Free Recall and Memory Search

PSYC201: Cognitive Psychology

Mark Hurlstone
Lancaster University

Week 8

Learning Objectives

- Memory Search and Free Recall
- Benchmark Findings:
  - Serial position effects
    - recency, primacy
  - Retrieval dynamics
    - starting, transition, stopping
  - Semantic organisation
    - semantic clustering, semantic-proximity effect, similarity-based clustering
- Summary

Memory Search

- We are often faced with the task of searching memory to recall events that belong to a particular context or that share some attribute
  - what happened at university today?
  - who did you meet at the party last week?
  - what did you do on a recent vacation?
  - which of the Cohen brother's movies have you seen?
- In the laboratory, this type of memory search is studied using the **free recall** task

Free Recall

- Classic method for studying memory search
- Participants study a list of words ($\approx$ 10–40)
- Items are presented one at a time (visually or aurally) at a rate of about 1 second per item
- Immediately after the final item (or following a filled or unfilled delay), participants must recall the list in *any order* during a fixed recall period ($\approx$ 2 mins)
- Recall is typically spoken or written

Free Recall

Free Recall

+

Free Recall

House

Free Recall

Shoe

Free Recall

Tree

Free Recall

Car

Free Recall

Dog

Free Recall

Key

Free Recall

Rose

Free Recall

"Recall"

Free Recall

- The key feature of free recall is that participants can recall items in any order
- We can ask:
  - where do people start recall?
  - how do people transition from one item to the next?
  - when do people stop recall?
  - what factors affect recall?
  - how do these factors interact to determine if an item is recalled?
- Answers to such questions give clues as to the underlying mechanisms of memory search

Today: Benchmark Findings of Free Recall

- Serial Position Effects
  - recency, primacy
- Retrieval Dynamics
  - starting, transition, stopping
- Semantic Organisation
  - semantic clustering, semantic proximity effect
- Intrusions
  - recency of prior-list intrusions

Tomorrow:

- Models of free recall

Today: Benchmark Findings of Free Recall

- Serial Position Effects
  - recency, primacy
- Retrieval Dynamics
  - starting, transition, stopping
- Semantic Organisation
  - semantic clustering, semantic proximity effect
- Intrusions
  - recency of prior-list intrusions

Tomorrow:

- Models of free recall

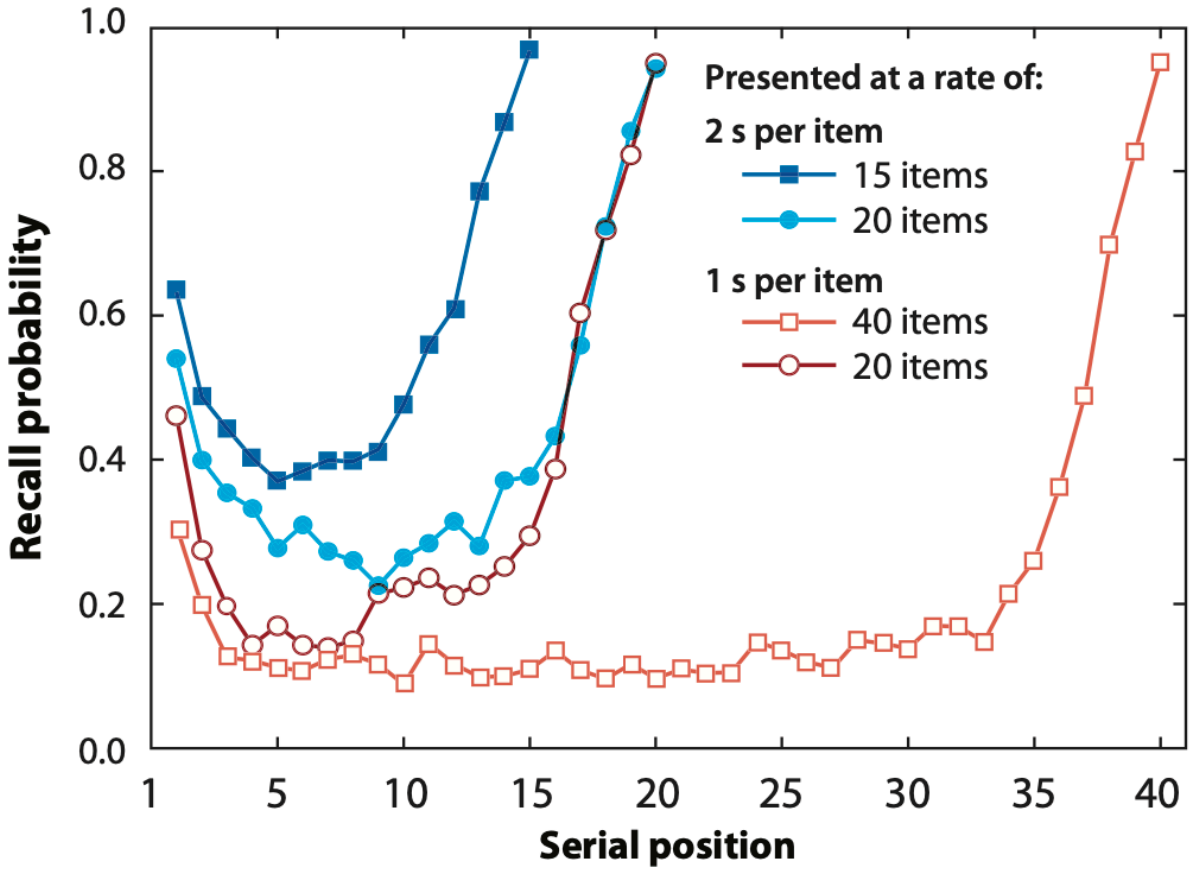
Serial Position Effects

- If a list is sufficiently short (e.g., six words or less), participants can easily recall all items
- With longer lists, participants will be unable to recall all items
- They will also occasionally recall items that were not on the list:
  - a **prior-list intrusion (PLI)** refers to recall of a nonlist item that appeared on an earlier list
  - a **extra-list intrusion (ELI)** refers to recall of a nonlist item that did not appear on any earlier list

Serial Position Effects

- A first step in understanding the way participants recall lists is by plotting the **serial-position curve**
- This plots the probability of recalling an item as a function of its serial position in the lists
- These curves have a characteristic form:
  1. excellent recall of the last few items (the **recency effect**)
  2. poorest recall of the middle items
  3. enhanced recall of the first few items (the **primacy effect**)

Serial Position Effects (Murdock, 1962)

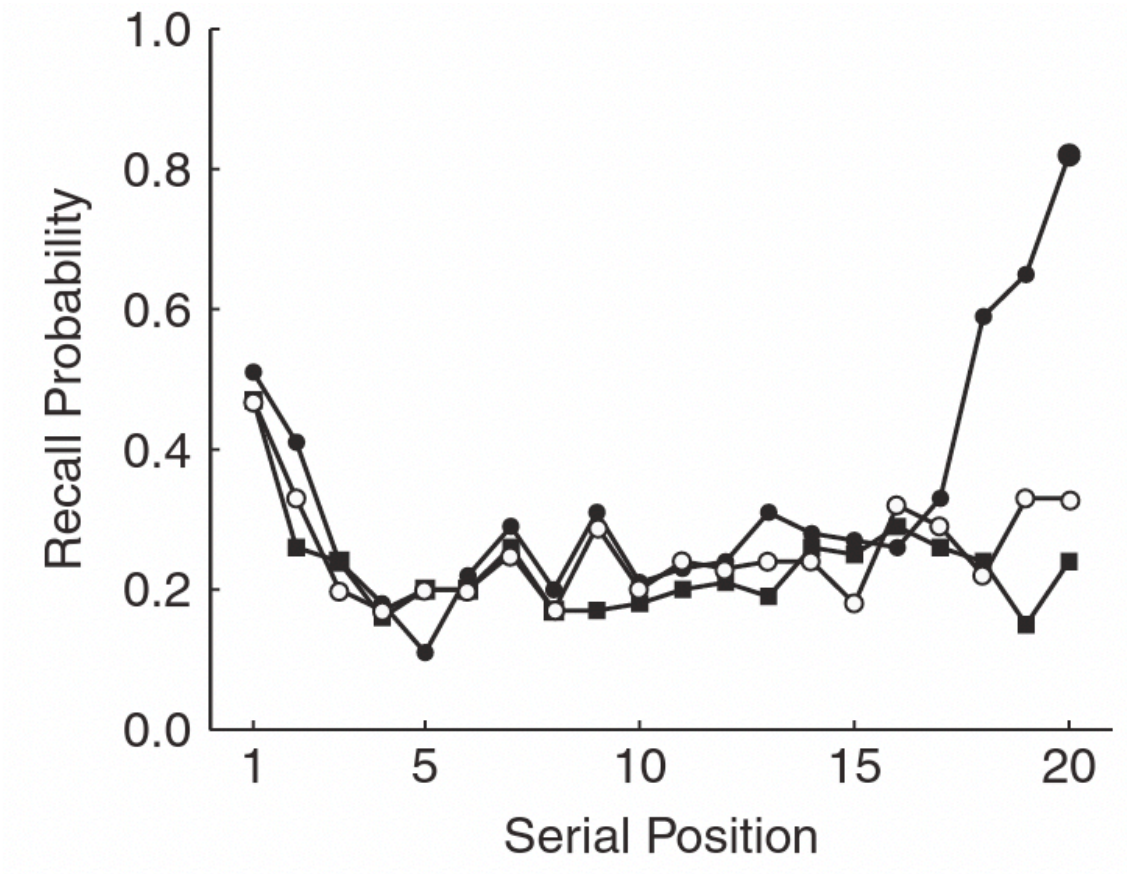


- Study time and list length affect early and middle (*prerecency*) items but have no effect on recency items

Fragile Nature of Recency

- The recency effect disappears when participants are tested following a brief distracter filled retention interval
- Postman and Philips (1965) had three groups of participants freely recall lists of 20 words after:
  1. 0-sec retention interval
  2. 15-sec retention interval
  3. 30-sec retention interval
- During the retention interval, participants were required to count backwards in threes starting from a three-digit number

Fragile Nature of Recency

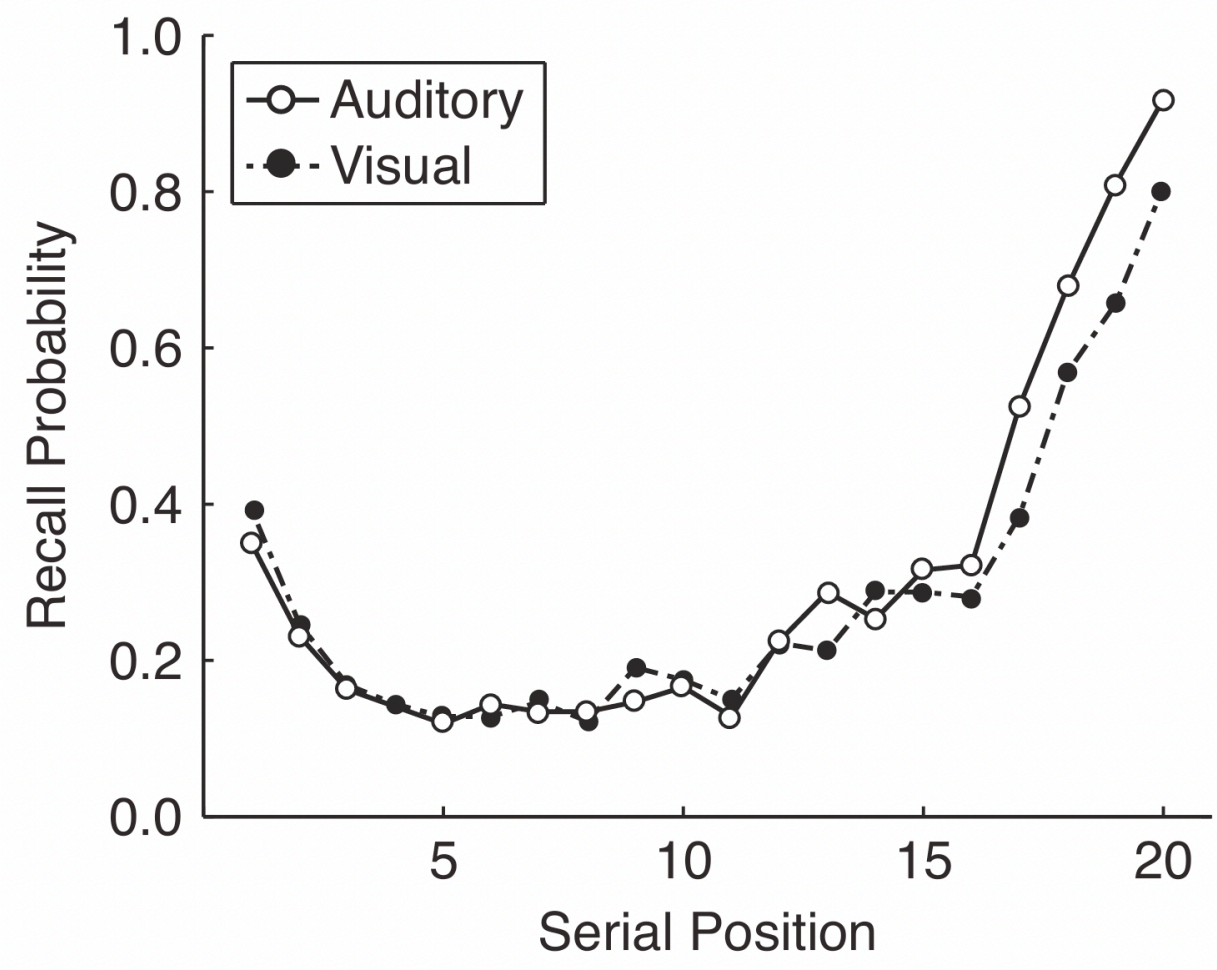


- Serial position curves for lists with 0 (filled circles), 15 (open circles), or 30 (filled squares) sec of distracter between study and test

Study Modality and Recency

- Modality of presentation is another factor that influences the recency effect but has no effect on prerecency items
- Murdock and Walker (1969) had participants study and free recall lists of 20 high-frequency words
- Words either presented:
  1. visually or
  2. auditorily
- Recall was always spoken

Study Modality and Recency



Recency and Short-Term Memory

- Fragile nature of recency led memory theorists in the 1960s to embrace a distinction between two memory systems:
  1. short-term memory
  2. long-term memory
- Items enter a short-term store (STS) as list is studied
- STS can only hold ≈ 4 items, so new items eventually displace existing items in STS
- While in STS, representations of items in STS and long-term store (LTS) are associated
- Longer an item resides in STS, the greater their associative strength in LTS

Recency and Short-Term Memory

- According to such **dual-store models**, at the time of test items in STS are available for immediate report
- This explains the recency effect
- Recency effect eliminated by end-of-list distractors because distractors displace the items from the STS
- Primacy effect arises because first few items spend more time in STS

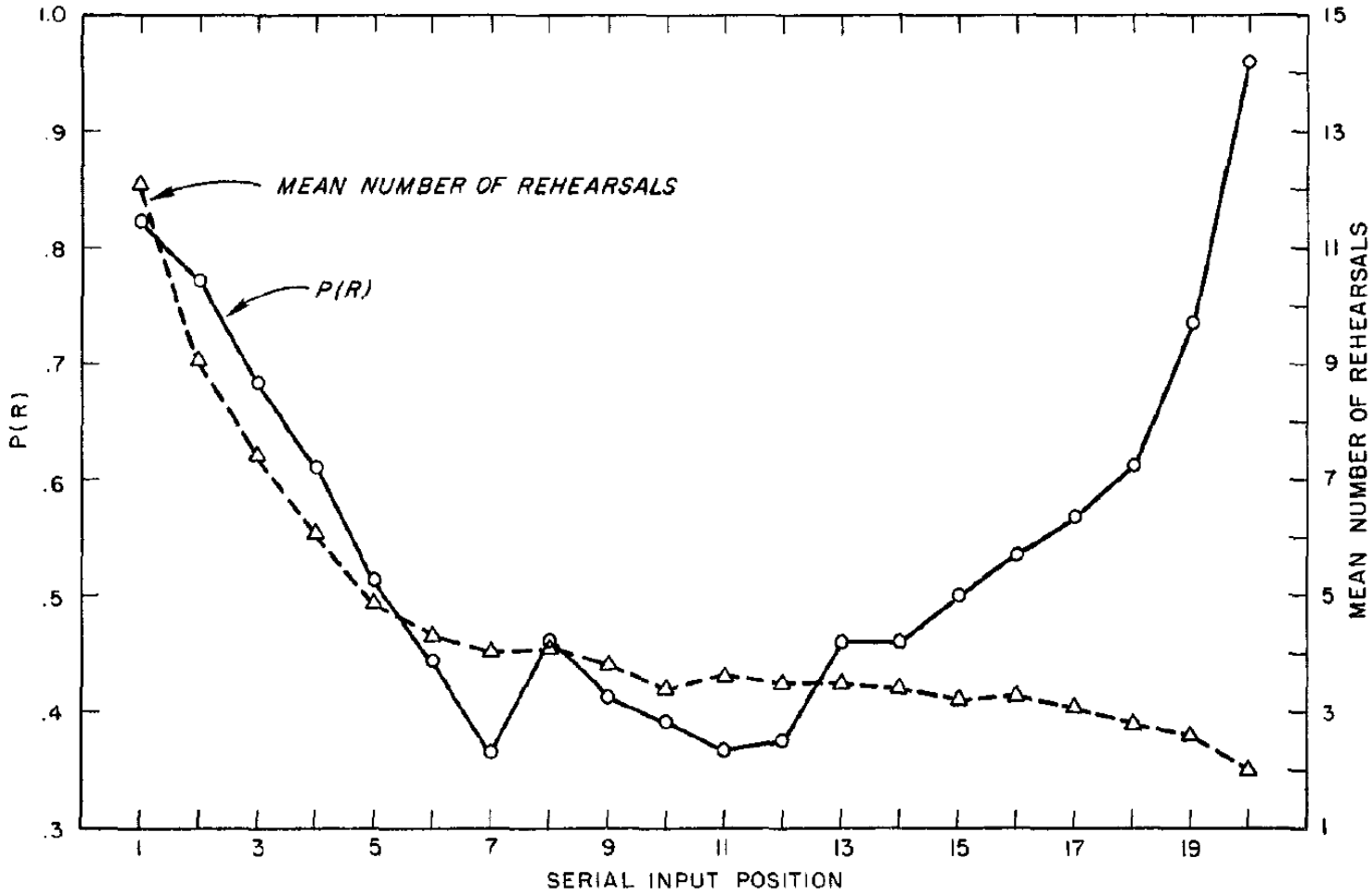
Rehearsal and Primacy

- Primacy effect is larger with a slow presentation rate and intentional learning instructions
- Fast presentation rates or a surprise memory test greatly reduce the primacy effect
- These manipulations minimise opportunities for rehearsal
- Suggests increased rehearsal of early list items underpins the primacy effect

Rehearsal and Primacy

- In the **overt-rehearsal technique**, participants say aloud everything that comes to mind as they memorise words on the study list (Rundus, 1971)
- Allows one to count the number of overt rehearsals each list item receives
- Primacy items receive the greatest number of rehearsals
- Number of rehearsals an item receives strongly predicts if it will be recalled
- Suggests primacy effect is consequence of rehearsal strategies

Rehearsal and Primacy (Rundus, 1971)



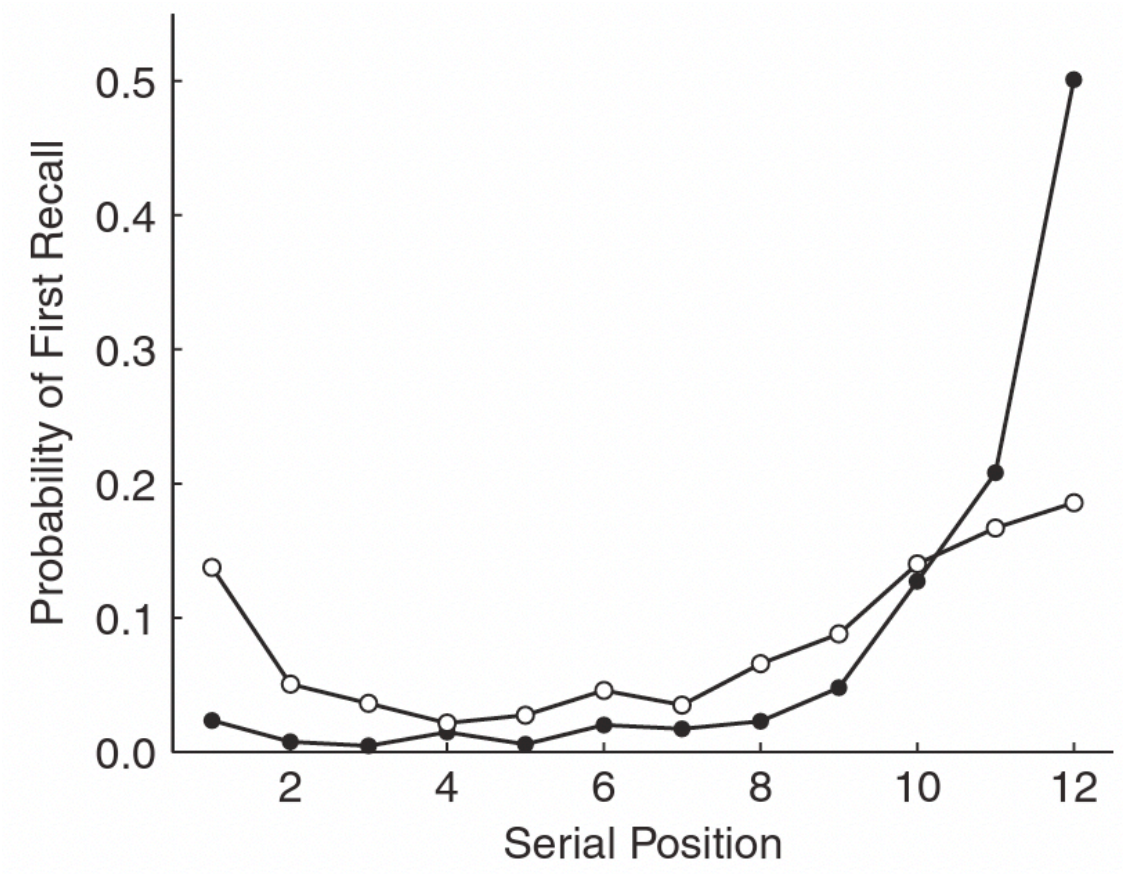
Retrieval Dynamics

- The serial position curve provides a simplistic view of the recall process
- Recall is a dynamic process that involves three different components:
  1. starting
  2. transition
  3. stopping
- We can gain greater insight into the mechanisms of memory search by studying these components of the recall process

Starting Recall

- *Starting* refers to how participants begin the recall process
- People tend to begin recall with the last few items and this tendency underlies the recency effect
- This tendency can be measured by plotting the **probability of first recall (PFR) curve**
- This is a serial-position curve for just the first item recalled

Starting Recall (Howard & Kahana, 1999)



- PFR curves for immediate free recall (filled circles) and delayed free recall (open circles) with 16 seconds of simple arithmetic problems

Recall Transitions and the Contiguity Effect

- *Transition* refers to the order in which participants recall items
- Suppose a participant has just recalled an item from serial position i and that the next recall is from serial position j
- We can measure the relation between recall probability and the lag between i and j, defined as $j - i$
- This measure is known as the **conditional-response probability as a function of lag** or **lag-CRP**

Recall Transitions and the Contiguity Effect

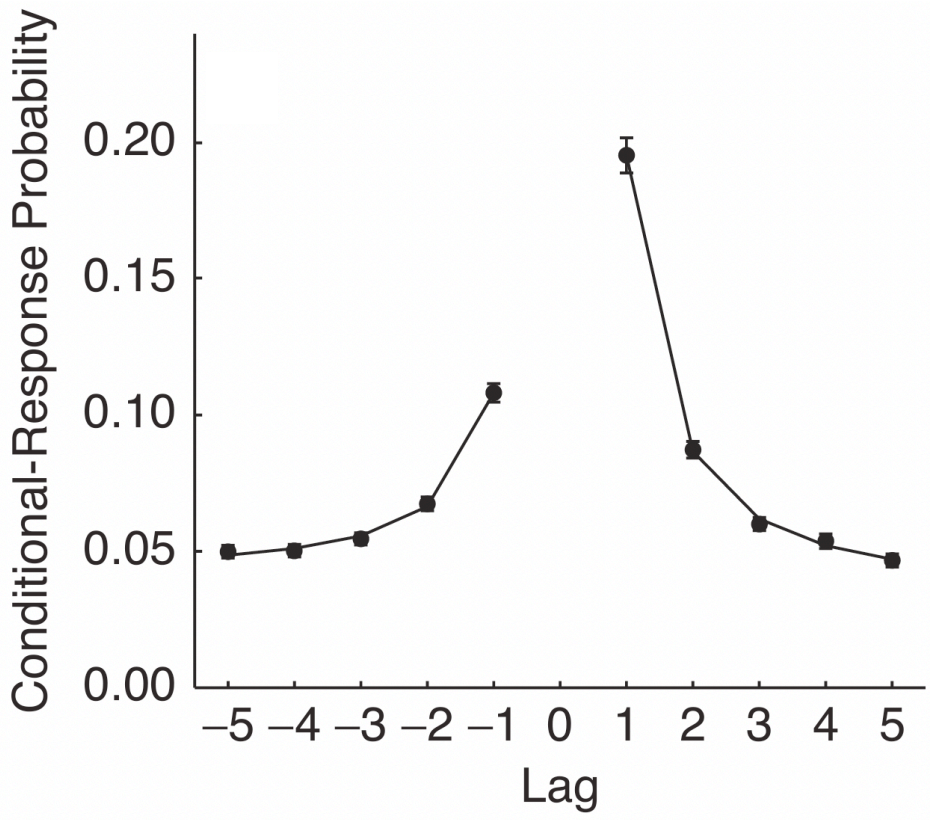
- Positive values of $lag = j - i$ correspond to *forward* transitions from earlier to later items
- Negative values of lag correspond to *backward* transitions from later to earlier items
- Large absolute values of lag (absolute lag) correspond to words spaced widely apart in the list
- Small absolute values of lag correspond to words spaced closely together in the list

Recall Transitions and the Contiguity Effect

- Suppose the list contained *absence hollow pupil*
- If a participant recalled *hollow*, then *pupil*, the recall of pupil would have a lag of +1
- If a participant recalled *hollow*, then *absence*, the transition to *absence* would have a lag of –1
- *absence* followed by *pupil* would have a lag of +2

Recall Transitions and the Contiguity Effect (Kahana, 1996)

- The lag-CRP has two key features:
  1. The function decreases monotonically as absolute lag increases (the **contiguity effect**)
  2. For small absolute lags, the function is asymmetric, with an $\approx$ 2:1 ratio favouring forward over backward transitions



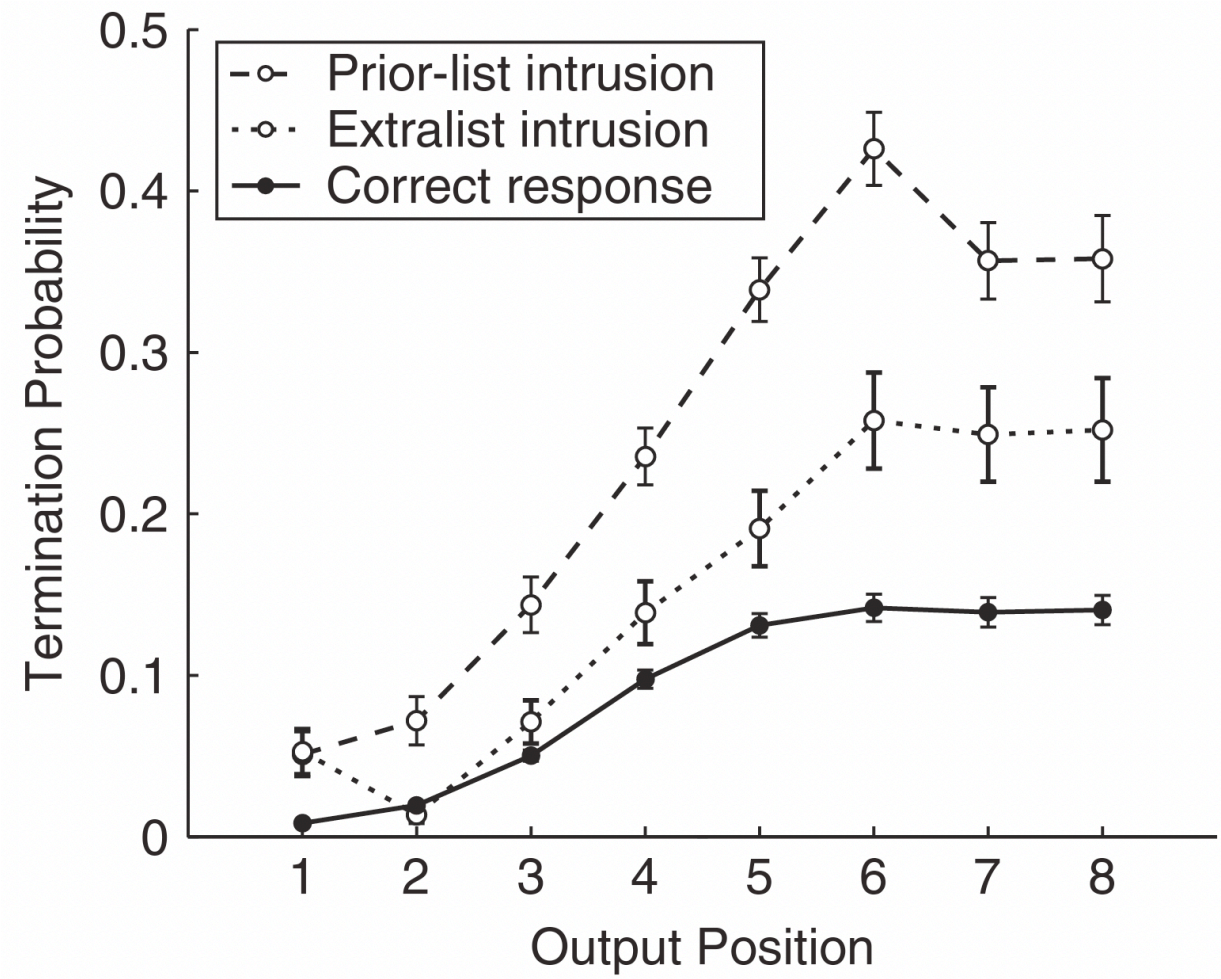
Stopping Recall

- *Stopping* refers to the point at which participants stop recalling
- Participants stop recalling because:
  1. their time has run out
  2. they cannot think of any other items that were on the list
  3. they have finished recalling all of the items
- Whatever accounts for recall termination determines the total number of items that are recalled
- How do we know if a participant has stopped recall?

Stopping Recall

- One option is to ask participants to indicate when they have finished recalling
- Dougherty and Harbison (2007) found that participants stop recall on average 10 sec after the last recalled item
- Miller et al. (2012) analysed 28,015 free recall trials from 15 published studies using a stopping criterion of 12 sec
- Of these trials, 18,829 met the criteria for recall termination (67.2%)
- Examined how recall termination varied with recall position and nature of last recalled item

Stopping Recall (Miller et al., 2012)



Semantic Organisation

- The contiguity effect shows how *temporal organisation* affects free recall
- Participants use newly formed temporal associations between items to search memory (**episodic memory**)
- However, it is also well known that *semantic organisation* affects free recall
- Participants also rely on pre-existing semantic associations between items to search memory (**semantic memory**)

Semantic Clustering

- The effect of semantic relatedness on recall can be examined by comparing recall of two types of word lists
  1. *categorised:* contain words drawn from several semantic categories (e.g., *pear lime dog cow car train*)
  2. *non-categorised:* contain words drawn from unique semantic categories (e.g., *apple cat truck tennis pants lamp*
- Categorised lists are recalled better than non-categorised lists (Bousfield, 1953; Bousfield et al., 1954)
- In categorised lists, participants recall words from the same category together—known as **semantic clustering**

Semantic Clustering

- In categorised lists, semantic relatedness is either very strong (for within-category items) or very weak (for between-category items)
- Such a binary representation of similarity is overly simplistic
- Does semantic relatedness influence recall of lists that do not possess any obvious semantic organisation?
- Requires a fine-grained measure of semantic similarity

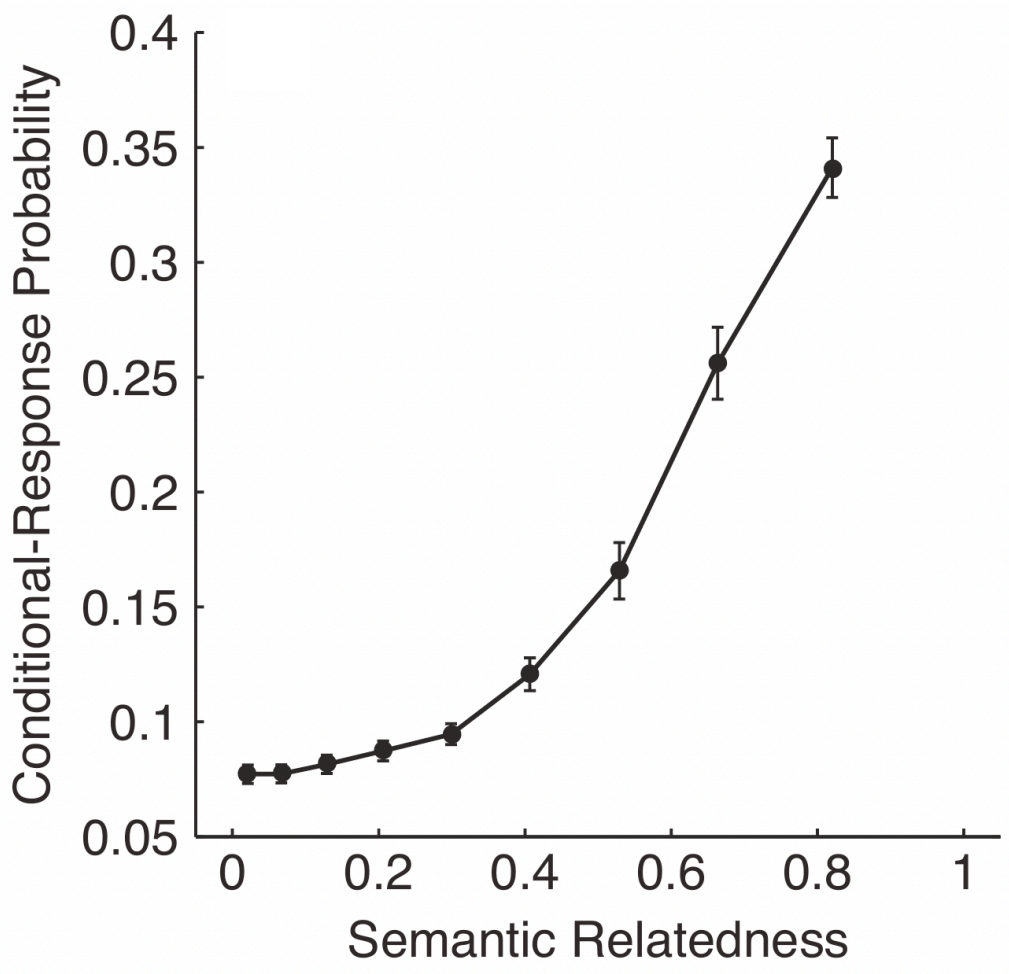
Latent Semantic Analysis (LSA)

- Computational method for determining semantic relatedness of words
- Takes a large corpus of text and determines how frequently different words co-occur in paragraphs
- Used to construct a high-dimensional geometric representation of every word in the English language
- Each word is represented as a vector
- Similarities among words computed by calculating the cos θ between any two "word" vectors (cos θ = 0 for unrelated words; cos θ = 1 for synonyms)

Latent Semantic Analysis

- We can measure the conditional probability of a recall transition as a function of an item's semantic relatedness to the just recalled item (as measured using LSA)
- This measure is known as the **semantic-CRP**
- Howard and Kahana (2002) examined free recall of lists of randomly arranged common nouns
- The stronger the semantic relation between two list words, the more likely they would be recalled in neighbouring recall positions—the **semantic proximity effect**

Semantic Proximity Effect (Howard & Kahana, 2002)



Similarity-Based Clustering

- Two source of clustering in free recall:
  - *contiguity effect:* items in temporally contiguous positions cluster together in recall
  - *semantic proximity effect:* semantically related items cluster together in recall
- Clustering can be observed for other attributes of items, such as *similarity:*
  - modality in which list items are presented (Murdock & Walker, 1969)
  - gender in which list items are spoken (Hintzman et al., 1972)

Summary

- Memory Search and Free Recall
- Benchmark Findings:
  - Serial position effects
    - recency, primacy
  - Retrieval dynamics
    - starting, transition, stopping
  - Semantic organisation
    - semantic clustering, semantic-proximity effect, similarity-based clustering

Tomorrow:

- Models of free recall

Summary

- Memory Search and Free Recall
- Benchmark Findings:
  - Serial position effects
    - recency, primacy
  - Retrieval dynamics
    - starting, transition, stopping
  - Semantic organisation
    - semantic clustering, semantic-proximity effect, similarity-based clustering

Tomorrow:

- Models of free recall

Recommended Reading

Moreton, BJ. and Ward, GD., (2010). Time scale similarity and long-term memory for autobiographical events. *Psychonomic Bulletin & Review 17 (4),* 510-515.

References

Bousfield, W. A. (1953). The occurrence of clustering in the recall of randomly arranged associates. The *Journal of General Psychology, 49(2),* 229-240.

Bousfield, W. A., Sedgewick, C. H. W., & Cohen, B. H. (1954). Certain temporal characteristics of the recall of verbal associates. *The American Journal of Psychology, 67(1),* 111-118.

Dougherty, M., & Harbison, J. (2007). Motivated to Retrieve: How Often Are You Willing to Go Back to the Well When the Well Is Dry? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33(6),* 1108.

References

Hintzman, D. L., Block, R. A., & Inskeep, N. R. (1972). Memory for mode of input. *Journal of Verbal Learning and Verbal Behavior, 11,* 741-749.

Howard, M. W., & Kahana, M. J. (1999). Contextual variability and serial position effects in free recall. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 25(4),* 923-941.

Howard, M. W., & Kahana, M. J. (2002). When does semantic similarity help episodic retrieval? *Journal of Memory and Language, 46,* 85-98.

References

Kahana, M. J. (1996). Associative retrieval processes in free recall. *Memory & Cognition, 24(1),* 103-109.

Miller, J. F., Weidemann, C. T., & Kahana, M. J. (2012). Recall termination in free recall. *Memory & Cognition, 40,* 540-550.

Murdock, B. B. (1962). The serial position effect of free recall. *Journal of Experimental Psychology, 64,* 482-488.

References

Murdock, B. B., & Walker, K. D. (1969). Modality effects in free recall. *Journal of Verbal Learning and Verbal Behavior, 8,* 665-676.

Postman, L., & Phillips, L. W. (1965). Short-term temporal changes in free recall. *Quarterly Journal of Experimental Psychology, 17,* 132-138.

Rundus, D. (1971). An analysis of rehearsal processes in free recall. *Journal of Experimental Psychology, 89,* 63-77.