Computational Memory Lab
University of Pennsylvania

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Accounting For Short-Term Variability in Human Memory

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Abstract

This study was designed to determine if short-term variability in human memory (within minutes or hours) can be significantly accounted for by external environmental factors.

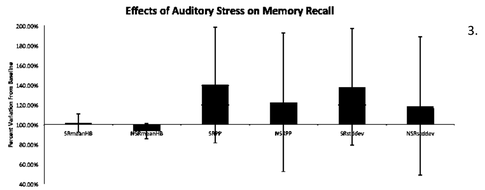
If so, this would suggest that there do not exist any endogenous states of the brain that are better suited for memory than others, and that the brain has a constant innate memory capacity that is affected by environmental changes.

Participants were situated in a room without external stimuli and distractions while completing a free recall experiment to measure changes in their memory abilities throughout the task.

This variance was then analyzed to determine if a model of external variables could be generated to account for a significant portion of its existence.

Introduction

Much prior research has been done to account for changes in an individual's memory ability over long periods of time. Additionally, studies have investigated the effects of different environmental variables on memory**. If nearly every possible *environmental* cause of fluctuation in a person's memory were accounted for, would we still observe variability?**



Prior studies, such as one conducted at the Rotman Research Institute of Baycrest[1.] showing that auditory stimuli during encoding experiments impair memory, have repeatedly demonstrated the detrimental effects of external stimuli on recall abilities.

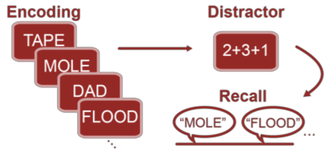
Memory fatigue due to repetitive recall tasks within a short period of time is an expected cause of variability in recall performance.

Studies have shown that words with a relatively higher frequency in the English language are more likely to be recalled by a participant in a memory task than words that are less common[2.].

Other qualities about the words presented in a free recall task can also influence the strength of the word in memory, including the words' concreteness and emotional valence.

Methods and Materials

Our experiment eliminates as many external distractions as possible, with a sound-proof, temperature-controlled room devoid of visual distractions.



- Each subject performs **24 ninety-minute sessions**, with each session consisting of **24 lists** of **24 words each**.
- Subjects freely recall as many words as they remember after a distractor.

Results

Each subject's sessions were analyzed to determine range of list-level performance. These ranges were then analyzed by a multiple regression model of external variables.

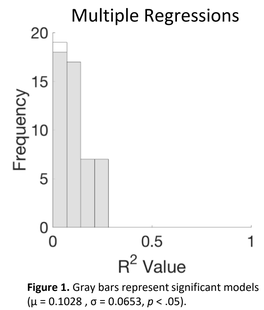


Figure 1. Gray bars represent significant models ($\mu = 0.1028$, $\sigma = 0.0653$, $p < .05$).

- The **average range of probability of recall** for lists within one session was 0.557 for all participants.
- A **multiple linear regression model** was created for each participant in the experiment to regress external variables such as list number and word frequency by probability of recall.
- Subject models were then used to calculate a **predicted P_{rec}** for each list based on the variables.
- Average variability, or range of list performance, was reduced to 0.543 by the predictive models, which is a **2.5% reduction**.

Table 1. Multiple Regression Variables.

	Mean *β*	SD *β*
Session Number (1-24)	-0.013	0.029
List Number (1-24)	-0.158*	0.014
Average Frequency[2.]	0.019*	0.007
Emotionality[4.]	-0.005	0.005
Concreteness	0.004	0.006

Note: *$p < 0.05$

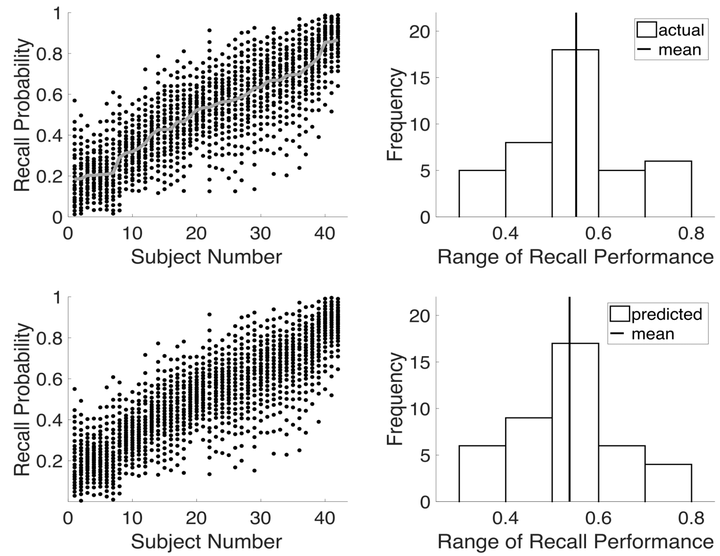


Figure 2. Multiple Regression Variables.

Discussion

The model took into account almost every remaining external variable not accounted for by the experiment, but did not significantly reduce variability.

This suggests that independent of external environmental and situational changes**, the brain biologically fluctuates between relatively better and worse states for memory**, resulting in the variability seen in memory performance.

The results of this study provide insights into the biological phenomena present memory systems in the brain, and depict a reasonable and actual basis for research being done to intracranially account for and control variability in human memory.

Works Cited

1. Craik, F. (2014). Effects of distraction on memory and cognition. *Frontiers in Psychology* 5.
2. Lohnas, Lynn J., and Michael J. Kahana. "The Word Frequency Effect in Recall and Recognition." *Journal of Experimental Psychology: Learning, Memory, and Cognition* 39.6 (2013): 1943-946. Web.
3. Nelson, Tyler S., and David W. Pittman, Ph.D. "Auditory Stress and Short-Term Memory Recall." *Wofford College's Program in Neuroscience* (2016): n. pag. Web.
4. Long, N., Danoff, M., & Kahana, M. (2015). Recall dynamics reveal the retrieval of emotional context. Psychonomic Bulletin & Review Psychon Bull Rev, 1328-1333

Mentor: Michael J. Kahana, Ph.D. *Department of Psychology.* **Note:** The results of this project were presented to the director of DARPA.