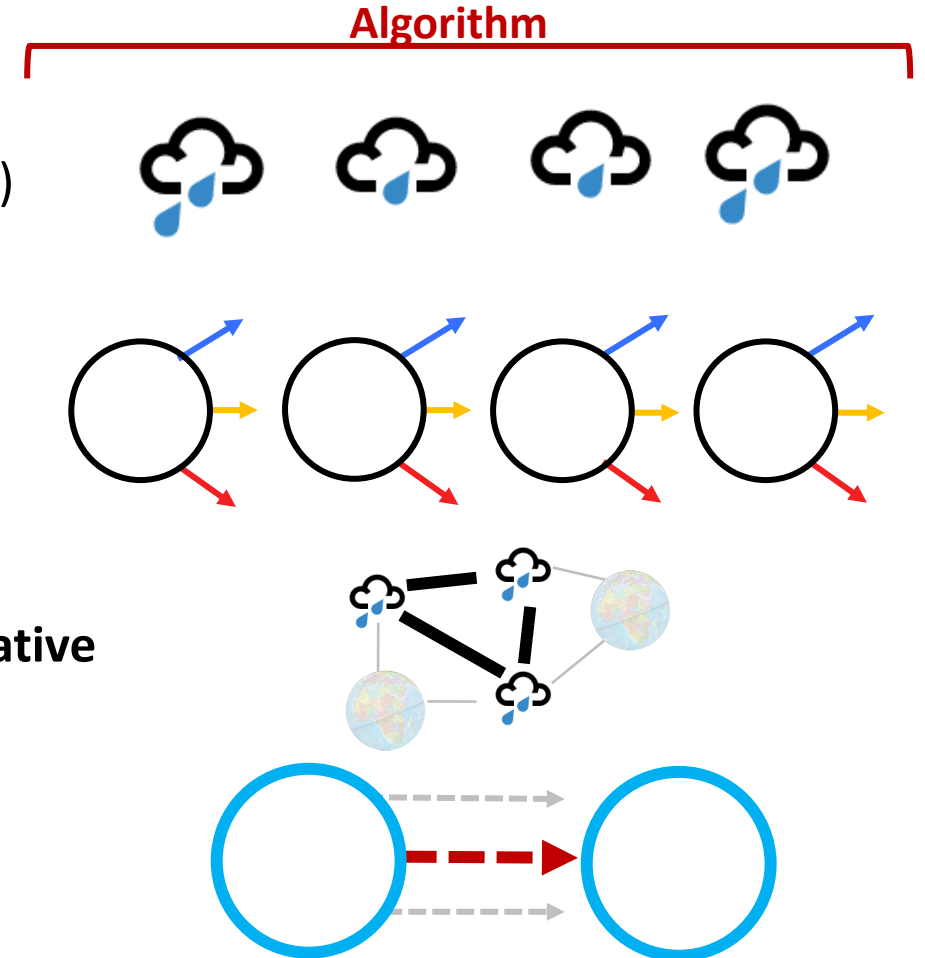
- This could increase tendency to ruminate by...
  - **Pruning** selection of alternative strategies (e.g. walk to clear head, CBT exercises)
  - **Increased rejection of policies** within ruminative episode (i.e. nothing will work!)
- **Negative overgeneralization** to the self is associated with **depression** *Beck (1976), Carver (1998)*.

Rumination contains positive feedback dynamics to reinforce its prevalence over time

# The full story...



- Rumination is a **sequence of negatively biased memories** (states)
- Rumination can be maintained by **low costs to sampling**
- Rumination integrates **negative valenced features** to create **negative beliefs** about the **self**
- Rumination contains **positive feedback dynamics** to reinforce its prevalence over time



# Thanks to...

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