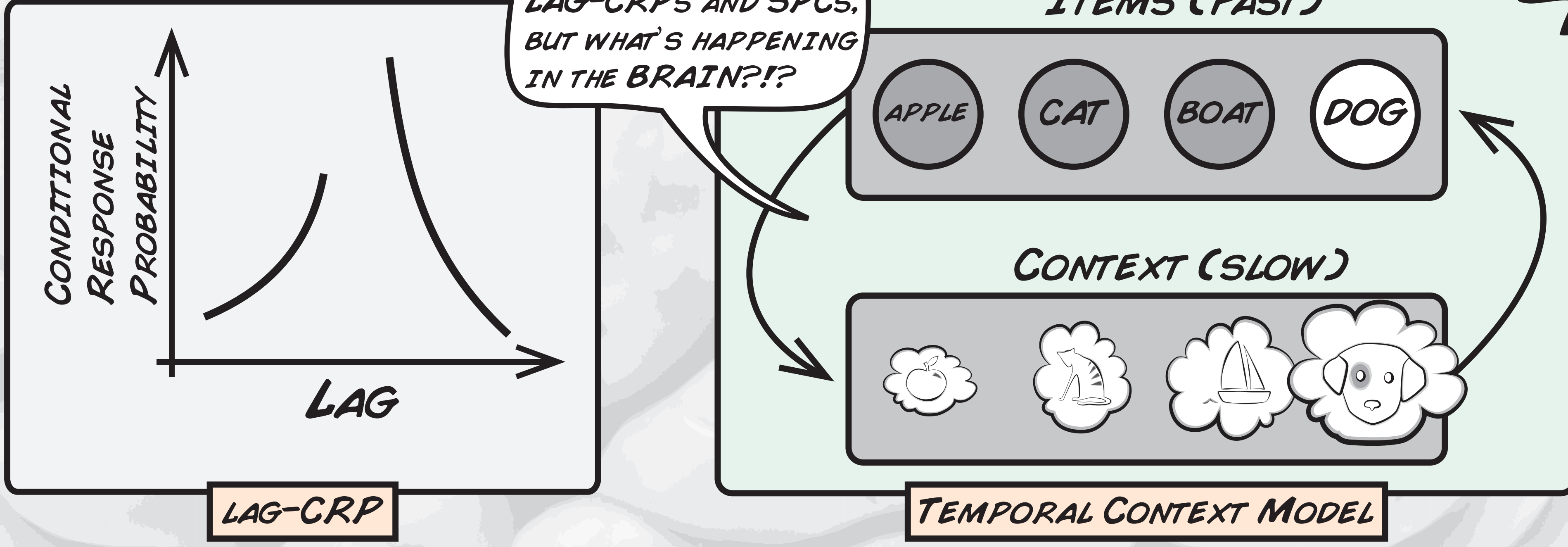# A PROBABILISTIC TEMPORAL CONTEXT MODEL FOR TRACKING MENTAL CONTEXT USING NEURAL AND BEHAVIORAL DATA
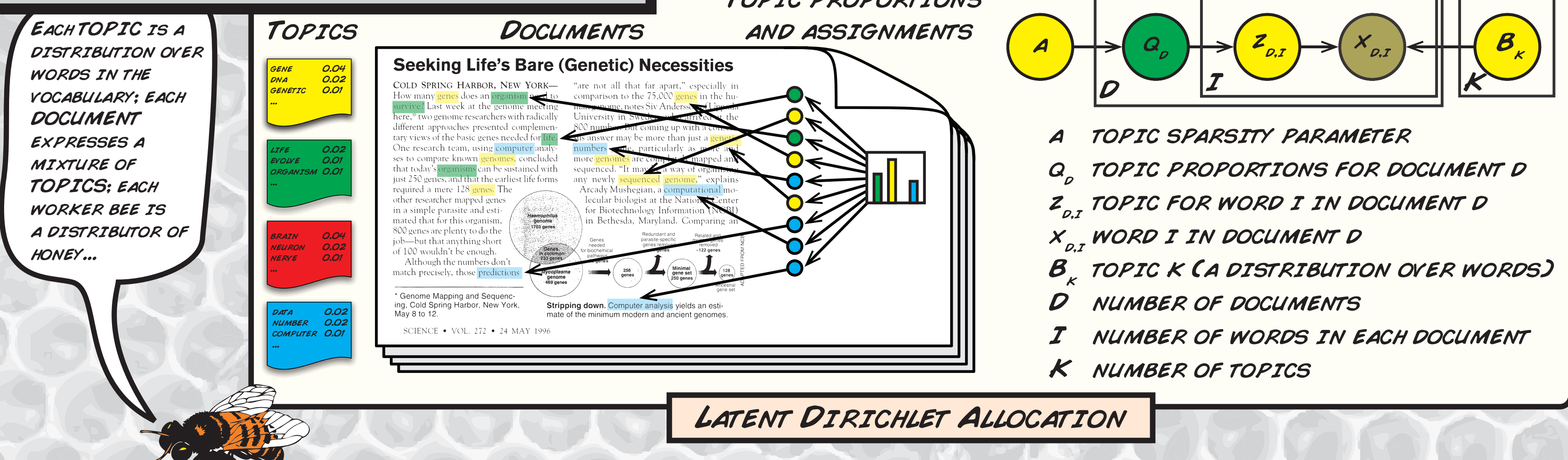
JEREMY R. MANNING
DAVID M. BLEI
KENNETH A. NORMAN

THE AMAZING "CONTEXT TRACKER!"

INTRODUCTION

I CAN UNDERSTAND LAG-CRPs AND SPCs, BUT WHAT'S HAPPENING IN THE BRAIN?!?

ITEMS (FAST)
APPLE CAT BOAT DOG

CONTEXT (SLOW)

CONDITIONAL RESPONSE PROBABILITY — LAG
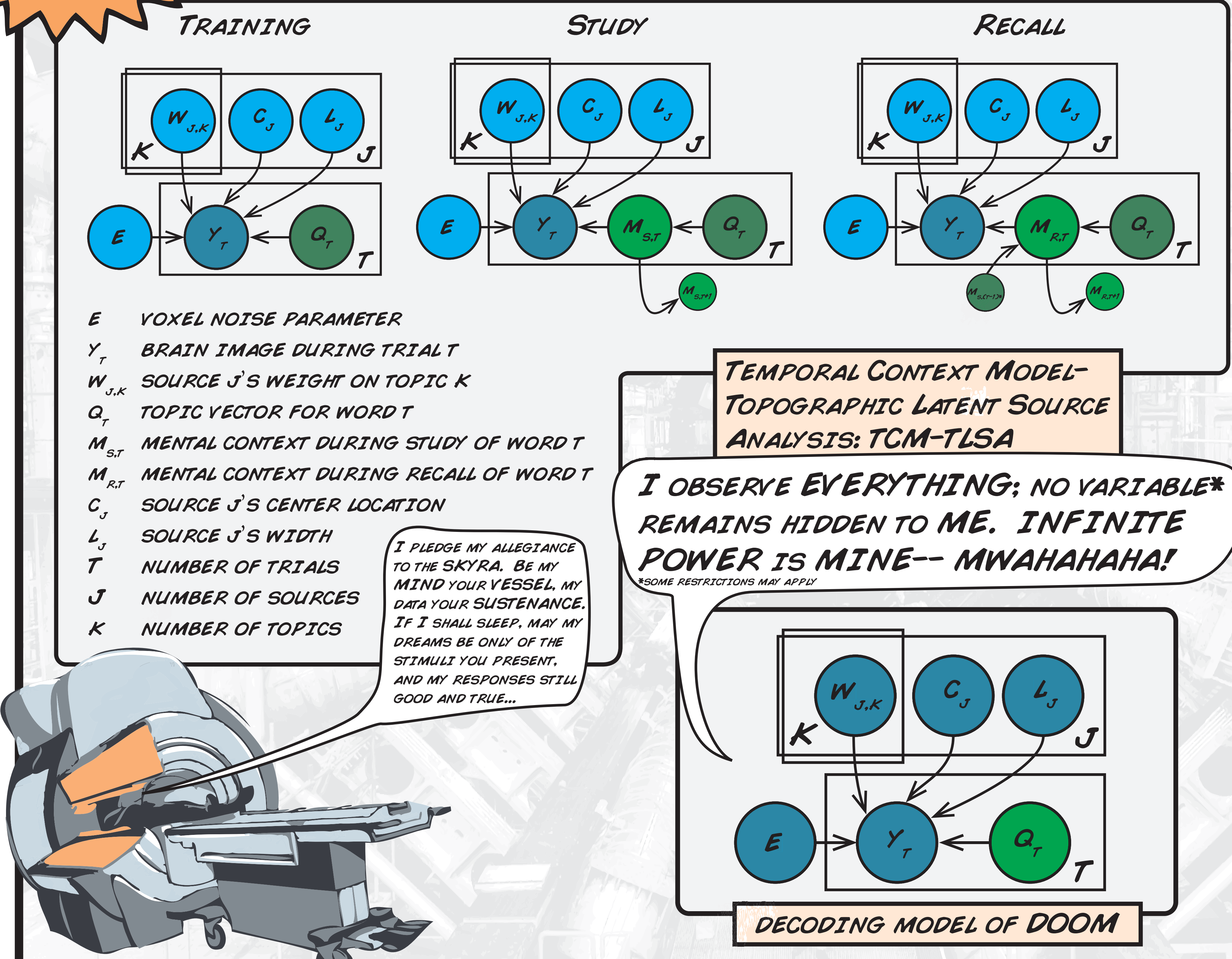
LAG-CRP

TEMPORAL CONTEXT MODEL

DESPITE DEVELOPING SOPHISTICATED BEHAVIORAL MODELS, MEMORY RESEARCHERS ARE STRUGGLING TO UNDERSTAND THE NEURAL UNDERPINNINGS OF EPISODIC MEMORY.

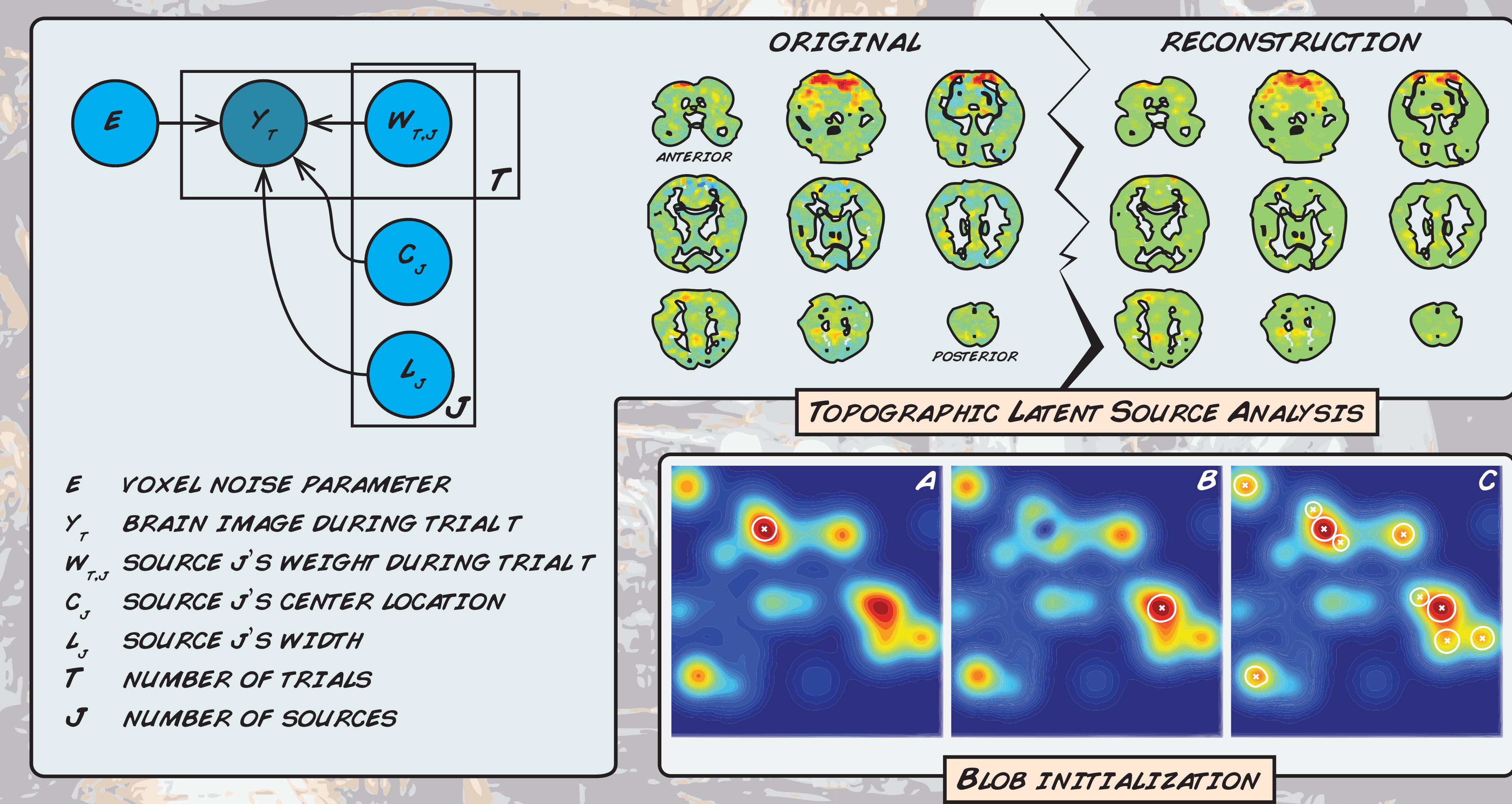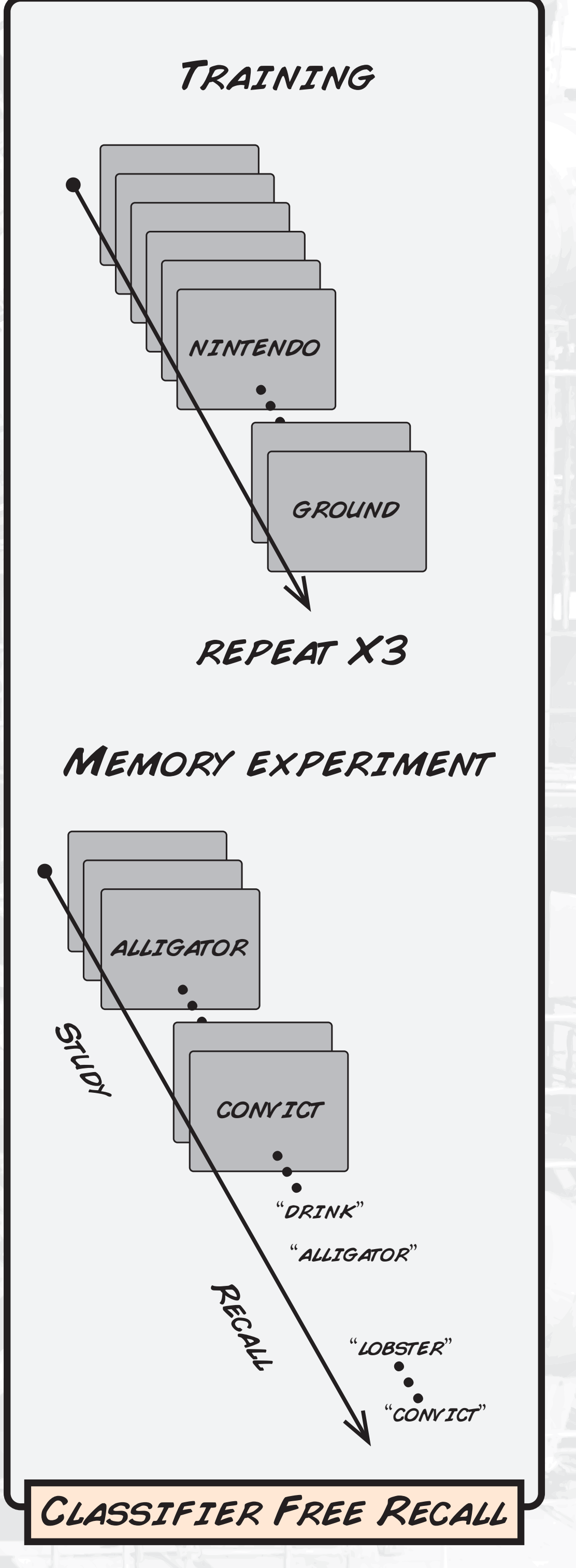MEANWHILE IN A WINDOWLESS OFFICE HIDDEN DEEP WITHIN THE BOWELS OF PRINCETON...

EACH TOPIC IS A DISTRIBUTION OVER WORDS IN THE VOCABULARY; EACH DOCUMENT EXPRESSES A MIXTURE OF TOPICS; EACH WORKER BEE IS A DISTRIBUTOR OF HONEY...

TOPICS DOCUMENTS TOPIC PROPORTIONS AND ASSIGNMENTS

A — TOPIC SPARSITY PARAMETER
Q_D — TOPIC PROPORTIONS FOR DOCUMENT D
$Z_{D,I}$ — TOPIC FOR WORD I IN DOCUMENT D
$X_{D,I}$ — WORD I IN DOCUMENT D
B_K — TOPIC K (A DISTRIBUTION OVER WORDS)
D — NUMBER OF DOCUMENTS
I — NUMBER OF WORDS IN EACH DOCUMENT
K — NUMBER OF TOPICS

LATENT DIRICHLET ALLOCATION

RENEGADE "COMPUTER SCIENTISTS" WORK FEVERISHLY TO DEVELOP MACHINE LEARNERS TO QUICKLY & EFFICIENTLY PROCESS HUGE TEXT CORPORA.

TRAINING   STUDY   RECALL

E — VOXEL NOISE PARAMETER
Y_T — BRAIN IMAGE DURING TRIAL T
$W_{J,K}$ — SOURCE J'S WEIGHT ON TOPIC K
Q_T — TOPIC VECTOR FOR WORD T
$M_{S,I}$ — MENTAL CONTEXT DURING STUDY OF WORD T
$M_{R,I}$ — MENTAL CONTEXT DURING RECALL OF WORD T
C_J — SOURCE J'S CENTER LOCATION
L_J — SOURCE J'S WIDTH
T — NUMBER OF TRIALS
J — NUMBER OF SOURCES
K — NUMBER OF TOPICS

TEMPORAL CONTEXT MODEL—TOPOGRAPHIC LATENT SOURCE ANALYSIS: TCM-TLSA

I OBSERVE EVERYTHING; NO VARIABLE* REMAINS HIDDEN TO ME. INFINITE POWER IS MINE-- MWAHAHAHA!
*SOME RESTRICTIONS MAY APPLY

I PLEDGE MY ALLEGIANCE TO THE SKYRA. BE MY MIND YOUR VESSEL, MY DATA YOUR SUSTENANCE. IF I SHALL SLEEP, MAY MY DREAMS BE ONLY OF THE STIMULI YOU PRESENT, AND MY RESPONSES STILL GOOD AND TRUE...

DECODING MODEL OF DOOM

AMIDST THIS CHAOS, A GROTESQUE HYBRID MODEL IS BORN. NEITHER FULLY MAN NOR FULLY MACHINE, TO THOSE BRAVE SOULS WHO DARE SPEAK OF ITS EXISTENCE, IT IS KNOWN ONLY AS...

TRAINING

NINTENDO
GROUND
REPEAT X3

MEMORY EXPERIMENT
ALLIGATOR
CONVICT
"DRINK"
"ALLIGATOR"
STUDY
RECALL
"LOBSTER"
"CONVICT"

CLASSIFIER FREE RECALL

ORIGINAL   RECONSTRUCTION

ANTERIOR
POSTERIOR

TOPOGRAPHIC LATENT SOURCE ANALYSIS

E — VOXEL NOISE PARAMETER
Y_T — BRAIN IMAGE DURING TRIAL T
$W_{T,J}$ — SOURCE J'S WEIGHT DURING TRIAL T
C_J — SOURCE J'S CENTER LOCATION
L_J — SOURCE J'S WIDTH
T — NUMBER OF TRIALS
J — NUMBER OF SOURCES

A B C

BLOB INITIALIZATION

THE UNSTOPPABLE BRAIN-BLOB GROWS IN [STATISTICAL] POWER; ITS THIRST FOR EVIL KNOWS NO [EVIDENCE LOWER] BOUNDS!

NEXT YEAR...
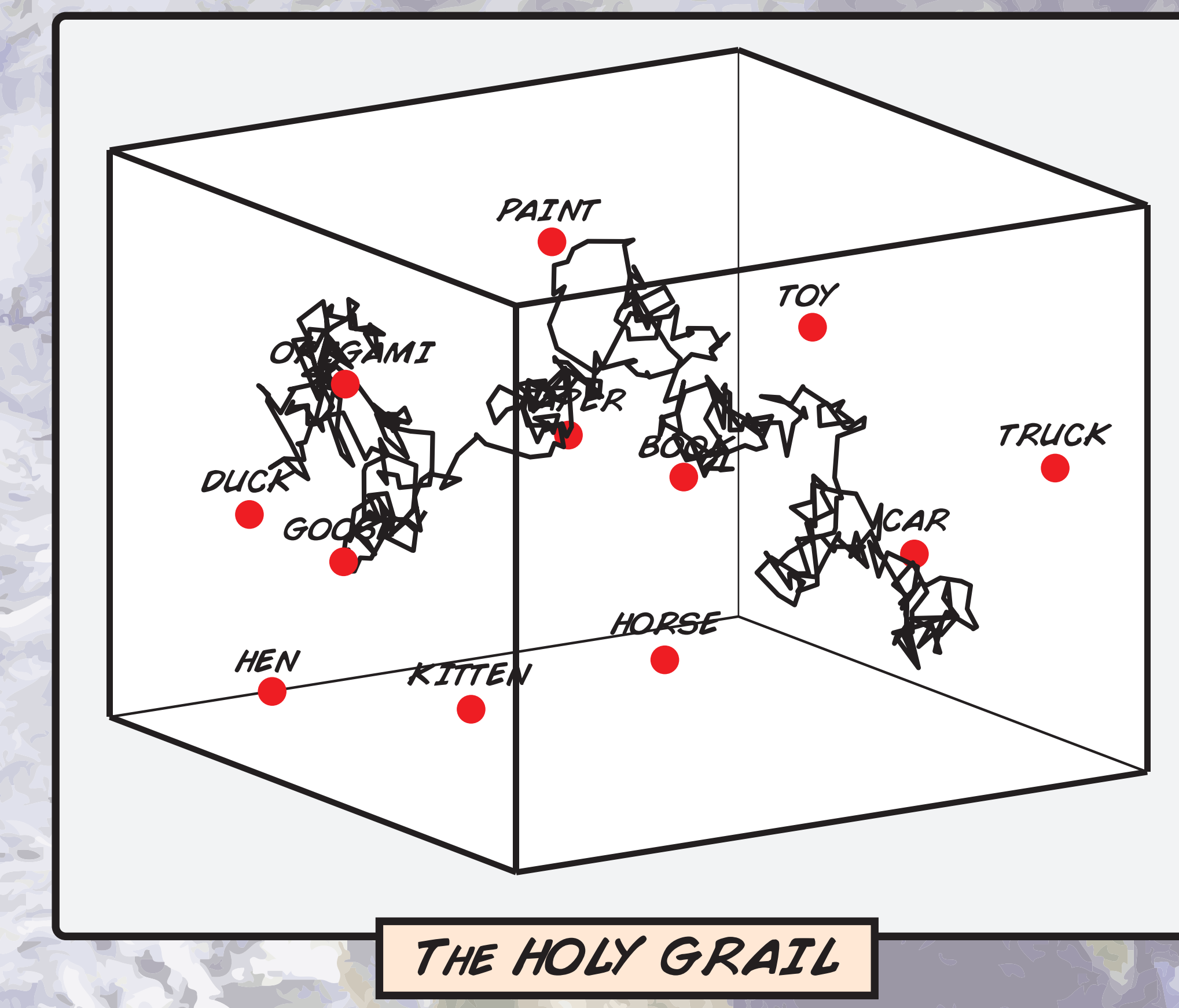
- THE CONTEXT TRACKER PROVIDES A MOMENT-BY-MOMENT ESTIMATE OF THE STATE OF MENTAL CONTEXT DURING AN EXPERIMENT

- THIS ALLOWS RESEARCHERS TO MEASURE HOW CONTEXT DRIFTS IN RESPONSE TO EACH PRESENTED STIMULUS, AND TO OBSERVE HOW MENTAL CONTEXT BEHAVES JUST PRIOR TO RECALL

- WE CAN USE THIS FRAMEWORK TO RESOLVE AMBIGUITIES IN THE BEHAVIORAL DATA AND TO STUDY THE NEURAL BASIS OF CONTEXT AND EPISODIC MEMORY

PAINT TOY TRUCK ORIGAMI BER BOAT CAR DUCK GOOD HORSE HEN KITTEN

THE HOLY GRAIL

IF ONE COULD SOMEHOW HARNESS THE POWER OF THE FLUX CONTEXT-TRACKER...

REFERENCES & ACKNOWLEDGEMENTS

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