PSYC 2530: Memory I

Early approaches

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Reminders

Reading is Chapter 8 on Memory I

Roadmap

1 Questions about memory

2 Early memory research

3 Memory as information processing

4 Multi-store model

Questions about memory

What is it like for you to remember something from your past?

How many events from your experience can you remember?

Why can you remember something from years ago, but forget new information from seconds ago?

How do you preserve your experiences so that they can be remembered later on?

Why is it sometimes hard to remember something, but later the answer pops in your head?

How can you improve your memory?

How can you forget things you don't want to think about?

What other animals besides humans have memories?

How are memories encoded, stored, and retrieved in the brain?

How do people use their environment to help them remember things?

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Early memory researchers

Hermann Ebbinghaus

Sir Frederick Bartlett

Bluma Zeigarnik

Hedwig von Restorff

Hermann Ebbinghaus (1850-1909)

Conducted some of the first experimental investigations of human memory

1885 - english translation from German, "Memory: A Contribution to Experimental Psychology"

What did Ebbinghaus do?

Systematically measured rates of learning and forgetting

Conducted single-subject research on himself

Invented use of nonsense material (CVC syllables)

Big Questions

How do people learn new associations?

What happens to new learning with delays between practice? (forgetting)

Issues

People already have many existing associations from their experience…

How to study learning of new associations?

Methodological insight

Adopt a task with very little pre-existing familiarity

Ebbinghaus devised a serial learning task to measure how long it took to recite of a list of items from memory.

He used artificial stimuli so that pre-existing familiarity with the items would not interfere with the learning process.

Nonsense syllables

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	HOZ	VUK	JAL	ZIW	VIW	SAN	WAJ	XIQ	ZUC	RIR	XOQ	GEV	RIZ
2	DEH	TIJ	MUL	COF	KAK	SIW	WOV	ZOX	WUL	DUL	CEW	DUV	MIW
3	BOQ	YEL	QOR	KOM	POF	LIF	WOC	XUN	JUH	MUK	VIY	GIZ	KUD
4	JOH	RER	FEV	JUQ	JIM	MEV	DIQ	GIS	GEZ	FUH	NAQ	TUZ	LIM
5	VOZ	ROR	VOQ	WAZ	ZUD	WUC	KUL	QOP	TES	JOS	BIQ	HOV	SAK
6	YIC	DAC	JOH	CUL	LUQ	TIH	DAR	ZID	WEV	YAJ	REH	HOS	BAC
7	WIQ	RIT	HEC	NIY	FEG	TOJ	JIT	QUN	WUG	CAJ	VUN	WUR	ZUV
8	ZEF	XUV	WEY	YAV	KIQ	QOB	FEQ	JAZ	DIJ	QUS	GUD	QAB	LEW

Ebbinghaus's task

Ebbinghaus' task involved learning lists of nonsense syllables

Two basic phases:

1. Learning phase
2. Re-learning after a delay

Modern Replication

Murre, J. M. J., & Dros, J. (2015). Replication and Analysis of Ebbinghaus' Forgetting Curve. PLOS ONE, 10(7), e0120644. https://doi.org/f7vfcn

one-time perfect

Learning phase: practice reciting a row until it is recited perfectly one time, then move to next row

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	HOZ	VUK	JAL	ZIW	VIW	SAN	WAJ	XIQ	ZUC	RIR	XOQ	GEV	RIZ
2	DEH	TIJ	MUL	COF	KAK	SIW	WOV	ZOX	WUL	DUL	CEW	DUV	MIW
3	BOQ	YEL	QOR	KOM	POF	LIF	WOC	XUN	JUH	MUK	VIY	GIZ	KUD
4	JOH	RER	FEV	JUQ	JIM	MEV	DIQ	GIS	GEZ	FUH	NAQ	TUZ	LIM
5	VOZ	ROR	VOQ	WAZ	ZUD	WUC	KUL	QOP	TES	JOS	BIQ	HOV	SAK
6	YIC	DAC	JOH	CUL	LUQ	TIH	DAR	ZID	WEV	YAJ	REH	HOS	BAC
7	WIQ	RIT	HEC	NIY	FEG	TOJ	JIT	QUN	WUG	CAJ	VUN	WUR	ZUV
8	ZEF	XUV	WEY	YAV	KIQ	QOB	FEQ	JAZ	DIJ	QUS	GUD	QAB	LEW

Re-learning after delay

In the second phase, each row was re-learned after a delay. The delays were 20 minutes, 1 hour, 9 hours, or 1, 2, 6, or 31 days.

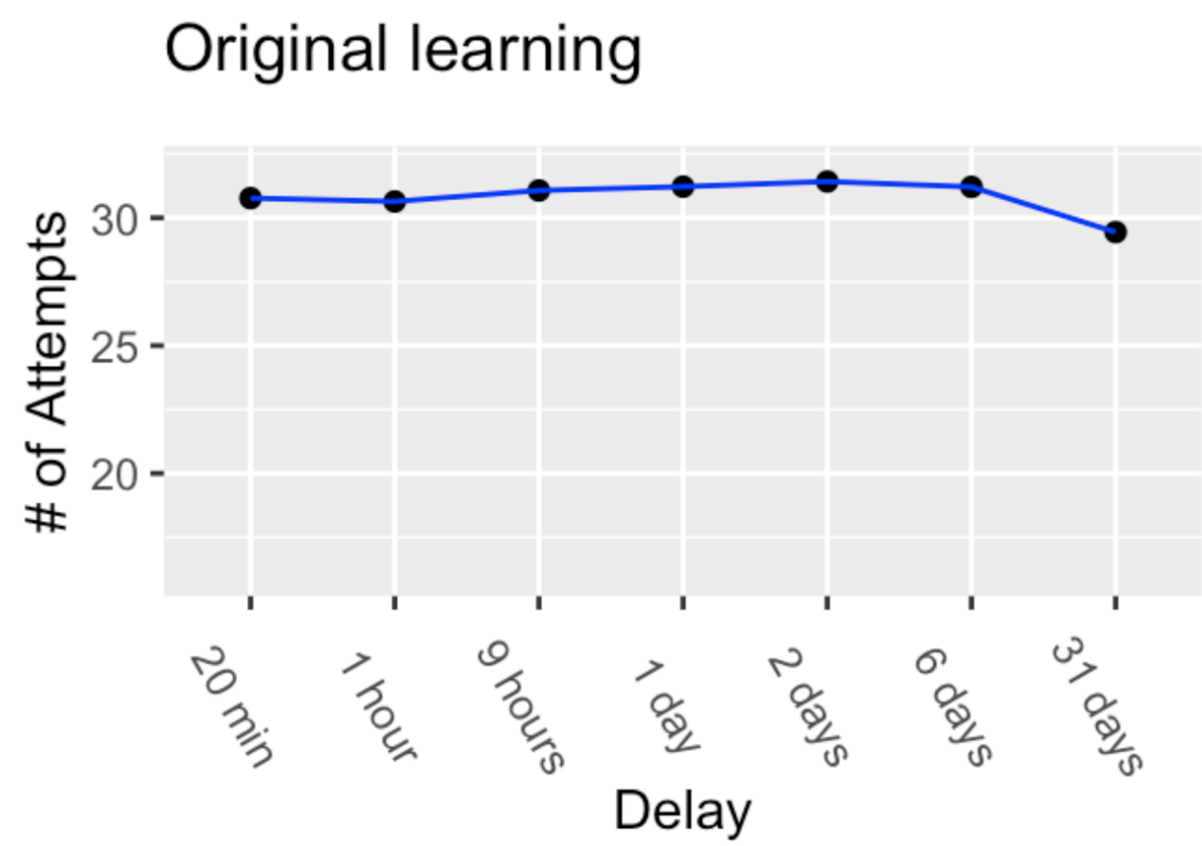
After each delay period, rows were shown again and relearned.

The number of relearning attempts to get to another “one-time perfect” recitation was also measured.

Original learning

How many practice attempts were necessary to memory a row of nonsense syllables?

The blue line shows that an average of 30-32 practice attempts were needed to memorize each row



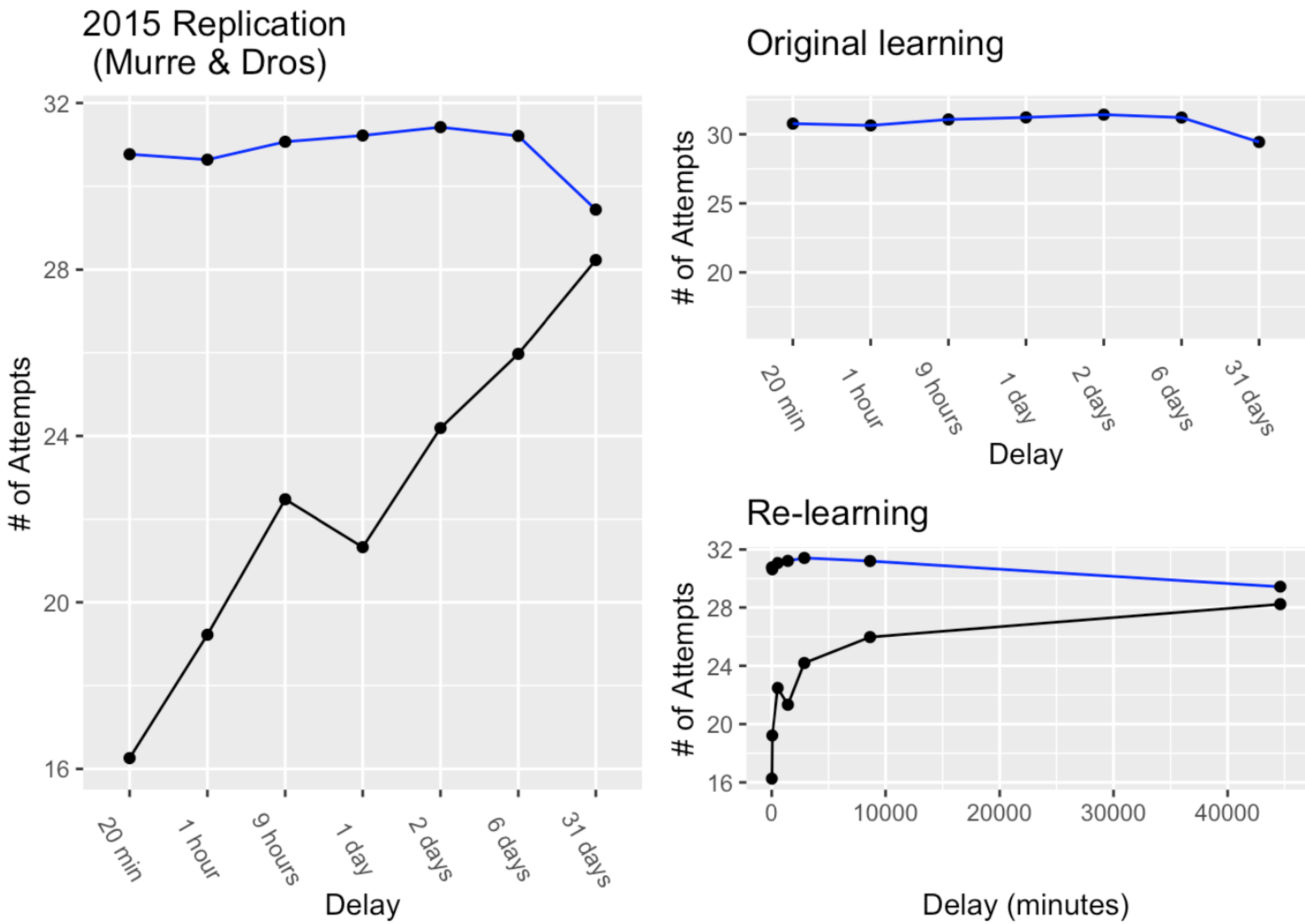
Data from Murre & Dros, 2015

Savings in Re-learning

How many attempts were required to re-learn a list after different delays?

The delays were 20 minutes, 1 hour, 9 hours, or 1, 2, 6, or 31 days.

Results



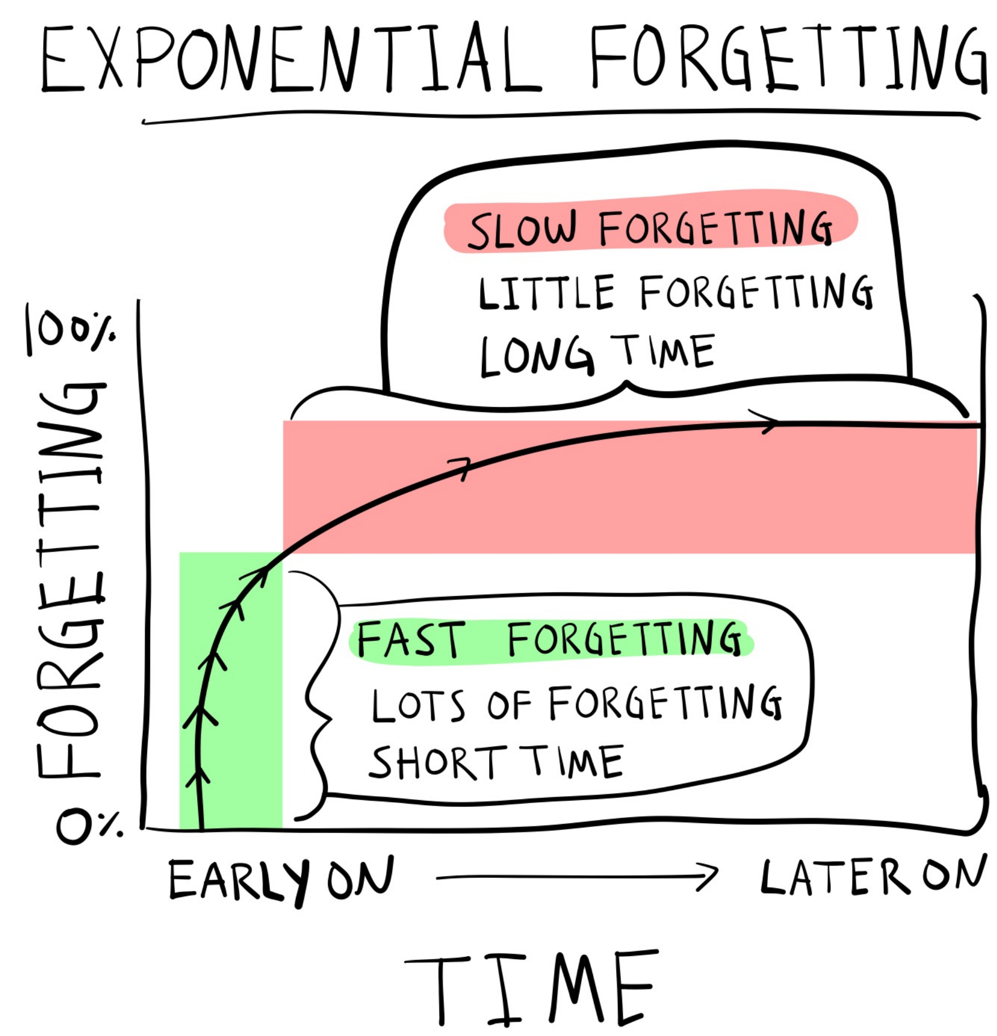
2015 Replication
(Murre & Dros)
# of Attempts
32
28
24
20
16
20 min
1 hour
9 hours
1 day
2 days
6 days
31 days
Delay
Original learning
# of Attempts
30
25
20
20 min
1 hour
9 hours
1 day
2 days
6 days
31 days
Delay
Re-learning
# of Attempts
32
28
24
20
16
0
10000
20000
30000
40000
Delay (minutes)

Exponential forgetting

Ebbinghaus was the first show evidence for exponential forgetting across delays

Most forgetting occurred immediately after learning, and the rate of forgetting slowed down as delay increased

"Exponential forgetting is like going to Las Vegas and spending most of your money on the first day, and then losing the rest of it slowly over the next week."

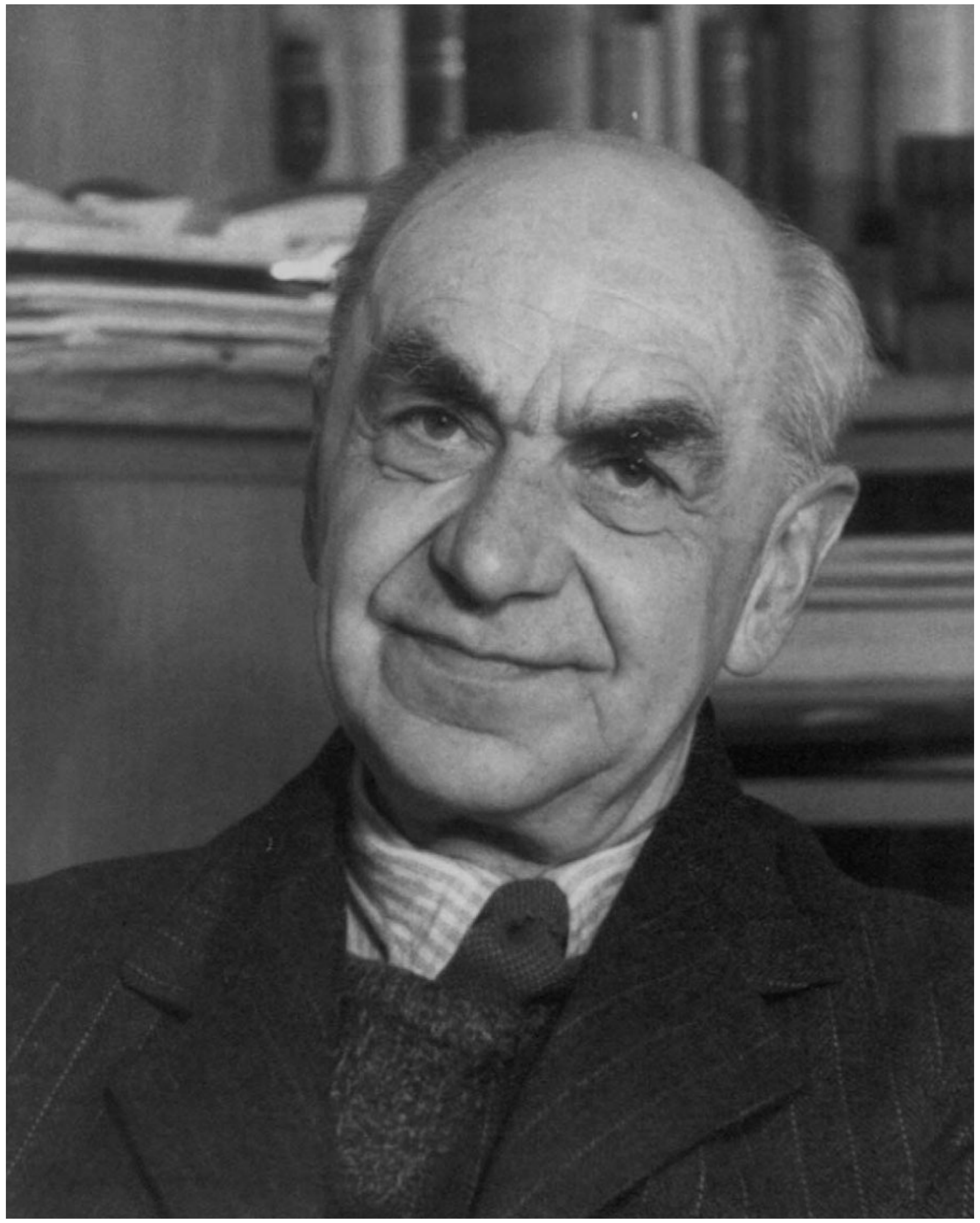


Sir Frederick Bartlett (1886-1969)

British Psychologist

Published book "Remembering" in 1932

Reconstructionist view of memory



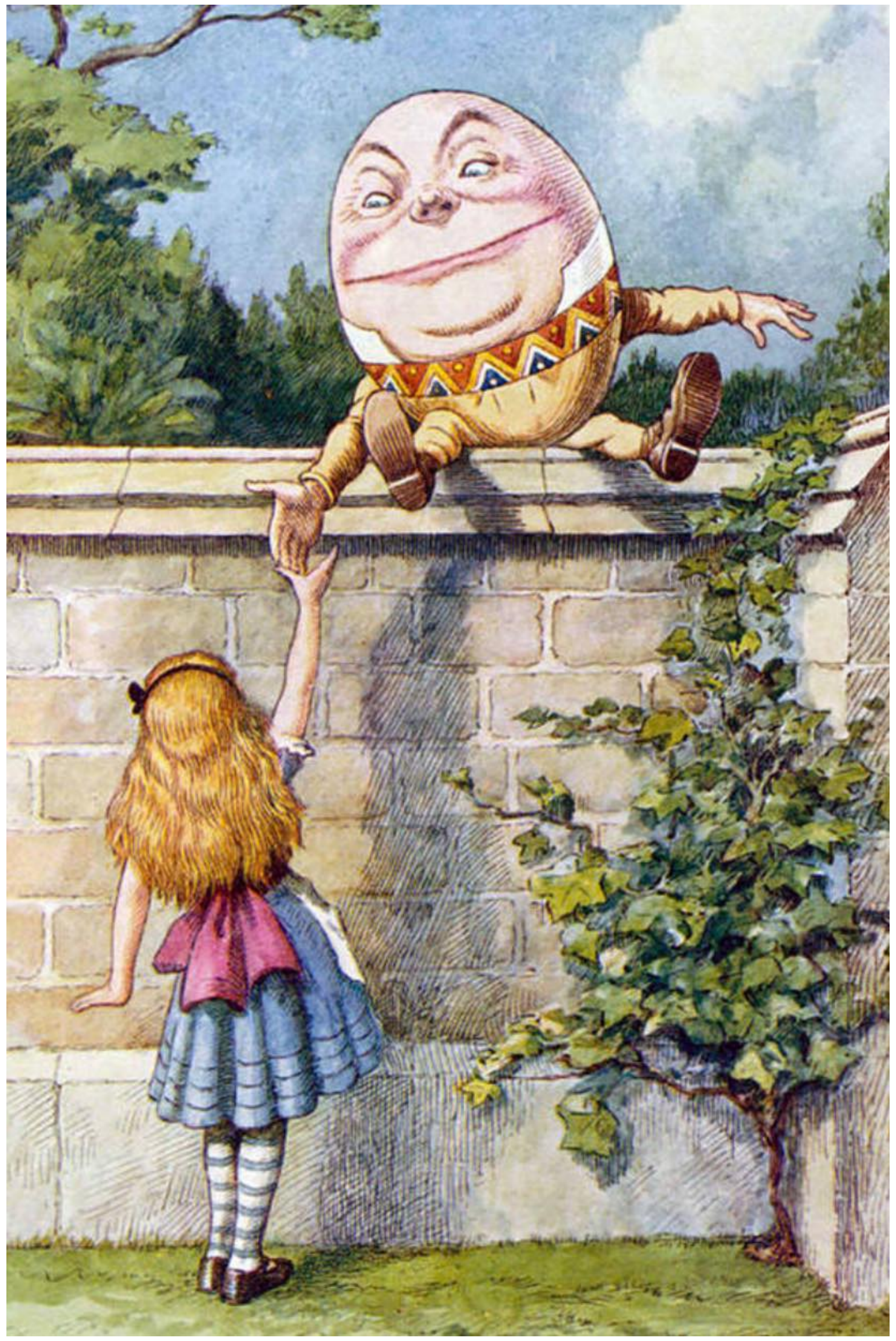
Memory metaphors

1. Memory is a file drawer
2. Memory is a camera
3. Memory is a bent-wire

Memory as “RE-” Membering

Memory is “Humpty-Dumpty”

Memory as a process of re-constructing, or actively putting back together



Big questions

How do people reconstruct a prior memory?

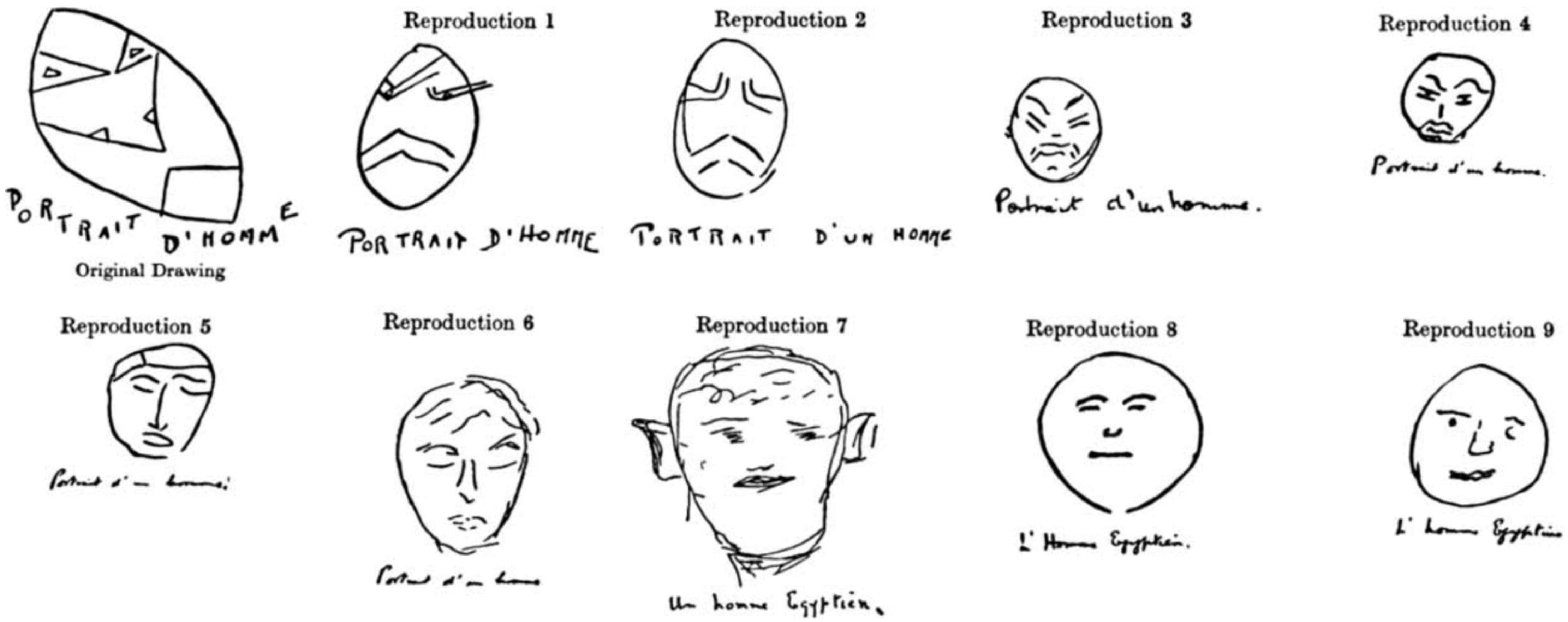
How does memory change over successive re-memberings?

Method of Serial Reproduction

Bartlett conducted experiments that involves two general phases:

1. Encoding/learning of some information
2. Reproduction phases: Had people reproduce the information from memory, many times over

L’Portraite D’homme



Bartlett’s Schemas

Bartlett suggested that remembering processes are guided by general schemas

People may distort their original experiences toward a schema

Reproducing Bartlett

Carbon, C.-C., & Albrecht, S. (2012). Bartlett's schema theory: The unreplicated "portrait d'homme" series from 1932. Quarterly Journal of Experimental Psychology, 65(11), 2258–2270. https://doi.org/gjs5bh

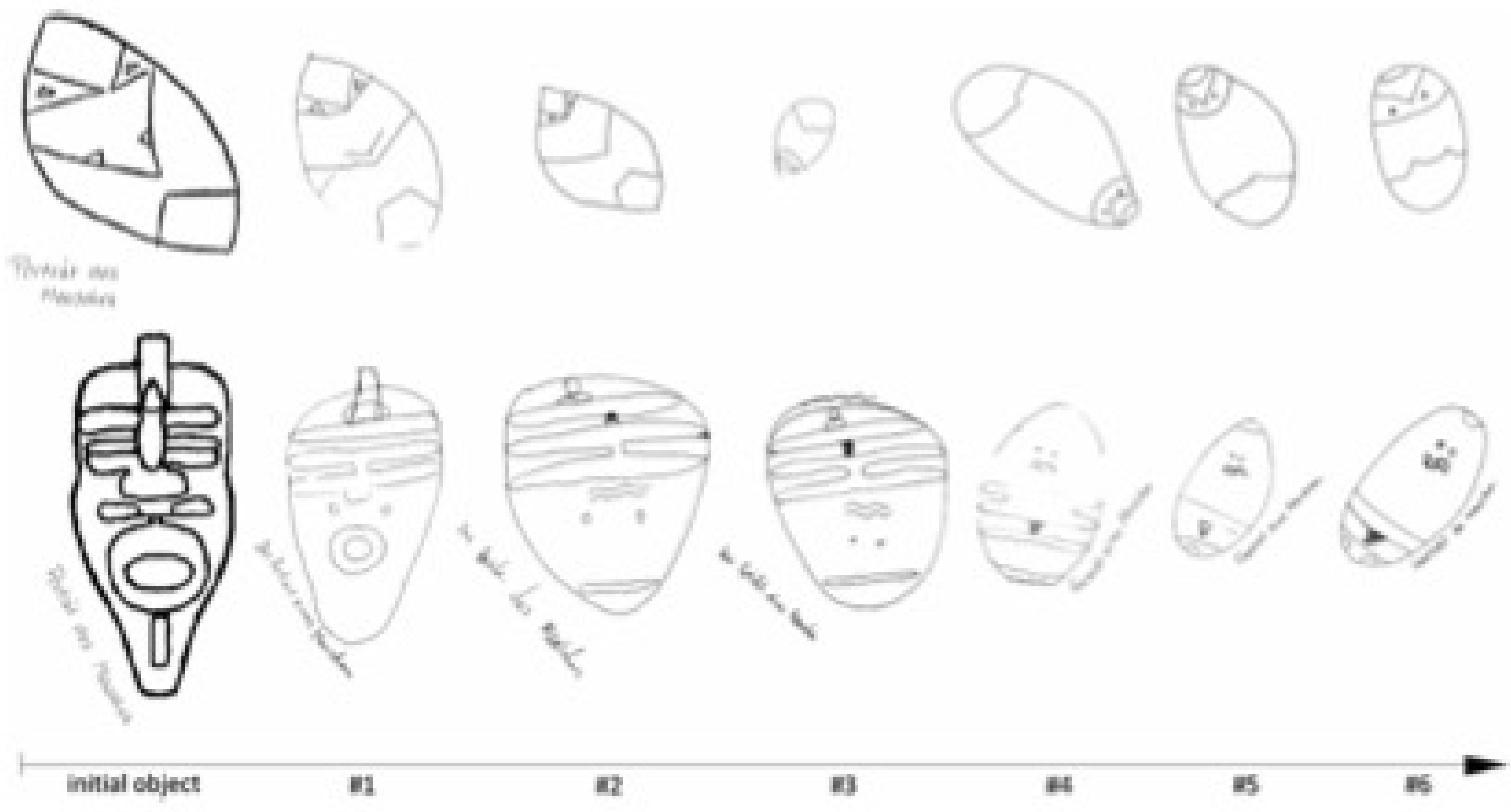


Figure 5. *Typical outcomes of the experiments.*

Memory distortions

Although some of Bartlett's findings may not stand the test of time, there are many reproducible findings showing that memory can be distorted in interesting ways.

So, even though memory reconstruction may not always head toward a schema, memory does appear to involve some kind of constructive process capable of returning accurate and distorted impressions of past experiences.

Bluma Zeigarnik (1901-1988)

Early memory researcher

“to-do” list effect

Phenomenon

Zeigarnik investigated an apparent phenomenon showing that uncompleted tasks are remembered better than completed tasks

Method

Participants were given a variety of tasks that took about 3- 5 minutes to complete (math, drawing, threading a needle).

Manipulation:

Partway through some of the tasks, she interrupted people and asked them to start on a new task.

At the end of the experiment, the participants had completed some of the tasks, and others remained incomplete.

Results

Zeigarnik then had participants recall all of the tasks.

Across several experiments she reliably found that people recalled more of the uncompleted tasks than the completed tasks.

One explanation was the goal to a complete a task created psychological tension that could only be resolved by completing the task. This goal-based tension is not resolved when a task is interrupted, and leads to differences in memory completed and uncompleted tasks.

Replication attempts

In 1968, Van Bergen published several replication attempts and found that her participants did not show systematic differences in their memory for completed and uncompleted tasks…

Hedwig von Restorff (1906-1962)

Applied Gestalt theory figure/ground concepts to memory

Demonstrated role of distinctiveness in memory

Big Questions

What makes some information more memorable than others?

Is memory better for things that “stand-out” from the background?

Method

Tested recall memory for lists of paired items.

Manipulated:

"massed" items (CVC syllables) vs

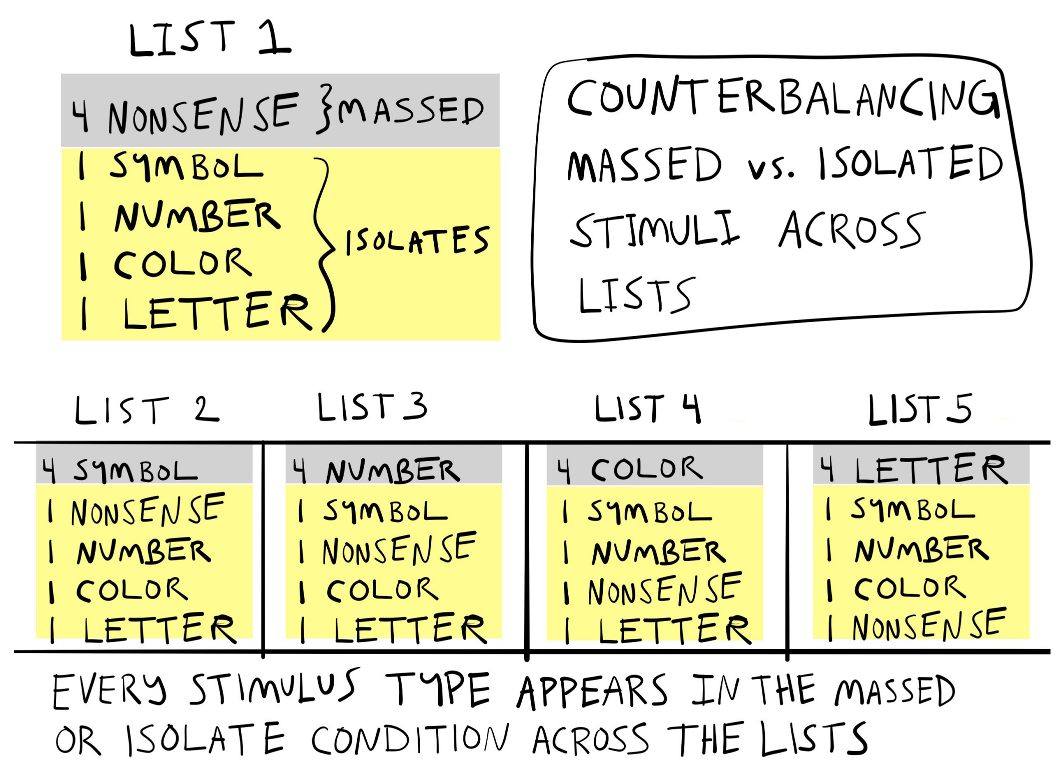
"isolated" items (unique pairs)

```
       laf -- rig
         # -- +
       dok -- pir
        89 -- 46
red square -- green square
       zül -- dap
         S -- B
       tög -- fem
```

Counterbalancing

Counterbalancing is an experimental technique used to control for the role of individual stimuli

Von Restorff counterbalanced the massed and isolated items across lists



Results

Von Restorff found:

Higher recall of isolated pairs compared to massed pairs…

Regardless of type of material

Important: particular stimuli were more or less memorable, not in and of themselves, but in relation to how distinct they were from other stimuli in the set.

Distinctiveness effects

..have been replicated many times in many ways since von Restorff

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George Miller (1920-2012)

Often considered a "founder" of cognitive psychology

Did early work on information processing limitations

Later work on language

Miller's Magic Number 7

Reviews evidence showing that absolute magnitude judgments in perception have similar information "channel" capacities

Considers whether perceptual processing limitations apply to immediate memory

VOL. 63, No. 2 MARCH, 1956

THE PSYCHOLOGICAL REVIEW

THE MAGICAL NUMBER SEVEN, PLUS OR MINUS TWO: SOME LIMITS ON OUR CAPACITY FOR PROCESSING INFORMATION [1]

GEORGE A. MILLER
Harvard University

My problem is that I have been persecuted by an integer. For seven years this number has followed me around, has intruded in my most private data, and has assaulted me from the pages of our most public journals. This number assumes a variety of disguises, being sometimes a little larger and sometimes a little smaller than usual, but never changing so much as to be unrecognizable. The persistence with which this number plagues me is far more than a random accident. There is, to quote a famous senator, a design behind it, some pattern governing its appearances. Either there really is something unusual about the number or else I am suffering from delusions of persecution.

I shall begin my case history by telling you about some experiments that tested how accurately people can assign numbers to the magnitudes of various judgment. Historical accident, however, has decreed that they should have another name. We now call them experiments on the capacity of people to transmit information. Since these experiments would not have been done without the appearance of information theory on the psychological scene, and since the results are analyzed in terms of the concepts of information theory, I shall have to preface my discussion with a few remarks about this theory.

INFORMATION MEASUREMENT

The "amount of information" is exactly the same concept that we have talked about for years under the name of "variance." The equations are different, but if we hold tight to the idea that anything that increases the variance also increases the amount of information we cannot go far astray.

Miller's Big Question

Are the information channels for perception and memory limited in the same way or different ways?

Absolute Perceptual Judgment

A method from psychophysics

People are presented with one stimulus at a time from a set of stimuli

Task is to identify (by name or label) the stimulus

Absolute Pitch

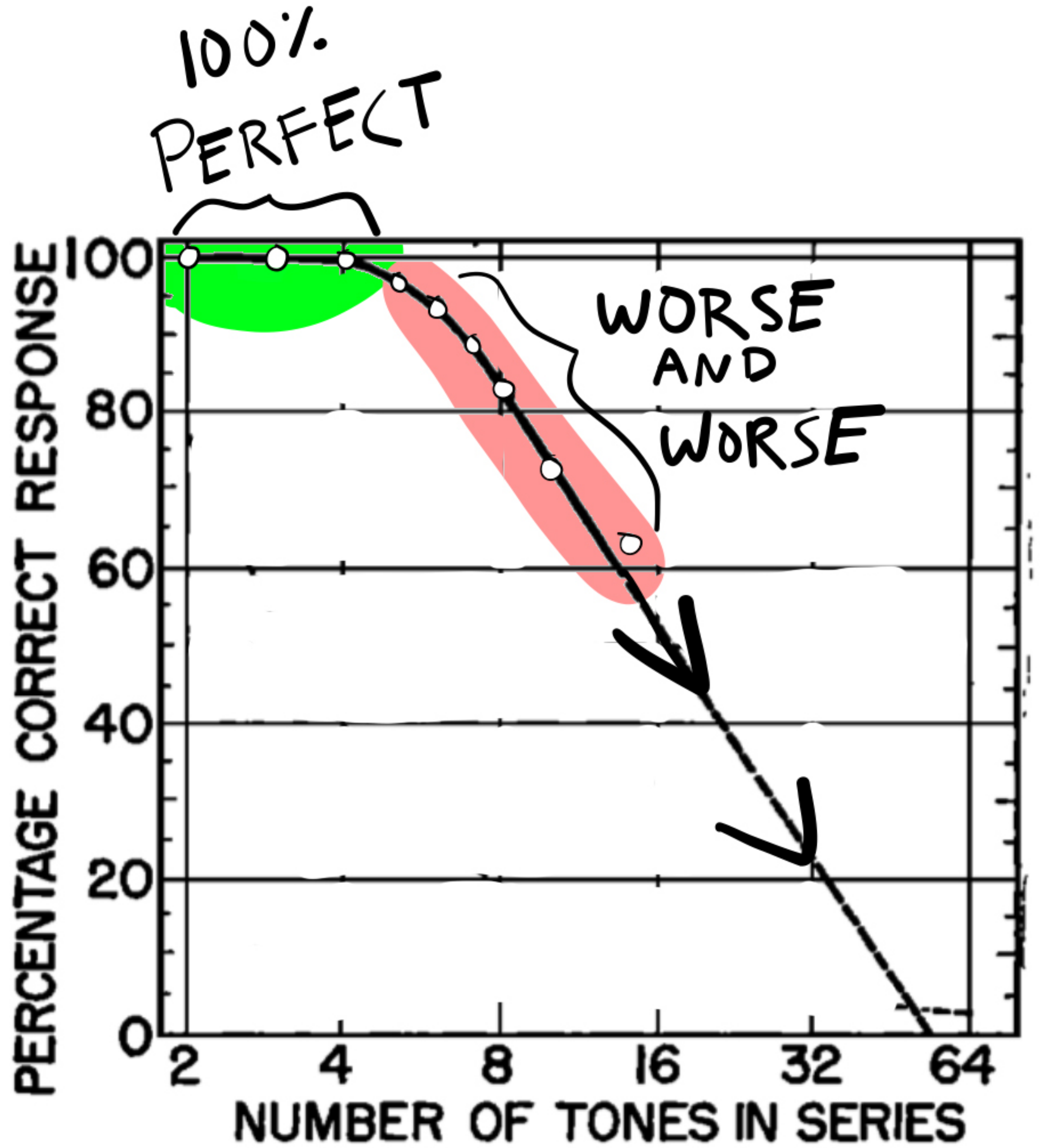
Absolute pitch is a rare musical ability to identify or name individual pitches played on a musical instrument without a reference tone

Most people are not able to name specific pitches

Pollacks' pitch judgment results

Pollack presented people with sets of tones (from 2 to 14 different tones)

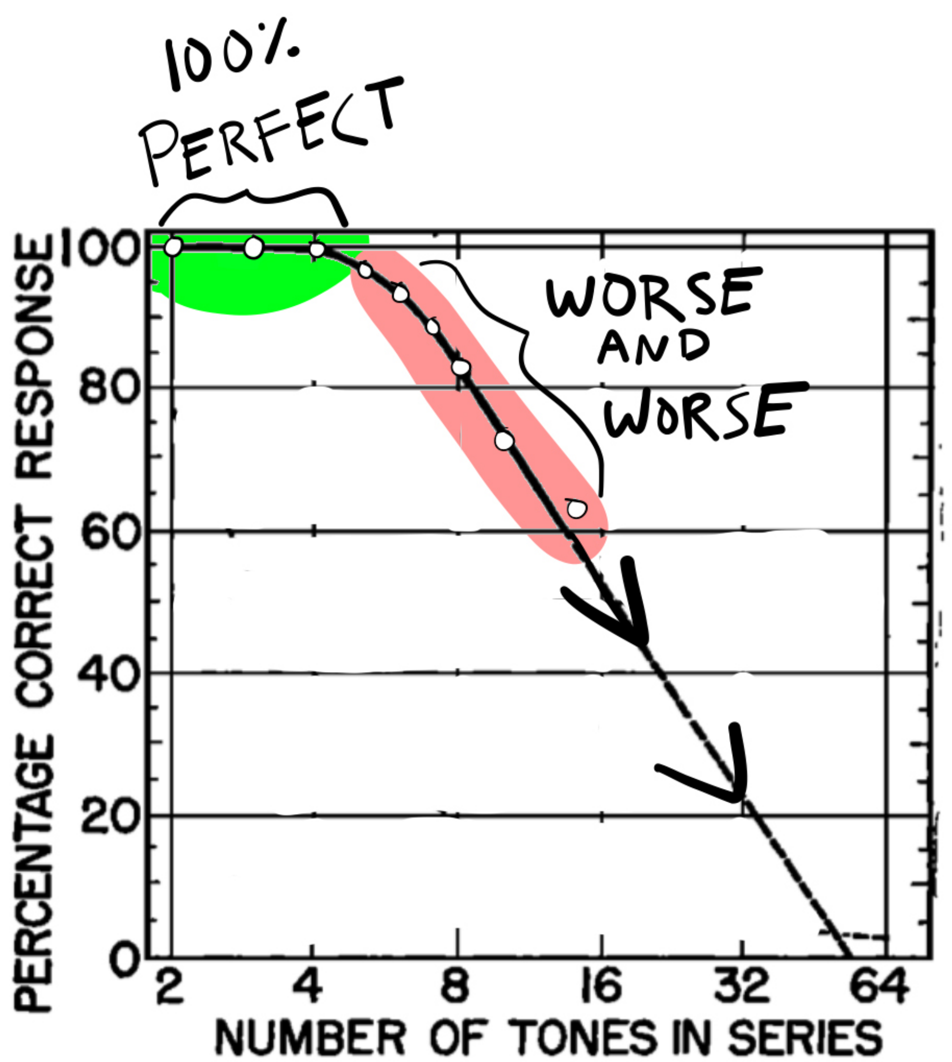
Subjects had identify the specific tone presented with a number

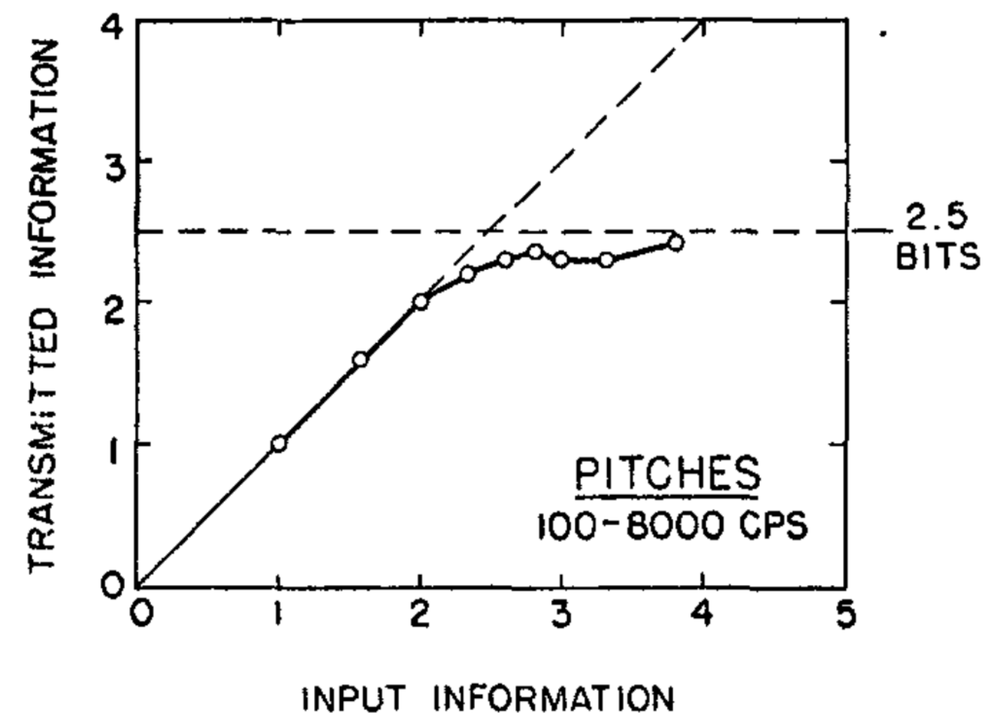


Pollack, I. (1952). The Information of Elementary Auditory Displays. The Journal of the Acoustical Society of America, 24, 745–749.

Translation to Channel Capacity

Results from absolute magnitude judgment tasks can be translated from accuracy to amount of information transmitted





Generalization across perceptual tasks

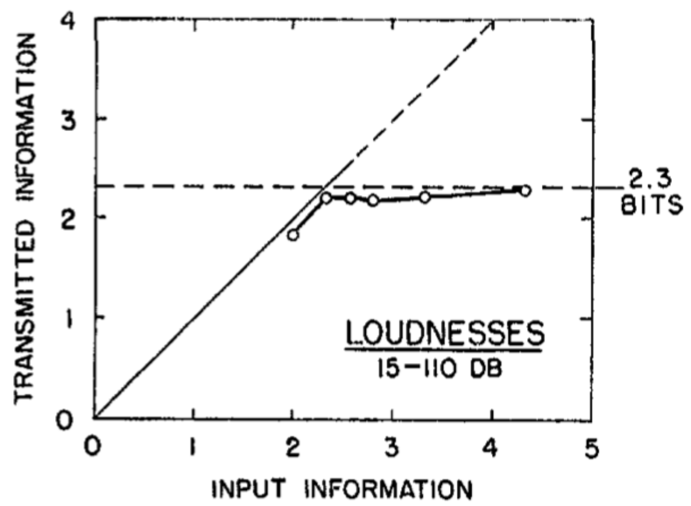


FIG. 2. Data from Garner (7) on the channel capacity for absolute judgments of auditory loudness.

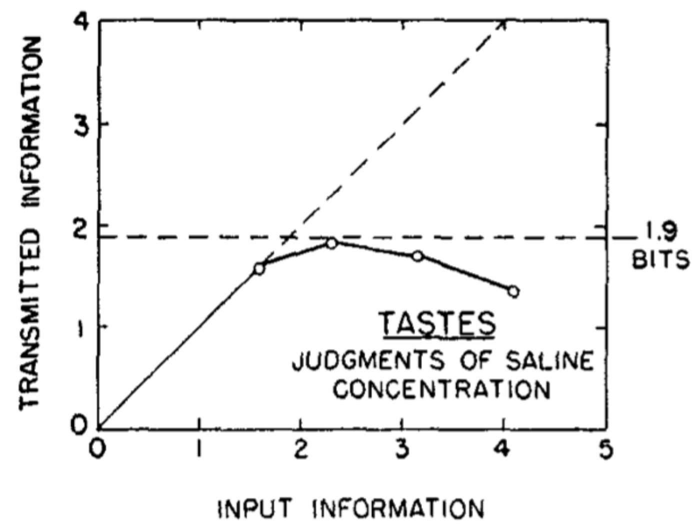


FIG. 3. Data from Beebe-Center, Rogers, and O'Connell (1) on the channel capacity for absolute judgments of saltiness.

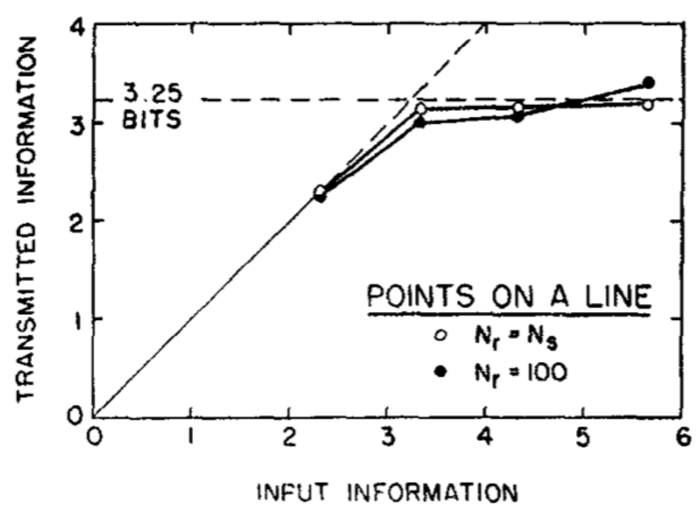


FIG. 4. Data from Hake and Garner (8) on the channel capacity for absolute judgments of the position of a pointer in a linear interval.

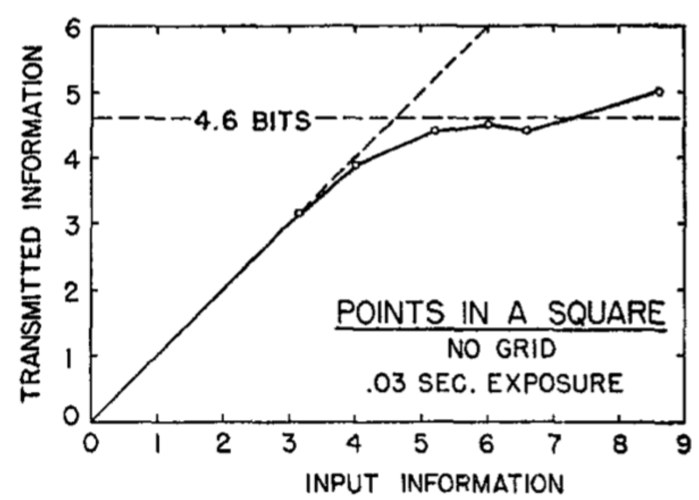


FIG. 5. Data from Klemmer and Frick (13) on the channel capacity for absolute judgments of the position of a dot in a square.

Interim summary

Judgments of absolute magnitude appear to be limited by stimulus set-size, which could be translated to amount of information

Performance was typically near perfect up to around set size of 7, plus or minus 2.

Generalization to immediate memory span?

Do perceptual judgment limitations also apply to your ability to remember information over the short term?

Is there a relationship to **immediate memory span**?

How items can memory hold?

Immediate memory span is a way to measure the ability to encode and recall an arbitrary list of items over a short period of time

People can often retain around 7, plus or minus two items

Immediate memory span and bits

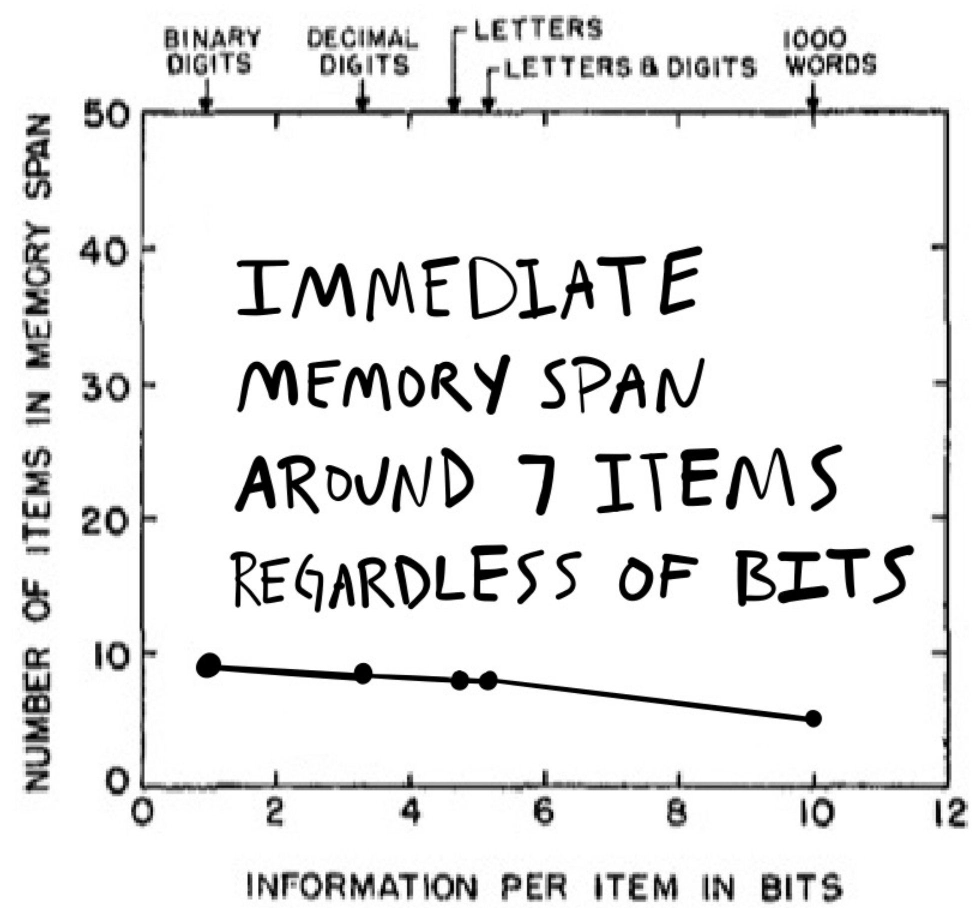
binary digits : 00010001101110

decimal digits: 17583285647390

letters: abhgkslhjbcksj

letters and digits: 4hsj3hd8fgj3h2g

1000 words: hello dolphin lamp tree plate car …



Recoding and Chunking

Miller suggests that people "recode" information into chunks, and that immediate memory is limited by number of chunks not amount of information in the chunks

TABLE 1

WAYS OF RECODING SEQUENCES OF BINARY DIGITS

	Binary Digits (Bits)	1 0 1 0 0 0 1 0 0 1 1 1 0 0 1 1 1 0								
2:1	Chunks	10	10	00	10	01	11	00	11	10
	Recoding	2	2	0	2	1	3	0	3	2
3:1	Chunks	101	000	100	111	001	110			
	Recoding	5	0	4	7	1	6			
4:1	Chunks	1010	0010	0111	0011	10				
	Recoding	10	2	7	3					
5:1	Chunks	10100	01001	11001	110					
	Recoding	20	9	25						

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Short vs long-term memory

We have all forgotten something that just happened

We can all remember things from a long time ago

How do we explain the short and long term aspects of memory ability?

Multi-store model

Atkinson, R. C., & Shiffrin, R. M. (1968). Human memory: A proposed system and its control processes. In Psychology of learning and motivation (Vol. 2, pp. 89–195). Elsevier.

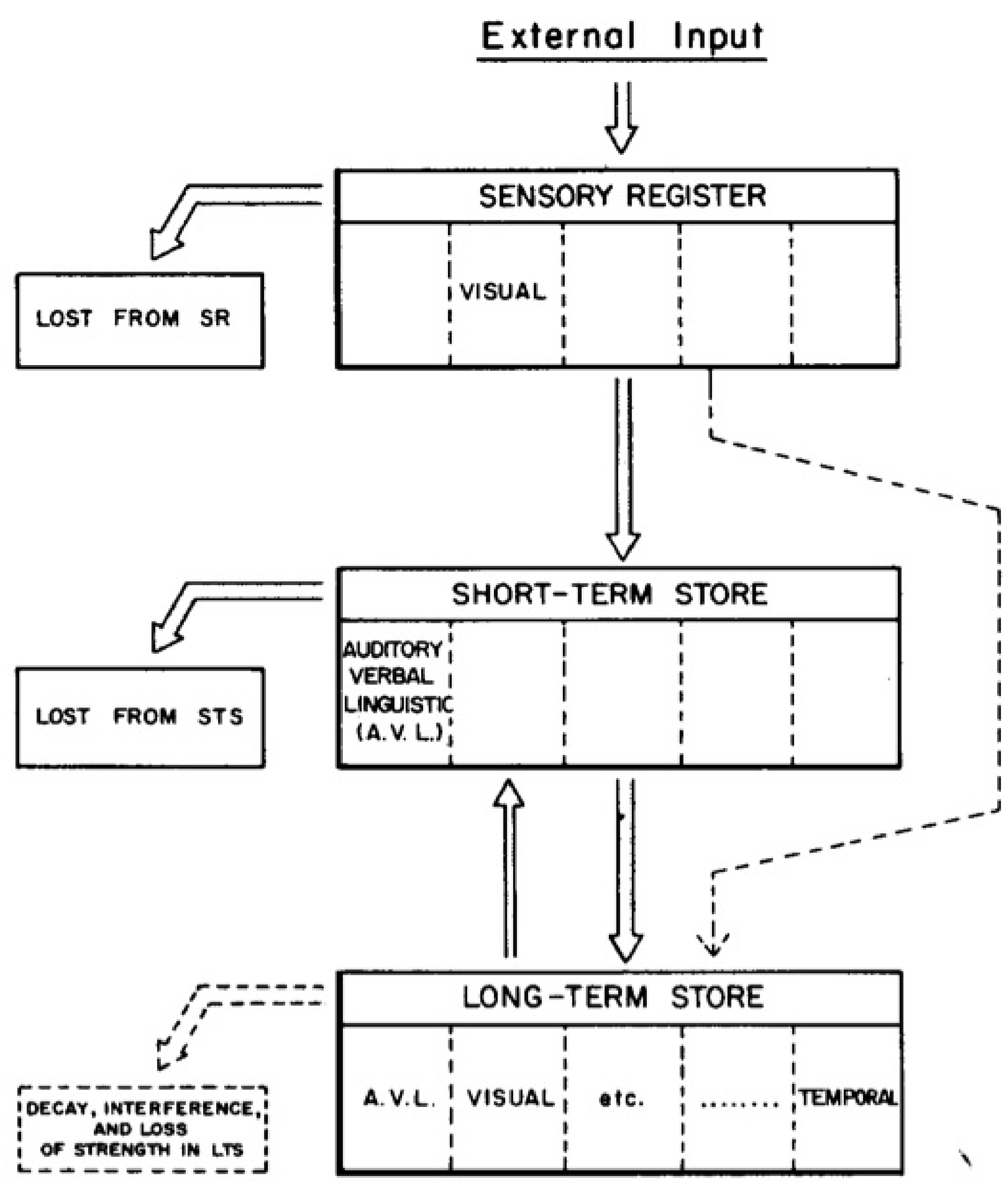

Fig. 1. Structure of the memory system.

Rehearsal buffer

According to the multi-store model, people can consciously rehearse items in a short term buffer

More rehearsal = more transfer to long-term memory

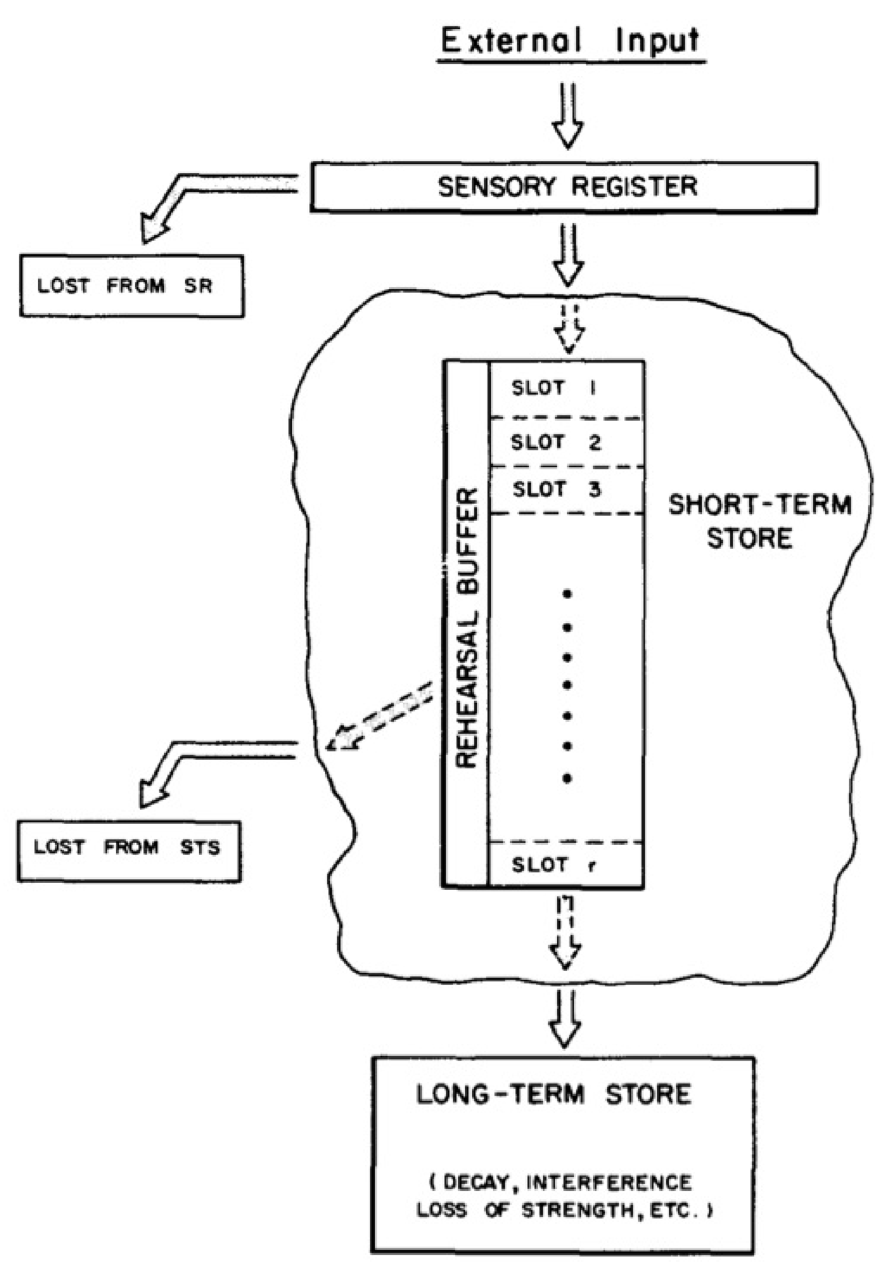

FIG. 2. The rehearsal buffer and its relation to the memory system.

Free recall task

A common memory task procedure

Encoding phase: read a list of words

Recall phase: write down all the words you can recall on a blank sheet of paper

Serial position curve

A common finding in free recall tasks

Primacy effect: better memory for items presented early in the list

Recency effect: better memory for items presented at the end of the list

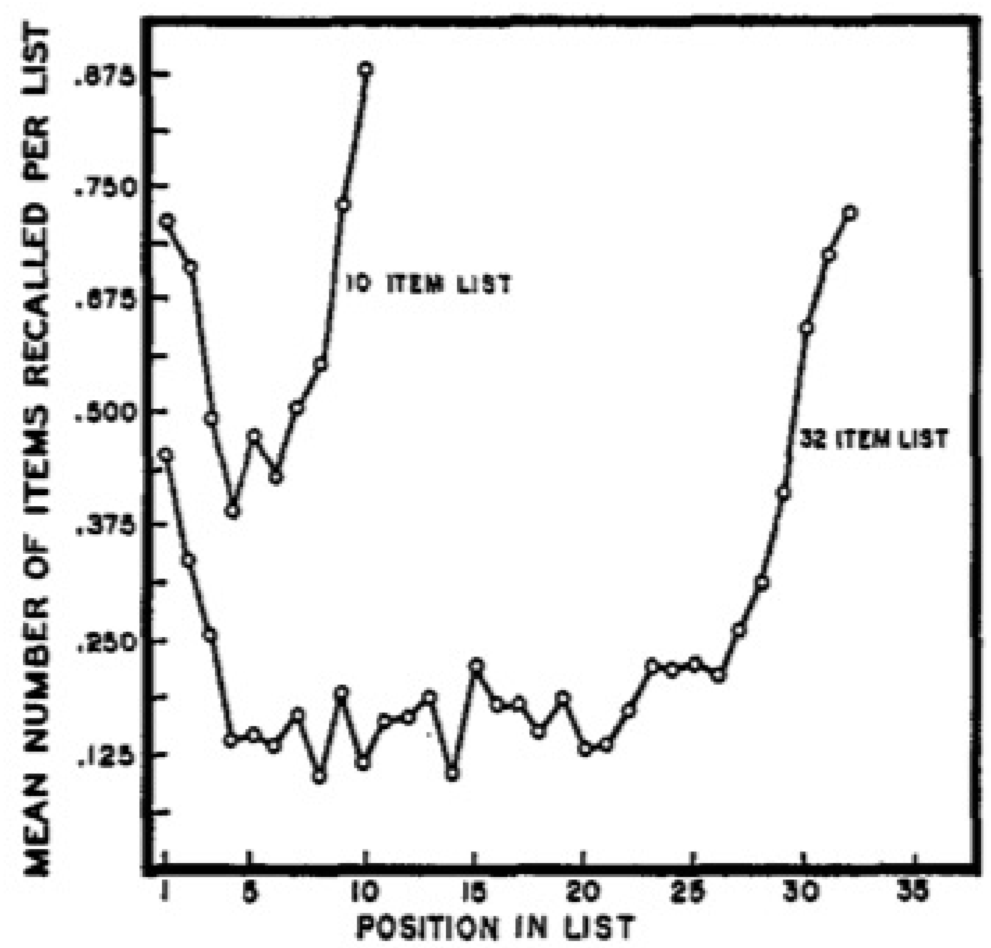

FIG. 1. Mean frequency of recall per list per S for lists of randomly arranged words as a function of position of items in original lists.

Deese, J., & Kaufman, R. A. (1957). Serial effects in recall of unorganized and sequentially organized verbal material. Journal of Experimental Psychology, 54(3), 180. https://doi.org/drc265

Explaining the serial position curve

How does the multi-store model explain the primacy effect?

How does the multi-store model explain the recency effect?

Testing the rehearsal account

How could we test the hypothesis that the rehearsal is causing the recency effect?

Manipulating Rehearsal

Postman & Philips (1965) manipulated whether or not participants did arithmetic problems before a recall test...

Arithmetic problem-solving should make rehearsal difficult

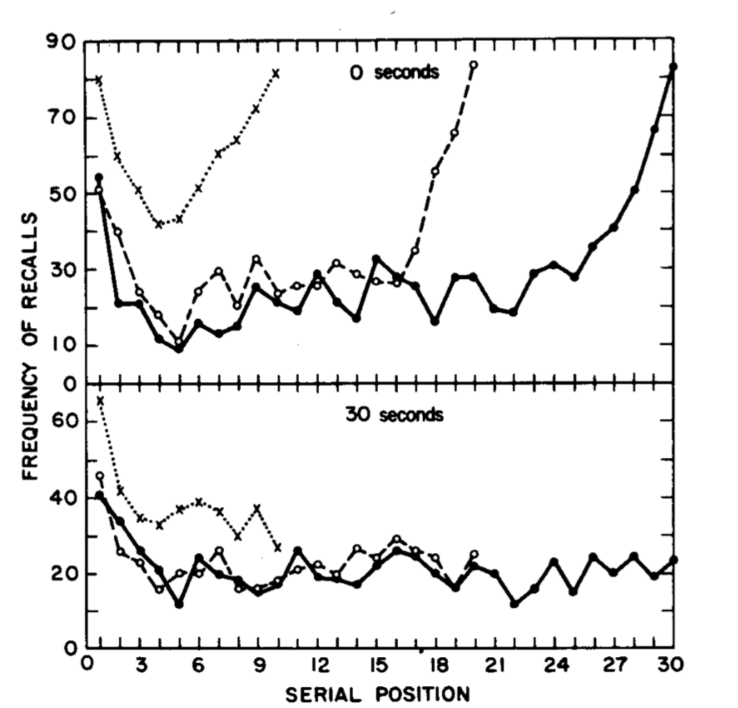

FIG. 28. Probability of correct recall as a function of serial position for free verbal recall with test following 0 seconds and 30 seconds of intervening arithmetic. After Postman & Phillips (1965).

Tzeng 1973

In 1973, Tzeng reported a standard free-recall experiment with a twist.

His subjects were given four lists of 10 words each. The twist was that after hearing each word, subjects spent 20 seconds counting backwards by 3s from a random starting digit.

Counting backwards by 3s was a very demanding task that should occupy and replace the contents of any short-term rehearsal buffer.

Long-term recency

According to the multi-store model, Tzeng should not have found recency effects in this experiment, but he did.

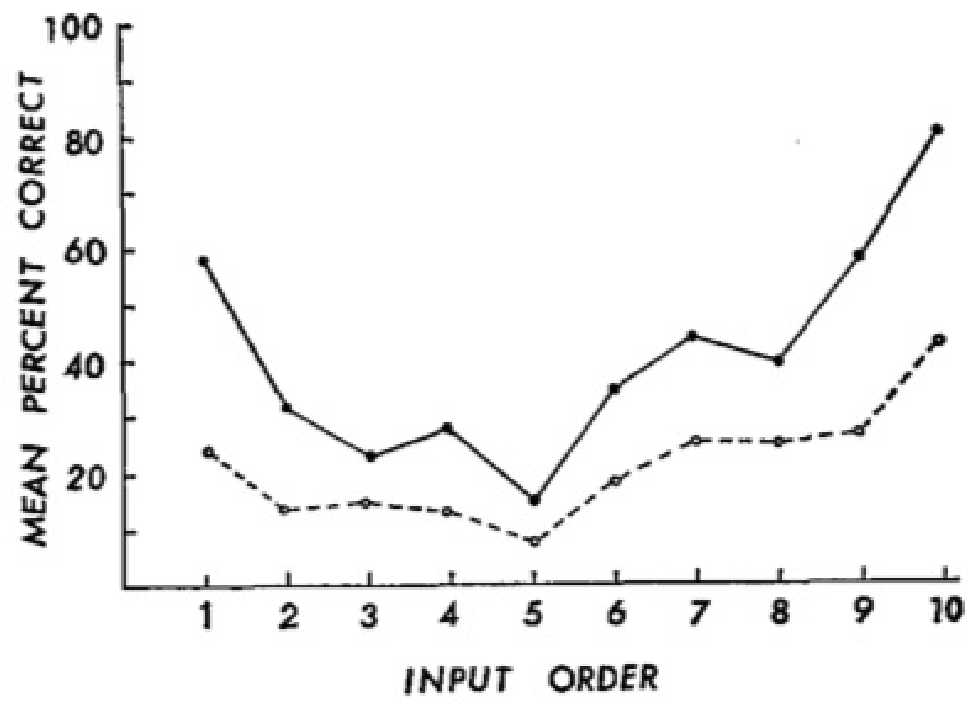

FIG. 1. Mean percent of correct recall on the initial (●—●) and the final (○ - - - ○) free recall as a function of serial positions at input.

Systems vs strategies

What's next?

Take the quiz and complete any assignments for the learning module by the due date.

The next learning module is Memory II.