Midterm…eek!

- We'll have our midterm one week from Monday: **Monday, May 10, 11:45AM — Tuesday, May 11, 11:45AM**
- Format: open book (but work individually)! Some graphs, some calculations, some short answers (like the problem sets)
- Know everything **fluently** from all recap slides

Midterm…eek!

- Material covered: everything through the end of class on **Friday, May 7** (Chapters 1-4)
- Review session: **Tuesday 5/4 at 3pm**

Midterm…eek!

- I’ve designed the exam to take about 2 hours, but you’ll have up to 24 hours if you need it
- No class on Monday 5/10, since you’ll be working on the midterm

Recap

- Evidence for summed similarity models
- Explaining the mirror effect with summed similarity
- Summed similarity ROC curves

The role of noise

Have you ever seen TV static?

1. No, my TVs all just turned blue

2. Not in person, but I've seen it in the background of a TV show or movie

3. Yes

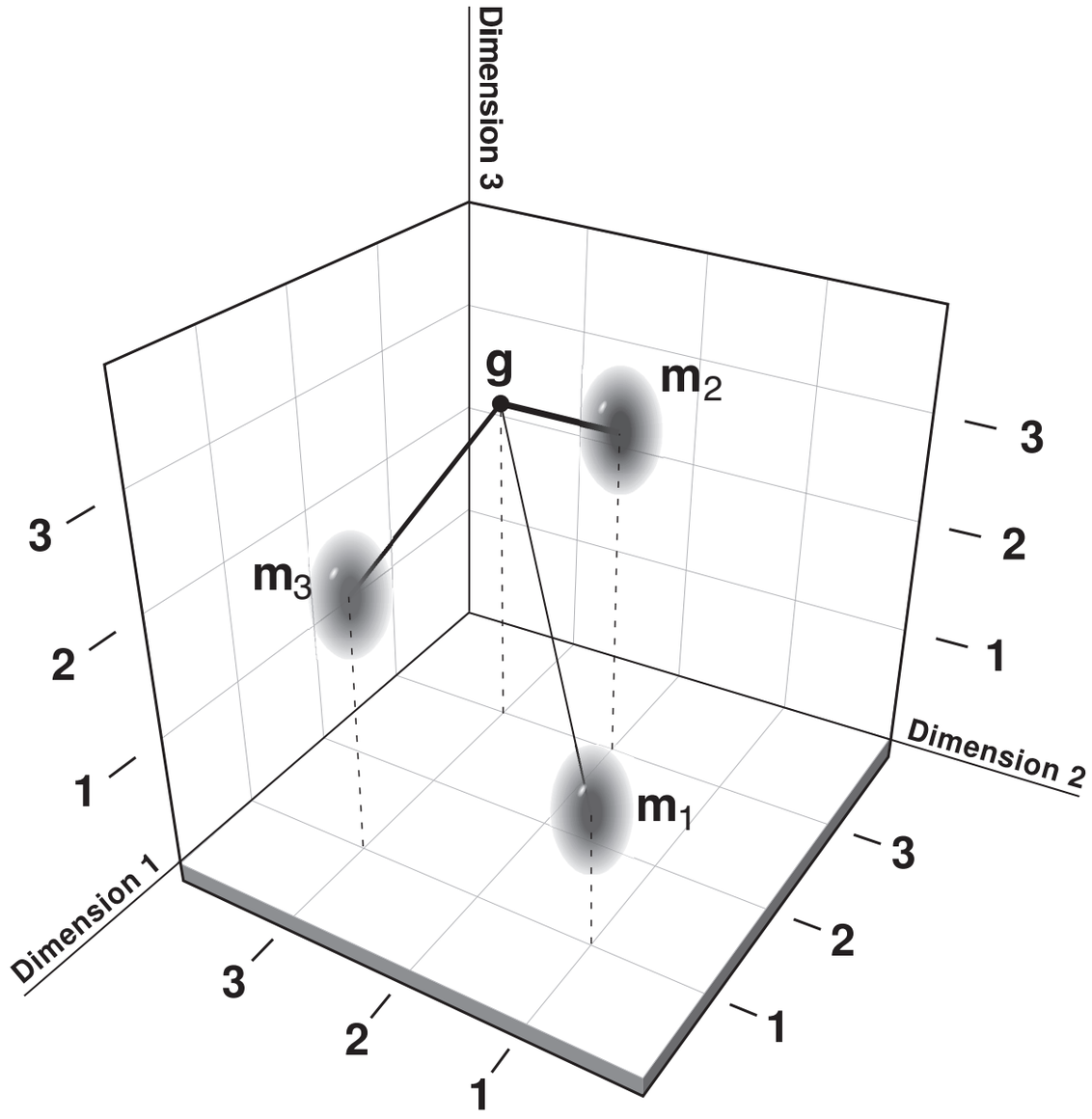
4. This question makes me uncomfortable

Extending summed-similarity theory

- Creating noisy memories: variable encoding
- Ratcliff's drift diffusion model
- Modeling how context changes over time

Variable encoding

Variable encoding: a cruddy old copier making noisy memories



Each memory is a noisy version of the original experience

Adding noise to memories

$$\mathbf{s} = \begin{pmatrix} 10 & 3 & 6 \\ 4 & 7 & 12 \end{pmatrix} \qquad \epsilon = \begin{pmatrix} -3 & -3 & 1 \\ -1 & -3 & 2 \end{pmatrix}$$

$$M = \begin{pmatrix} m_1(1) & m_2(1) & m_3(1) \\ m_1(2) & m_2(2) & m_3(2) \end{pmatrix}$$

item noise equation

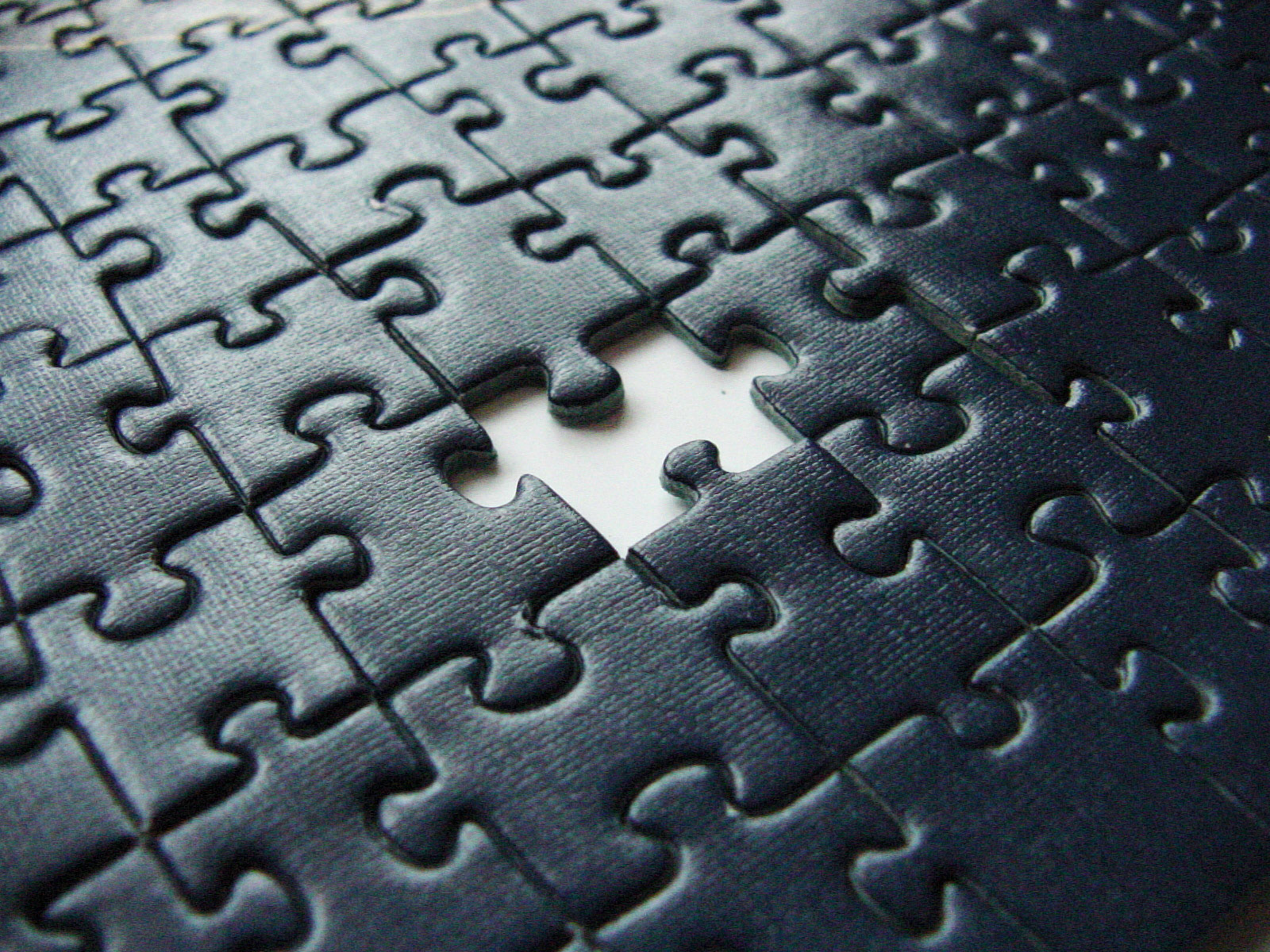
$$\mathbf{m_i = s_i + \epsilon_i}$$

Adding noise to memories

- We can think of adding noise as “perturbing” the memory traces (feature vectors)

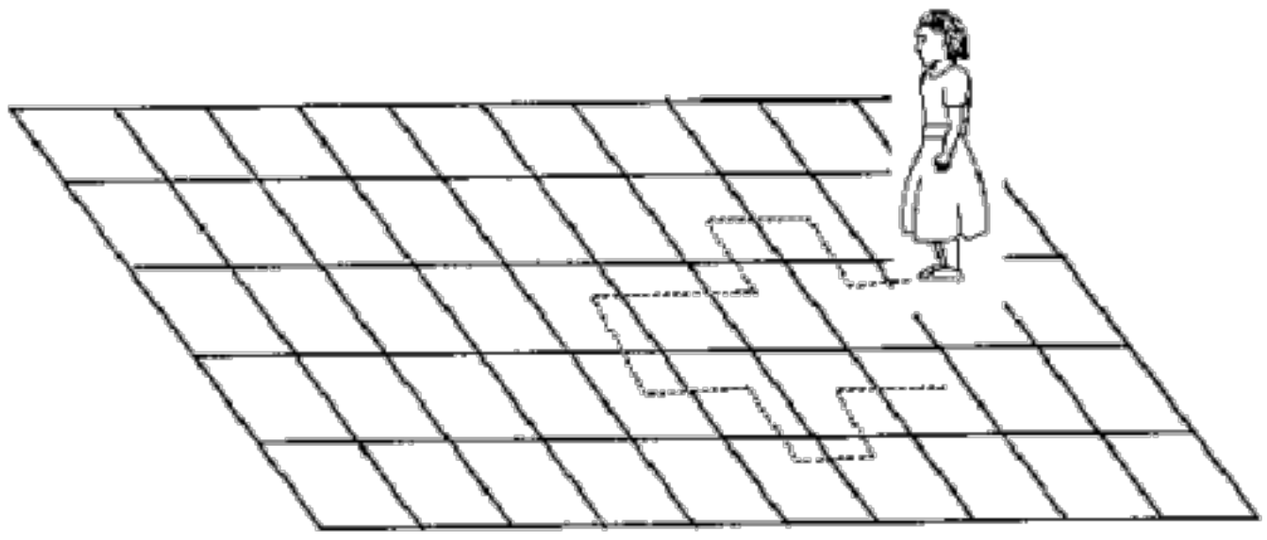
- Where might this noise come from? Are all features equally noisy?

Noisy memories and reconstruction of past experience



Decision making and reaction time

Brownian motion and random walks

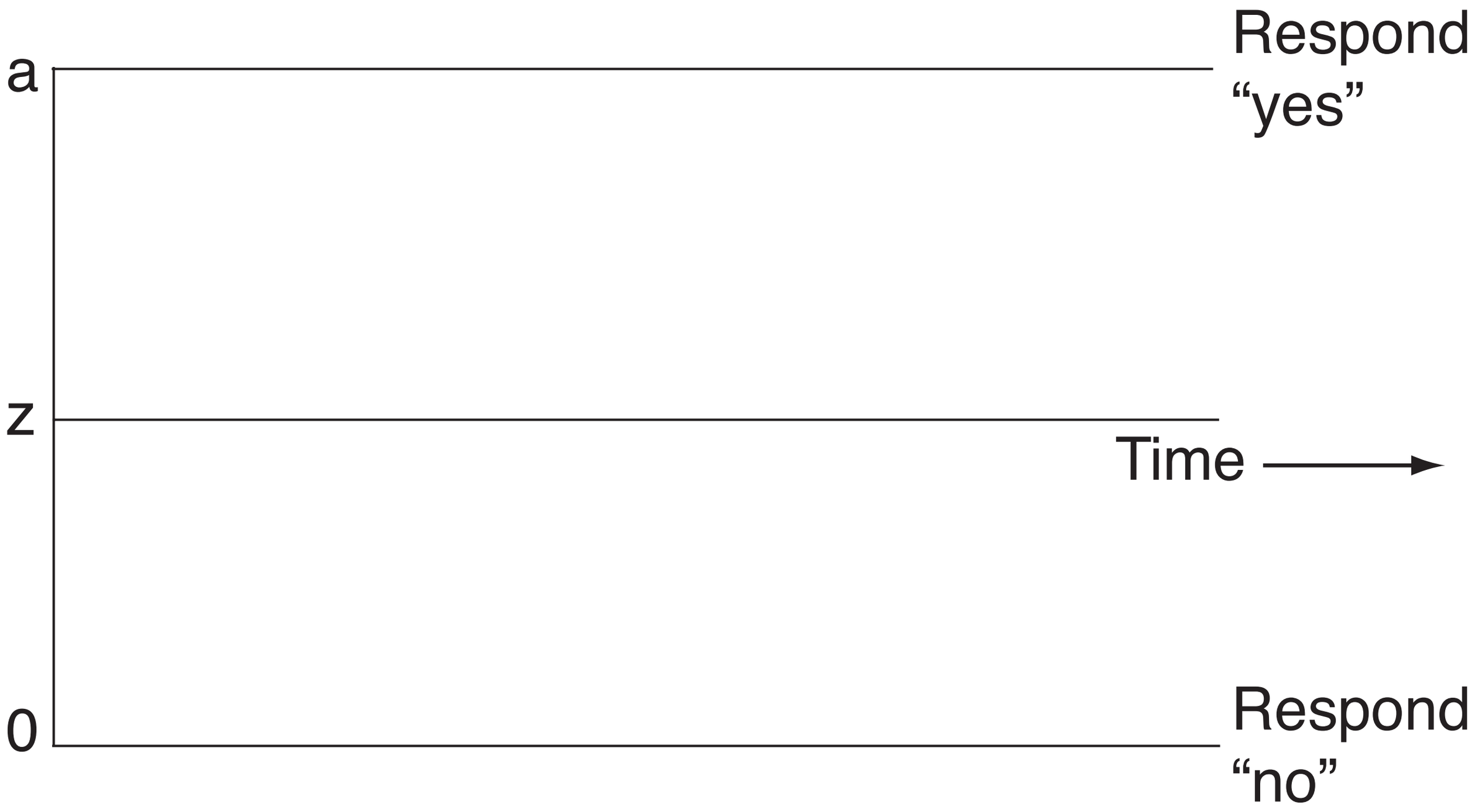


The drift-diffusion model: Evidence plus noise equals noisy decisions!

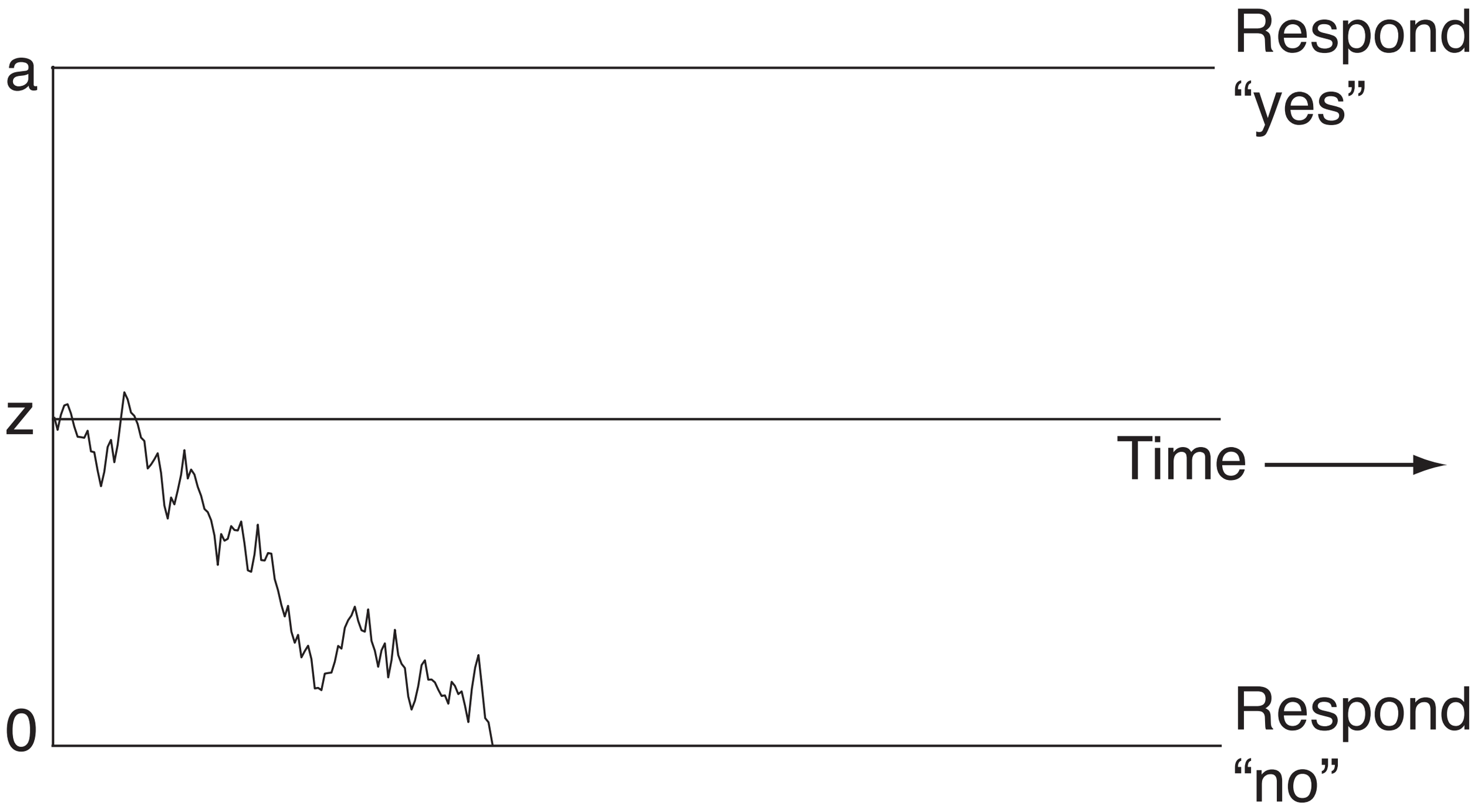
$$s_i = s_{i-1} + \text{evidence} + \varepsilon_i$$

Ratcliff, 1978

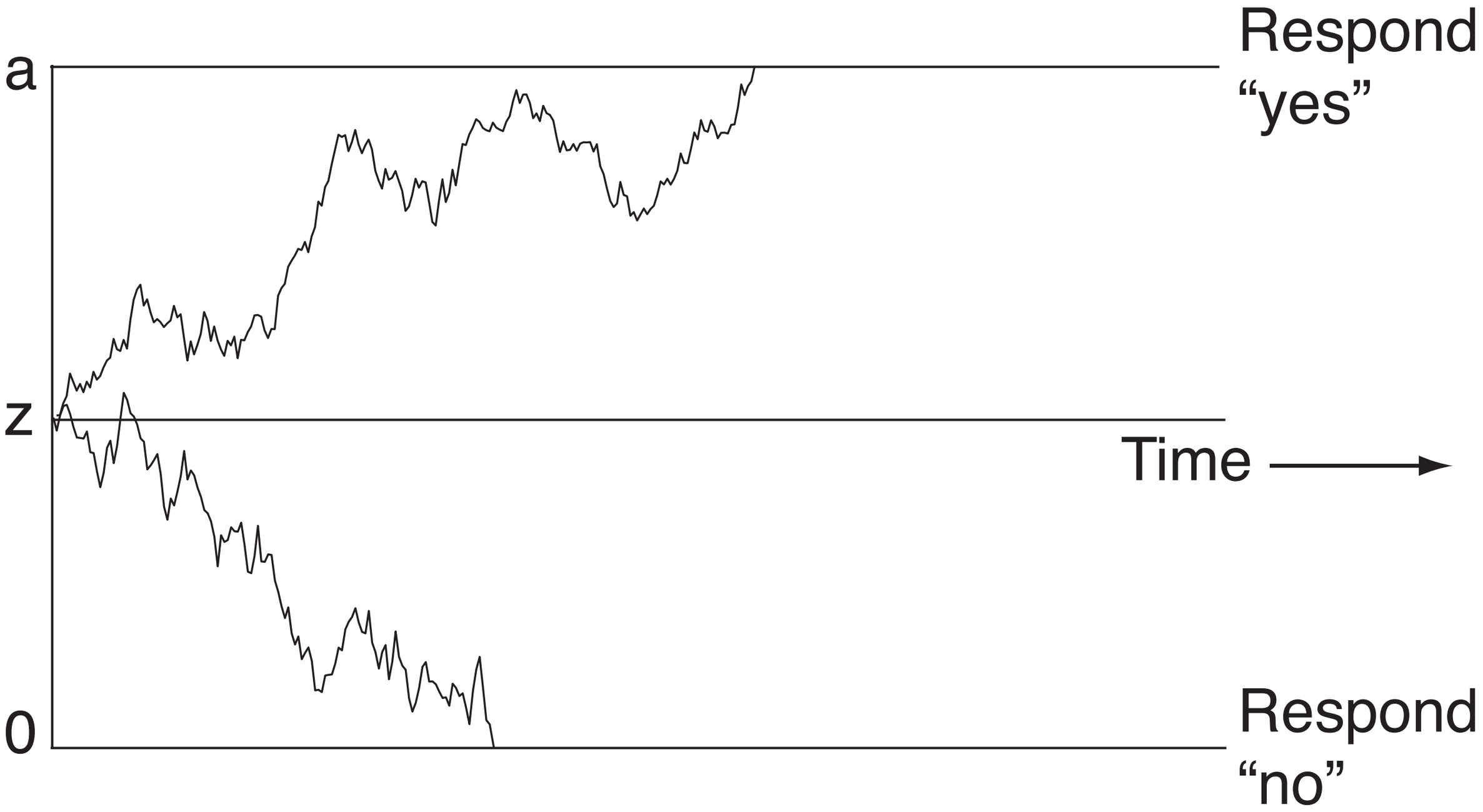
Modeling reaction time

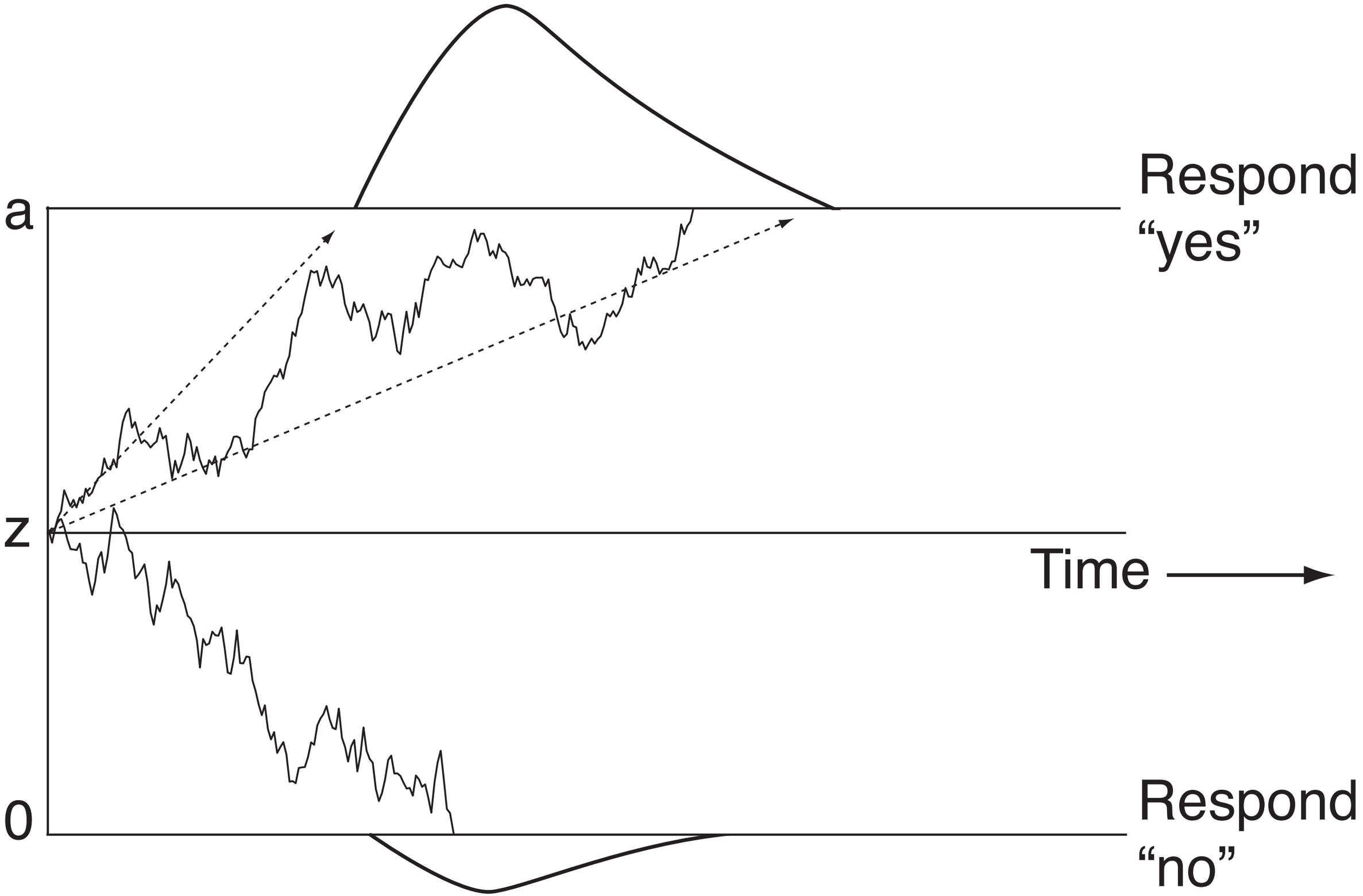


Modeling reaction time

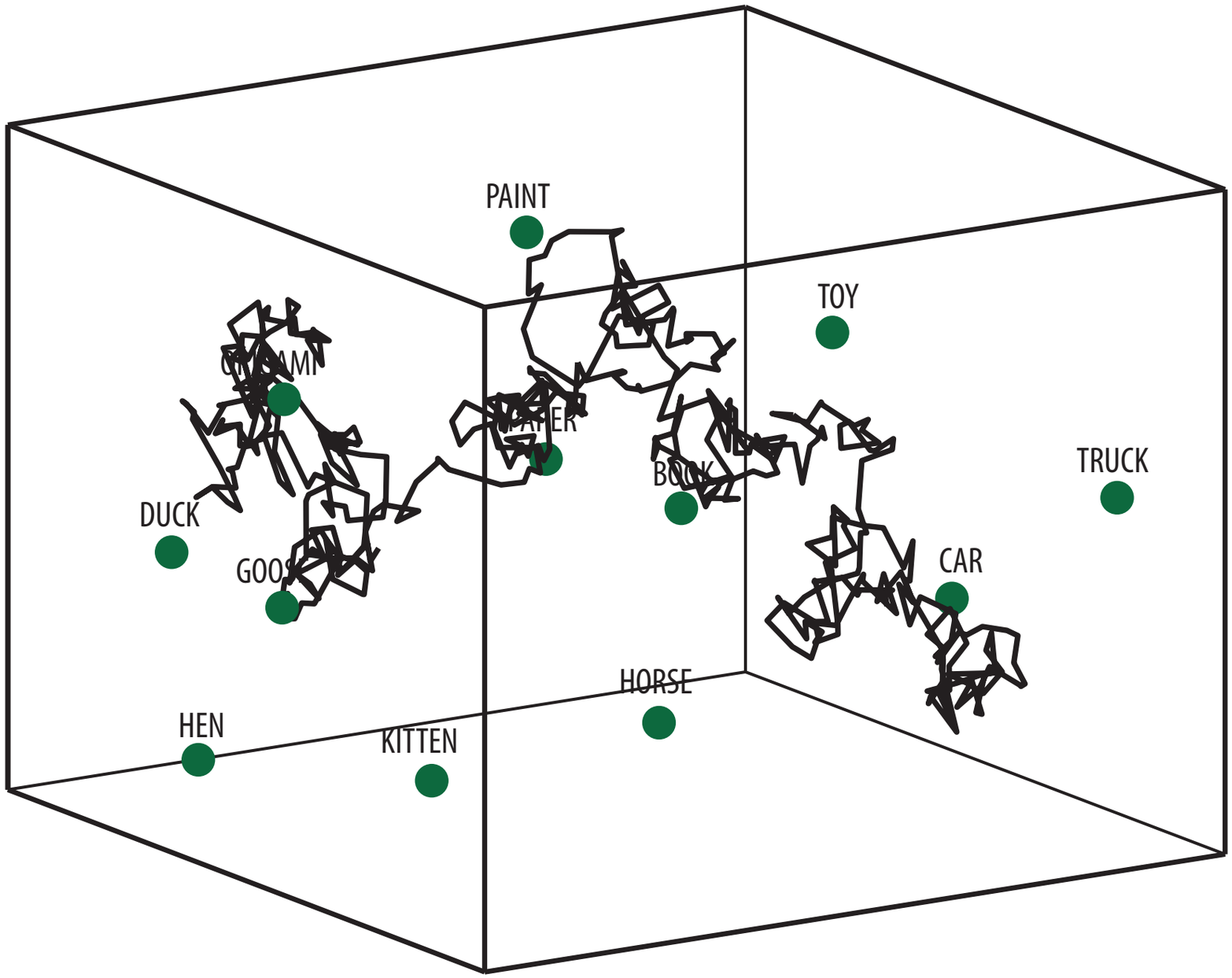


Modeling reaction time




a
z
0
Respond
“yes”
Time
Respond
“no”

Thought trajectories



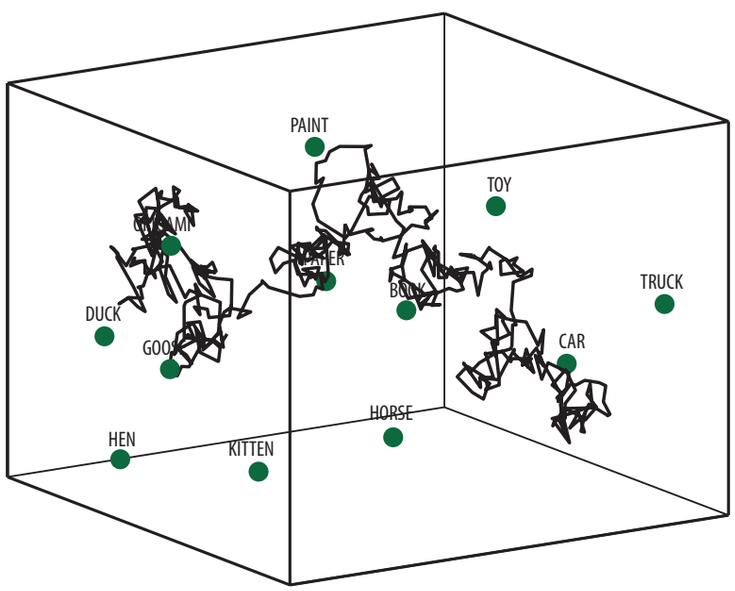
How do our thoughts change over time?

$$\mathbf{t} = \begin{pmatrix} t(1) \\ t(2) \\ t(3) \\ \vdots \\ t(N_{\text{context}}) \end{pmatrix}$$

$$\mathbf{t}_i = \mathbf{t}_{i-1} + \epsilon.$$

Context at time *i*

"noise"



What is context?

- How you feel, emotions
- Scenery
- Who you're with and how you feel about them
- Time of day
- Opinions
- Boredom, hunger
- The weather
- Where you are
- Music in the background
- Recent things you did that you're still thinking about
- Future goals and plans
- Situational understanding

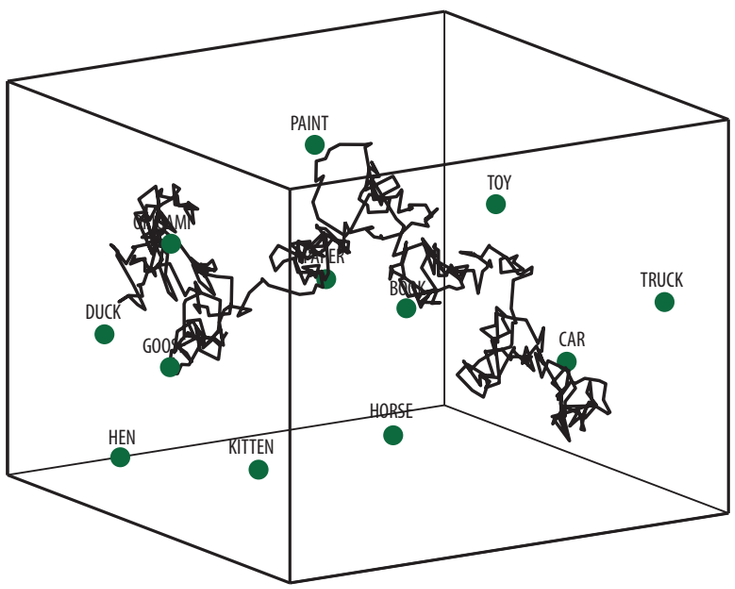
What is context?

$$\mathbf{c}_t = \rho\mathbf{c}_{t-1} + (1-\rho)\mathbf{f}_t$$

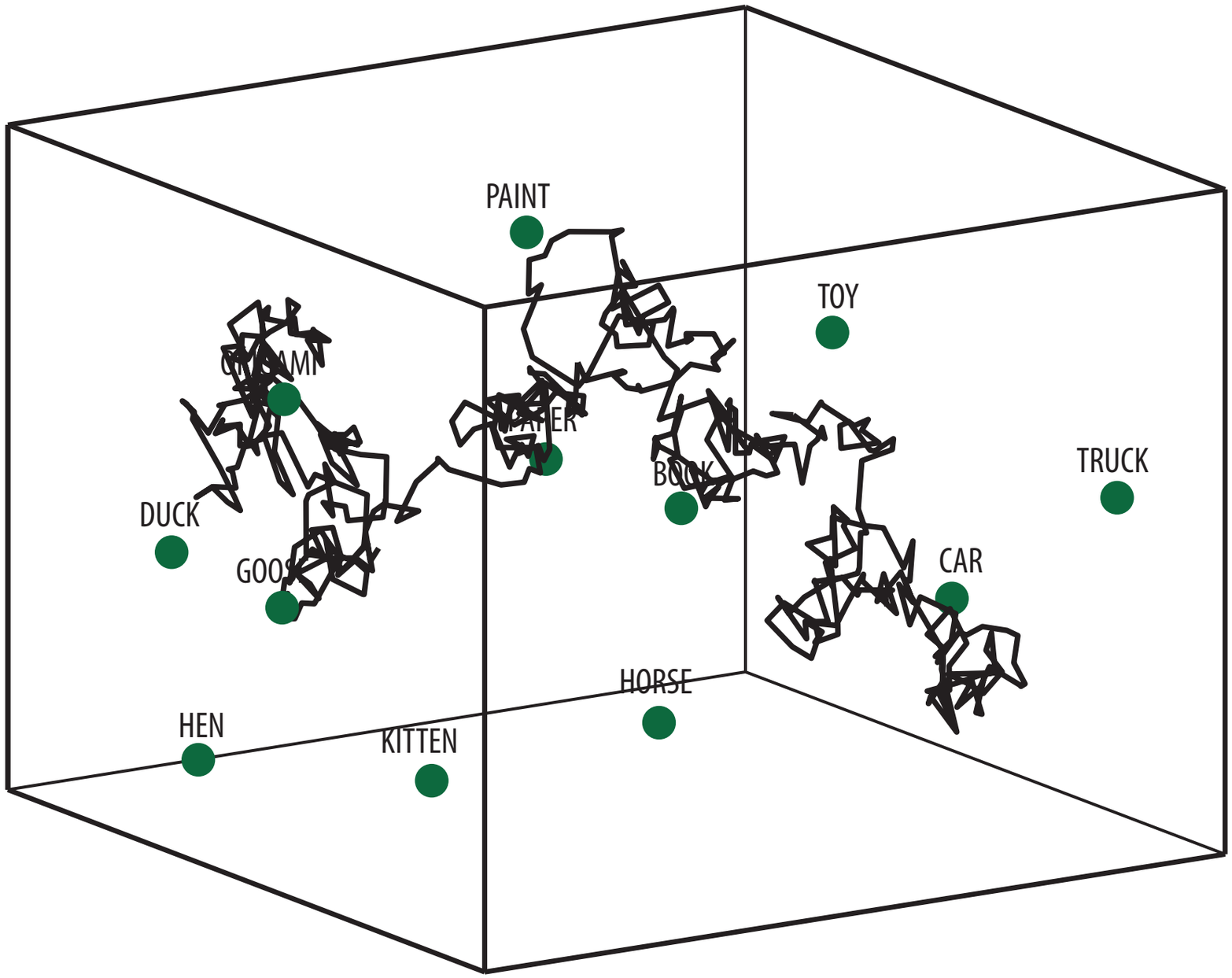
Context at time *t*

Drift rate

New experience at time *t*

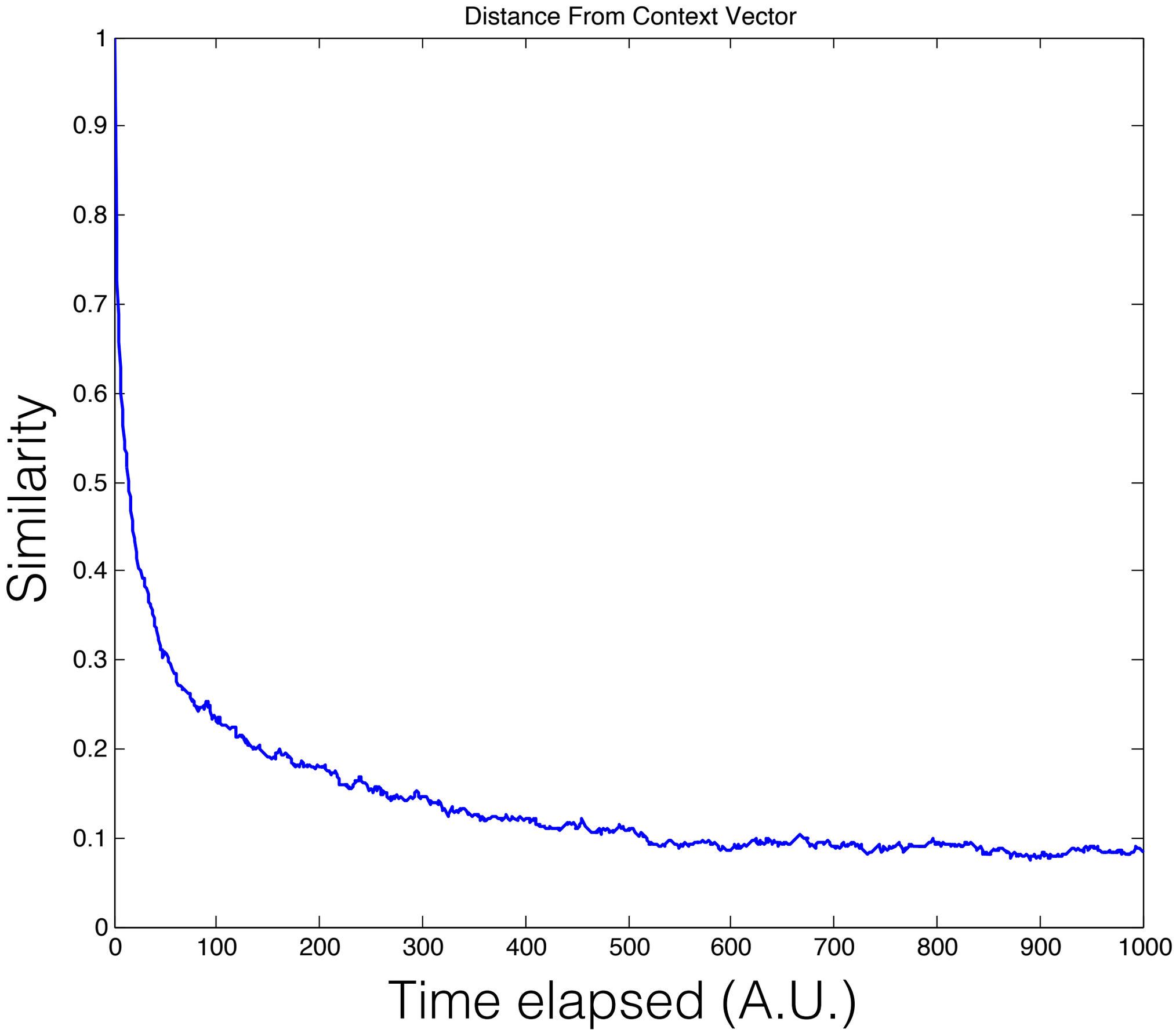


Thought trajectories



Context and time

- Context changes over time
- **Heuristic:** if we compare our current state of context to a previous state, the similarity should reflect how much time has elapsed
- **Prediction:** experiences that manipulate contextual similarity should affect how we judge time


Distance From Context Vector
Similarity
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
100
200
300
400
500
600
700
800
900
1000
Time elapsed (A.U.)

Memory retrieval and context

- When we remember a past experience, we bring back the associated context ("mental time travel")
- This "colors" our current context with thoughts from the past
- This makes our current context more similar to a previous context– this affects how much time we think has elapsed!
- If we "push out" thoughts related to a previous experience/context, we think *more* time has elapsed

Sahakyan and Smith, 2014

What have attribute models given us?

- A way of formally representing (and modeling) complex memories and thoughts: **feature vectors**

- A way of explaining **similarities and differences** between memories and thoughts: we can formalize the statistical structure of the world

- This helps us to better understand recognition memory, and will also help form a foundation for other types of memory