

# Metacognitively Guided Retrieval and Report (META-RAR): Quality Control Processes in Recall

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## General Research question

What are the processes used to control voluntary remembering?

## Rational

Manufacturing metaphor (Jacoby et al., 2005):  
Quality control in manufacturing involves:

- post-production monitoring and control processes that identify and screen out defects. **[back-end]**
- improved production techniques, so that fewer defects are produced in the first place. **[front-end]**



# Search engine metaphor:

The image displays two side-by-side Google search results. The left window shows a search for 'Minerva' with approximately 61,600,000 results. The right window shows a search for 'Minerva haifa technion' with approximately 599,000 results. Both windows show a list of search results with titles, URLs, and snippets of text.

**Left Window: Search for 'Minerva'**

Search: About 61,600,000 results (0.30 seconds)

**Web**

- [Minerva - Wikipedia, the free encyclopedia](http://en.wikipedia.org/wiki/Minerva)  
en.wikipedia.org/wiki/Minerva  
Minerva (Etruscan: Menrva) was the Roman goddess of wisdom, warfare, and commerce. She was the Roman equivalent of the Greek goddess Athena and the Etruscan Menrva. She was also the Roman goddess of the arts, science, and industry. She was the Roman goddess of the arts, science, and industry. She was the Roman goddess of the arts, science, and industry.

**Images**

**Maps**

**Videos**

**News**

**Shopping**

**More**

Show search tools

**Minerva Online Library Catalog**  
minerva.maine.edu/  
Search MINERVA... Type of search, Enter search text, Subject, Keyword, Dewey Call Number, LC Call Number

**Home | Minerva**  
www.minervanetworks.com/  
Provides interactive television infrastructure over IP networks, including set-top boxes, encoders; DVB gateways and middleware.

**Minerva Indian Cuisine**  
www.minervacuisine.com/  
Menu, catering details and directions. Located in the heart of the city.

**MINERVA EC Website**  
www.minervaeurope.org/  
Network of member states' ministries to discuss, coordinate and disseminate cultural and scientific content. Includes activities and projects.

**MINERVA - Idolatry**  
https://hylobatidae.org/minerva/  
< PREV | NEXT >. Final transmission in block has

**Right Window: Search for 'Minerva haifa technion'**

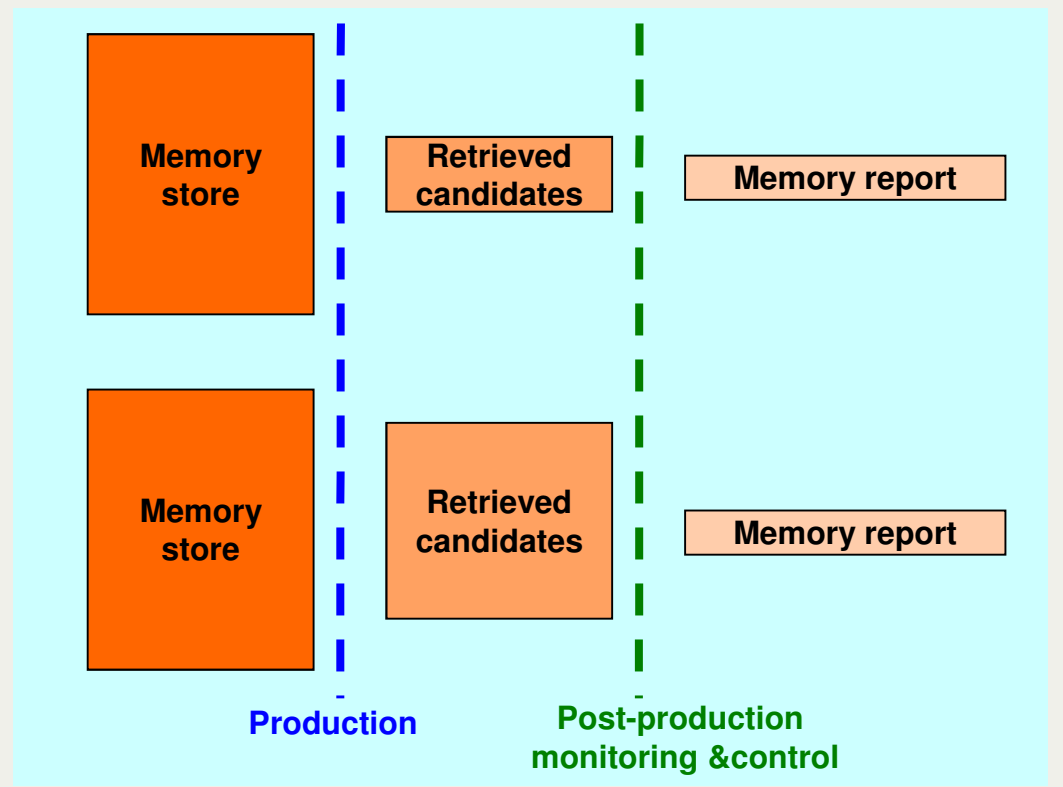
Search: About 599,000 results (0.19 seconds)

- [The Max Wertheimer Minerva Center for Cognitive Processes and...](http://minervacognitive.haifa.ac.il/)  
minervacognitive.haifa.ac.il/  
The Center was established with the support from the prestigious Minerva foundation ... Both the University of Haifa group and the Technion group share in the ...
- [Minerva summer school - Mathematik](http://www.mathematik.uni-regensburg.de/.../haifa/haifaschool.html)  
www.mathematik.uni-regensburg.de/.../haifa/haifaschool.html  
16 Jul 2012 – Department of Mathematics, Technion, Haifa. September 2-6, 2012. The goal of this Minerva summer school is to introduce young researchers ...
- [MINERVA Optimization Center](http://iew3.technion.ac.il/Labs/Opt/)  
iew3.technion.ac.il/Labs/Opt/  
The William Davidson Faculty of Industrial Engineering and Management, Technion.
- [Home | Technion - Israel Institute of Technology](http://www1.technion.ac.il/en)  
www1.technion.ac.il/en  
Technion - Israel Institute of Technology - Official Web site - a world ... Technion Facebook page ... Flows on homogeneous spaces, Minerva summer school ... Institute of Technology - Disclaimer - Contact Us - Technion City, Haifa 32000, Israel.
- [Die Ausstellung "Juden an der Universität Heidelberg"](http://www.tphys.uni-heidelberg.de/Ausstellung/show.cgi?P...)  
www.tphys.uni-heidelberg.de/Ausstellung/show.cgi?P...  
Minerva Center for Human Rights. University of Haifa, Technion-Israel Institute of Technology. Max Wertheimer Minerva Center for Cognitive Processes and ...
- [KIT - Fakultät für Mathematik - Minerva summer school](http://www.math.kit.edu/iag7/seite/haifaschool/de)  
www.math.kit.edu/iag7/seite/haifaschool/de  
16 Jul 2012 – Department of Mathematics, Technion, Haifa. September 2-6, 2012. Haifa. The goal of this Minerva summer school is to introduce young ...
- [Max Wertheimer Minerva Center for Cognitive Processes and Human](http://www.minerva.mpg.de/minerva.../center_43...)  
www.minerva.mpg.de/minerva.../center\_43... - Translate this page  
Max Wertheimer Minerva Center for Cognitive Processes and Human Performance University of Haifa, Technion-Israel Institute of Technology (Established 1995) ...

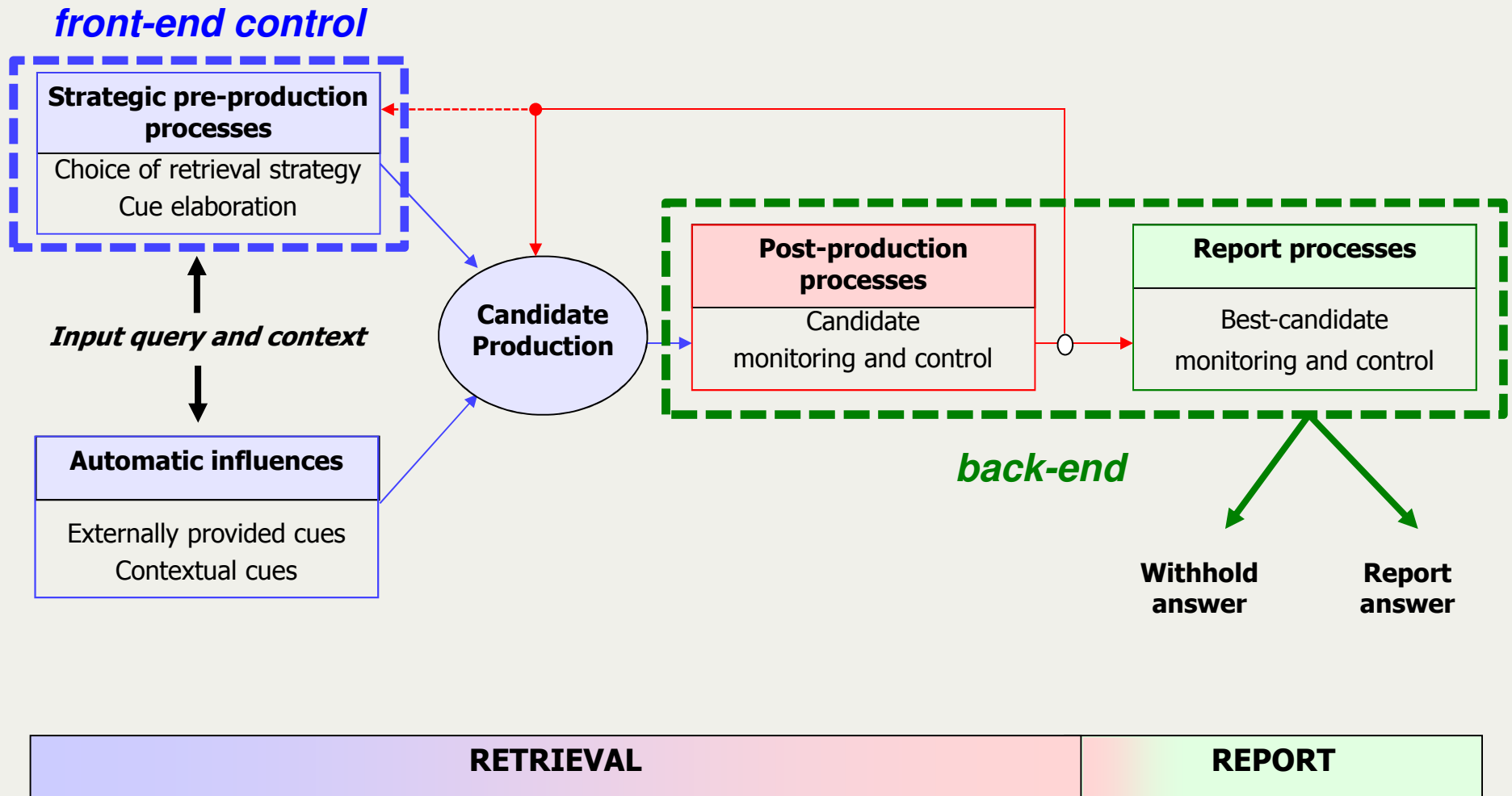
# Rational

The same may be true in memory:

- post-production monitoring and control processes that identify and screen out false memories. *[back-end]*
- improved production, so that fewer false memories are produced in the first place. *[front-end]*



# META-RAR: Metacognitively Guided Retrieval and Report



(Halamish, Goldsmith & Jacoby, In preparation; Koriat, Goldsmith, & Halamish, 2008;  
Based on Koriat & Goldsmith, 1996)

## RAR-QAP methodology

Cue Word	Produced Candidates	Confidence	Report Decision
TABLE	CHAIR CHAIR CHEER	<u>40</u> %	YES / NO
LIGHT	SKIRT S _ _ _ _ S _ _ _ _	<u>100</u> %	YES / NO
LOCK	TIMER TUNER T _ _ ER	<u>80</u> %	YES / NO

## RAR-QAP methodology

Cue Word	Produced Candidates	Confidence	Report Decision
TABLE	CH <u>A</u> IR CH <u>O</u> IR CH <u>E</u> ER	<u>40</u> %	YES/NO
LIGHT	SK <u>I</u> RT S _ _ _ S _ _ _	<u>100</u> %	YES/NO
LOCK	T <u>I</u> M <u>E</u> R T <u>U</u> N <u>E</u> R T _ _ E <u>R</u>	<u>80</u> %	YES/NO

### MEASURES:

➤ **Production quality**

➤ **Candidate monitoring**

➤ **Best-candidate monitoring and control**

➤ **Free-report performance**

### Production quality:

- **1<sup>st</sup>-Candidate target percent**– % of items for which the target is the first candidate that comes to mind.

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### MEASURES:

➤ Production quality

➤ Candidate monitoring

➤ Best-candidate monitoring and control

➤ Free-report performance

**Candidate monitoring** – proportion of identified\* produced targets (hits), minus proportion of identified non-targets when the target was not produced (false alarms). *[corrected hit rate]*

\*"Identified" = chosen as best-candidate answer with confidence > 50%.



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LOCK	T <u>IM</u> ER T <u>UN</u> ER T _ _ ER	<u>80</u> %	YES/NO

### MEASURES:

➤ Production quality

➤ Candidate monitoring

➤ Best-candidate monitoring and control

➤ Free-report performance

**Best-candidate monitoring** – relationship between subjective confidence and objective correctness of best-candidate answers. [(1) calibration bias; (2) within-subject gamma correlation].

**Report criterion** – subjective confidence level above which answers are volunteered and below which they are withheld.

## RAR-QAP methodology

Cue Word	Produced Candidates	Confidence	Report Decision
TABLE	CH <u>A</u> IR CH <u>O</u> IR CH <u>E</u> ER	<u>40</u> %	YES/NO
LIGHT	SK <u>I</u> RT S _ _ _ S _ _ _	<u>100</u> %	YES/NO
LOCK	T <u>I</u> M <u>E</u> R T <u>U</u> N <u>E</u> R T _ _ E <u>R</u>	<u>80</u> %	YES/NO

### MEASURES:

- Production quality
  - Candidate monitoring
  - Best-candidate monitoring and control
- Free-report performance

**Free-report quantity** – % of *items* for which the target was produced and volunteered.

**Free-report accuracy** – % of *volunteered answers* that are correct (targets).

## Current Research

- Literature review for controlled processes at retrieval (Koriat, Goldsmith & Halamish, 2008):
  - Previous research has emphasized various back-end processes  
(e.g., Brainerd, Reyna, Wright, & Mojardin, 2003; Goldsmith & Koriat, 1999; Jacoby, Kelley, & Dywan, 1989; Johnson, Hashtroudi, & Lindsay, 1993; Kelley & Jacoby 1998; Kelley & Rhodes, 2002; Koriat & Goldsmith, 1994, 1996; Whittlesea, 2002; Whittlesea & Williams, 2001a, 2001b; Dodson & Schacter, 2001, 2002)
  - Scarce work on front-end processes  
(Higham & Tam, 2005, 2006; Jacoby, Shimizu, Velanova, & Rhodes, 2005; Jacoby, Shimizu, Daniels & Rhodes, 2005)
- **In this project we have focused on possible means of front-end control.**
  - Source constrained retrieval
  - Choice of retrieval strategy

## Source-constrained retrieval

Self-initiated use of source information to constrain what comes to mind during retrieval (Jacoby et al., 2005)

- mental reinstatement of encoding operations

## Source-constrained retrieval

### Questions:

- Do rememberers use source-constrained retrieval in attempting to enhance recall?
- What is the locus of source-constrained recall?
  - Front-end (*production*)
  - Back-end (candidate or best-candidate *monitoring*)
  - Both?
- Does source-constrained recall actually enhance recall performance?

## Source-constrained retrieval

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# Source-constrained retrieval

## Exp. 1 Method

### Phase 1: reading

List 1

Read the following pairs:

salad - glass

bee - clip

### Phase 2: levels of processing

Lists 2 / 3

Deep

Which word is more pleasant?

bucket - circus

lighter - street

Within

Shallow

Which word has more syllables?

food - tango

tunnel - bead

Filler task (5 min)

### Phase 3: cued recall

Lists 2 / 3 + 1

Deep

Recall targets compared on pleasantness

bucket - c\_\_\_\_\_

Salad - g\_\_\_\_\_

Within

Shallow

Recall targets compared on # of syllables

food - t\_\_\_\_\_

bee - c\_\_\_\_\_

Filler task (15 min)

### Phase 4: recognition

Lists 1 + distractors

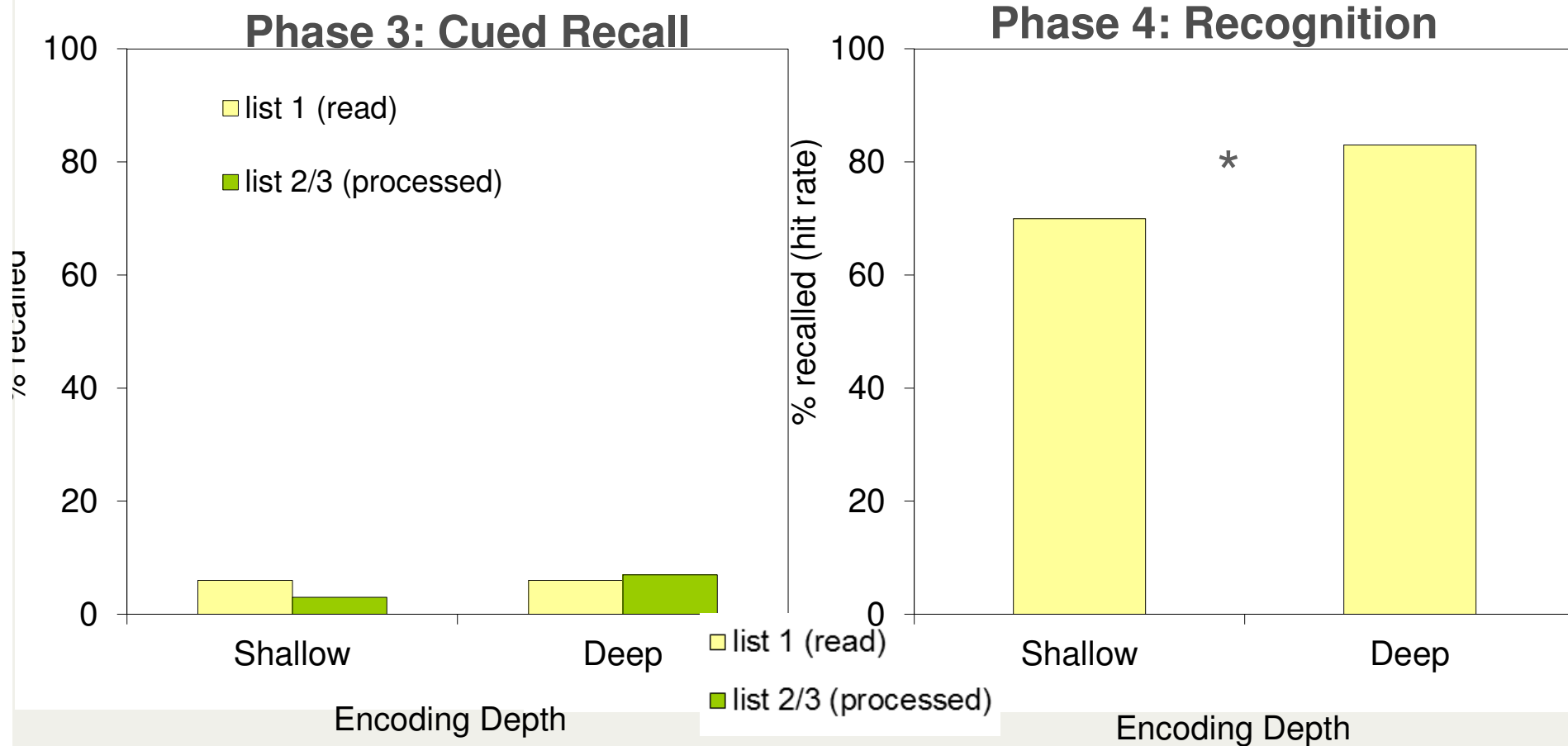
Was this word presented before (as a cue)?

salad

bee

# Source-constrained retrieval

## Exp. 1 Results





## Source-constrained retrieval

### Questions:

- Do rememberers use source-constrained retrieval in attempting to enhance recall? **YES**
- What is the locus of source-constrained recall?
  - Front-end (*production*)
  - Back-end (candidate or best-candidate *monitoring*)
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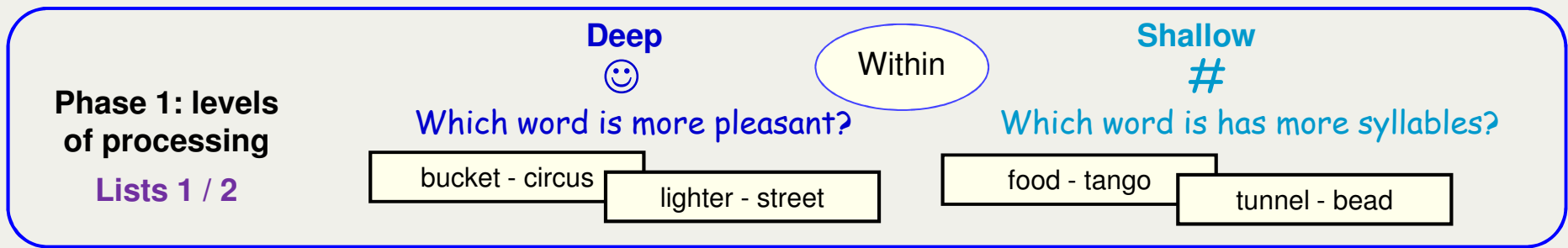
## Source-constrained retrieval

### Questions:

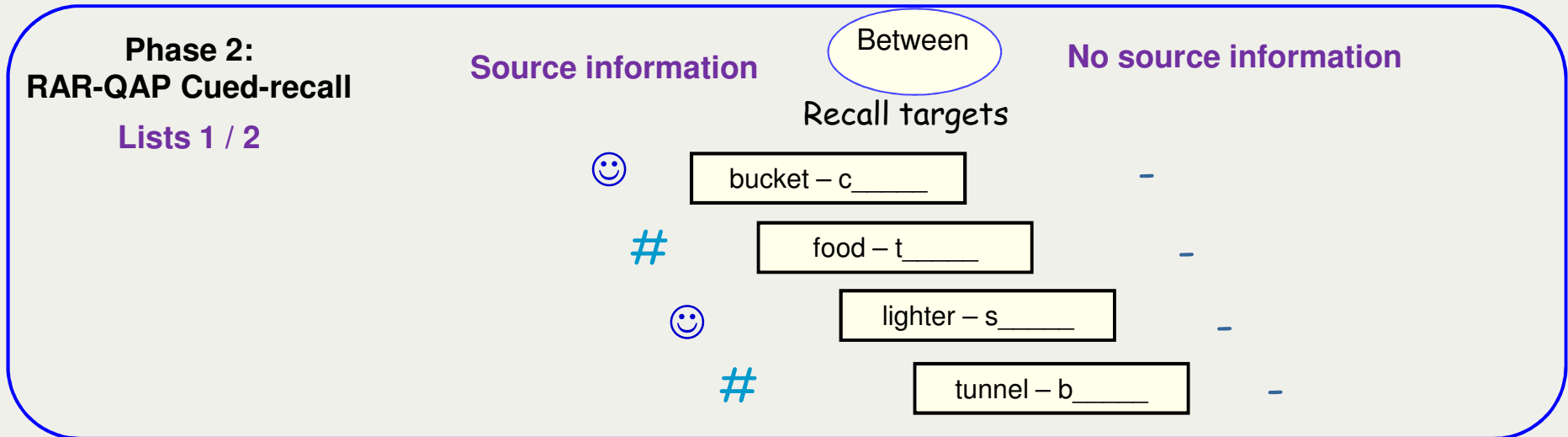
- Do rememberers use source-constrained retrieval in attempting to enhance recall? **YES**
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# Source-constrained retrieval

## Exp. 2 Method

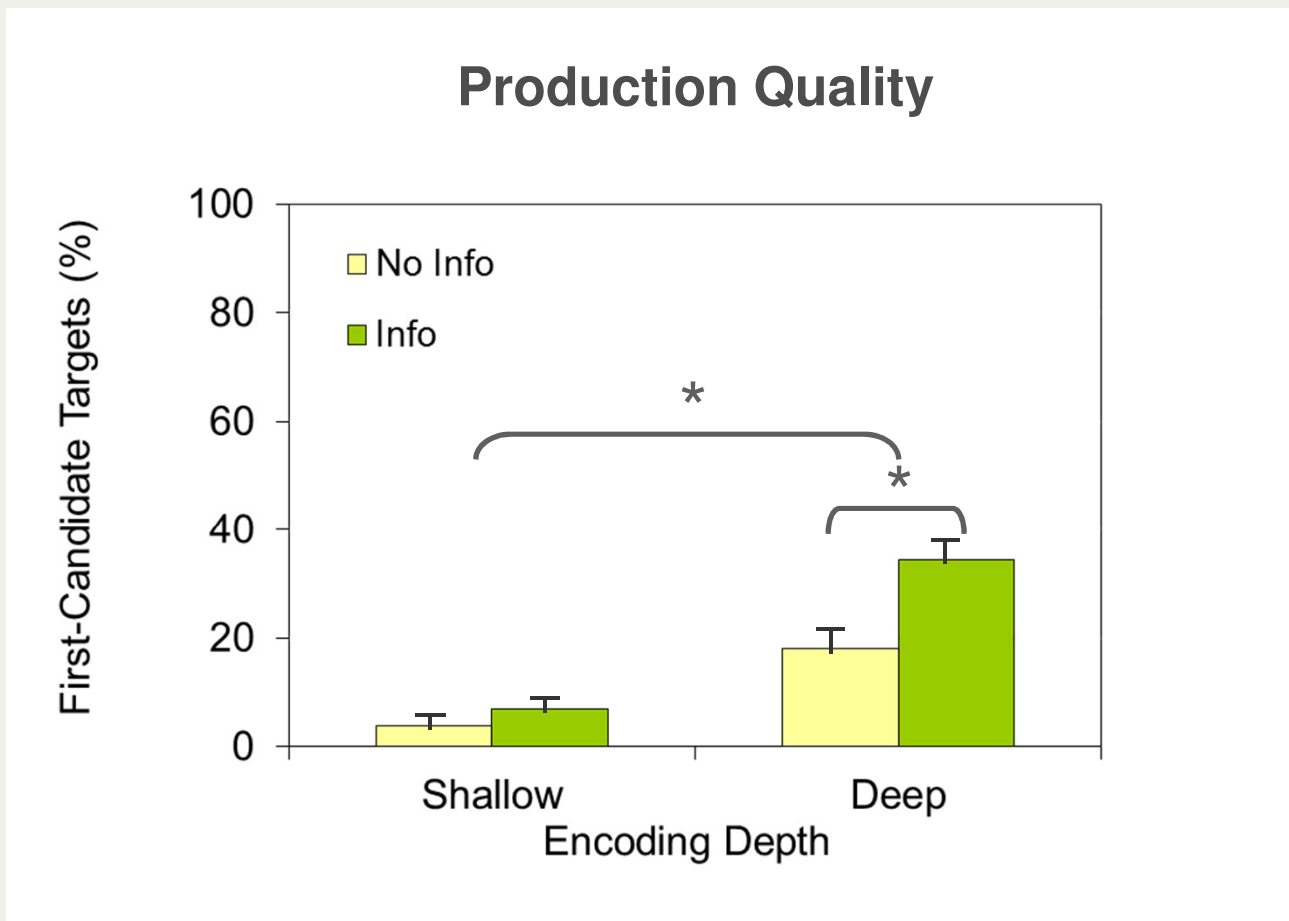


Filler task (5 min)



# Source-constrained retrieval

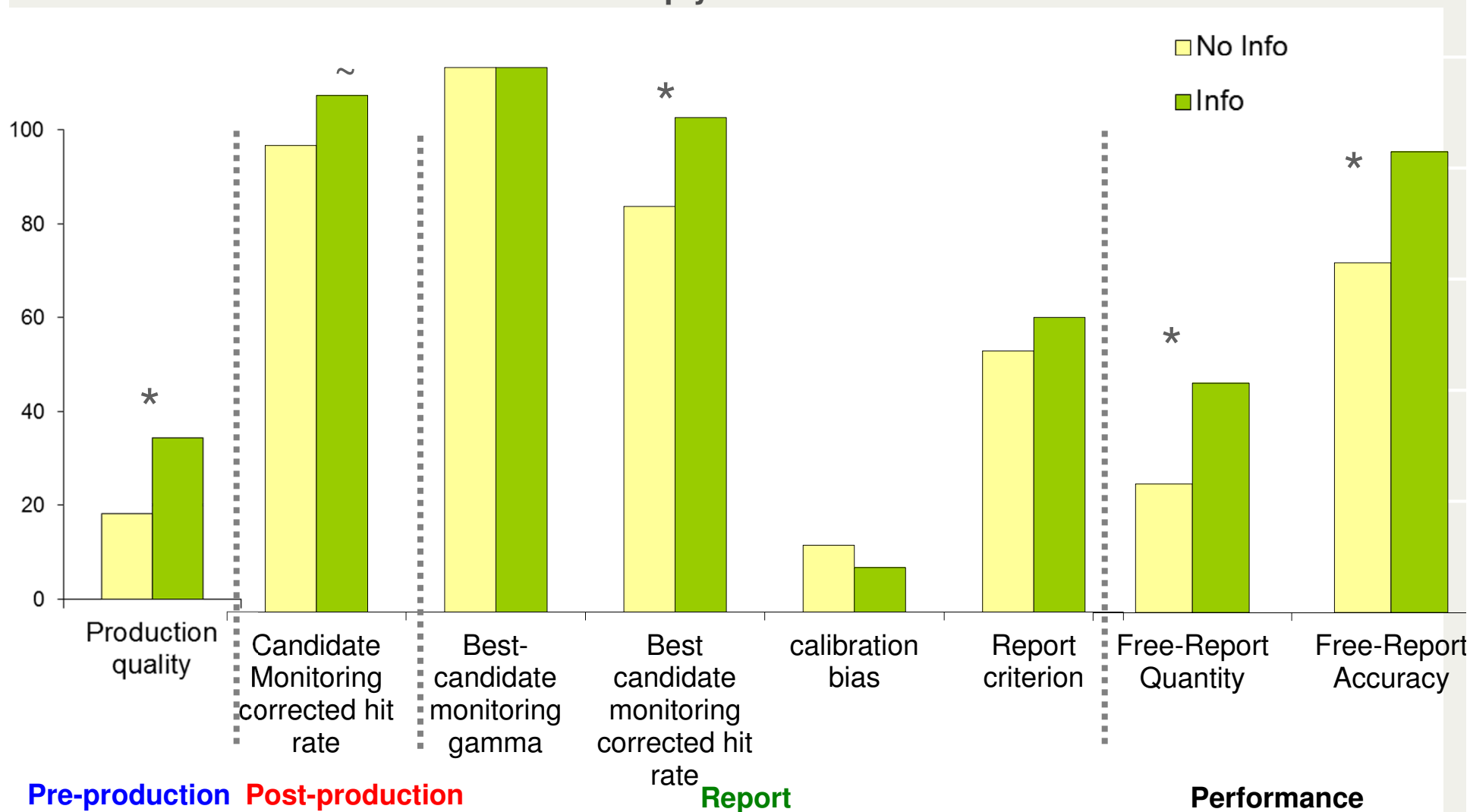
## Exp. 2 Results



# Source-constrained retrieval



## Exp. 2 Results

### Effects of Source Information Deeply Encoded Pairs



## Source-constrained retrieval

### Questions:

- Do rememberers use source-constrained retrieval in attempting to enhance recall? **YES!**
- What is the locus of source-constrained recall?
  - Front-end (*production*) 
  - Back-end (candidate or best-candidate *monitoring*) 
  - Both?
- Does source-constrained recall actually enhance recall performance? **YES**

## Current Research

- Previous research has emphasized various post-production processes

(e.g., Brainerd, Reyna, Wright, & Mojardin, 2003; Goldsmith & Koriat, 1999; Jacoby, Kelley, & Dywan, 1989; Johnson, Hashtroudi, & Lindsay, 1993; Kelley & Jacoby 1998; Kelley & Rhodes, 2002; Koriat & Goldsmith, 1994, 1996; Whittlesea, 2002; Whittlesea & Williams, 2001a, 2001b; Dodson & Schacter, 2001, 2002)

- Scarce work on pre-retrieval processes

(Higham & Tam, 2005, 2006; Jacoby, Shimizu, Velanova, & Rhodes, 2005; Jacoby, Shimizu, Daniels & Rhodes, 2005)

- **In this project we have focused on possible means of front-end control.**

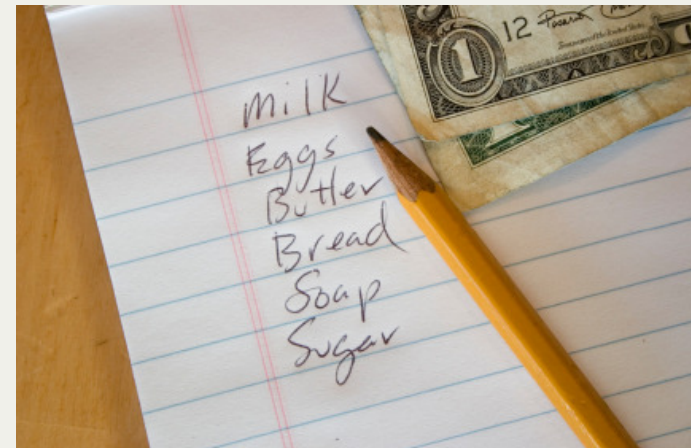
- Source constrained retrieval
- Choice of retrieval strategy

## Choice of retrieval strategy

### Two modes of candidate production:

- **Direct retrieval** – "homing in" on the episodic memory representation, using relatively specific and constraining retrieval cues.
- **Generate-recognize** – "casting a wide net" using less specific episodic cues and relying more on semantic-associative cues to generate a set of candidates from which the target can be identified.

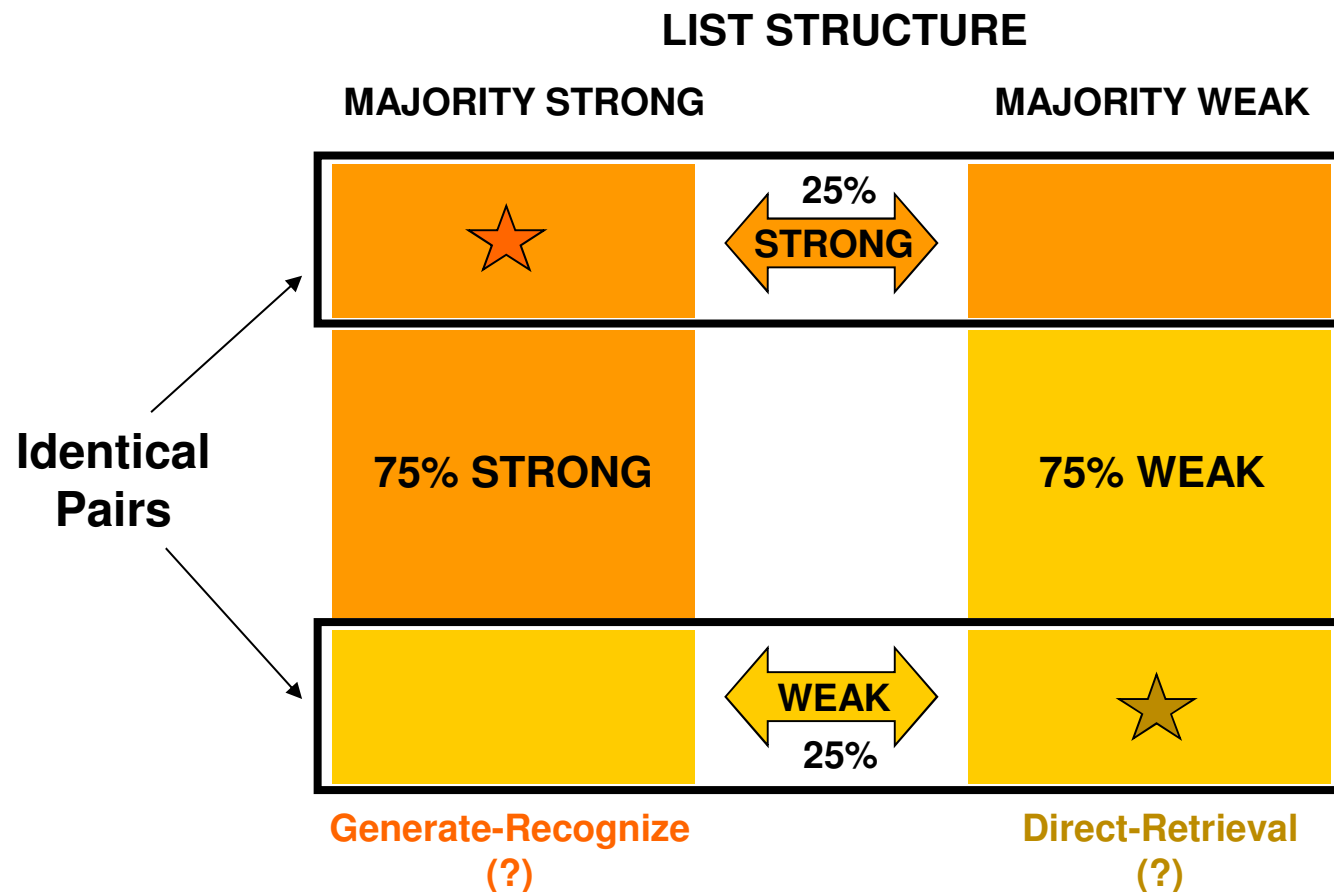
**QUESTION:** Are these two modes under strategic control?





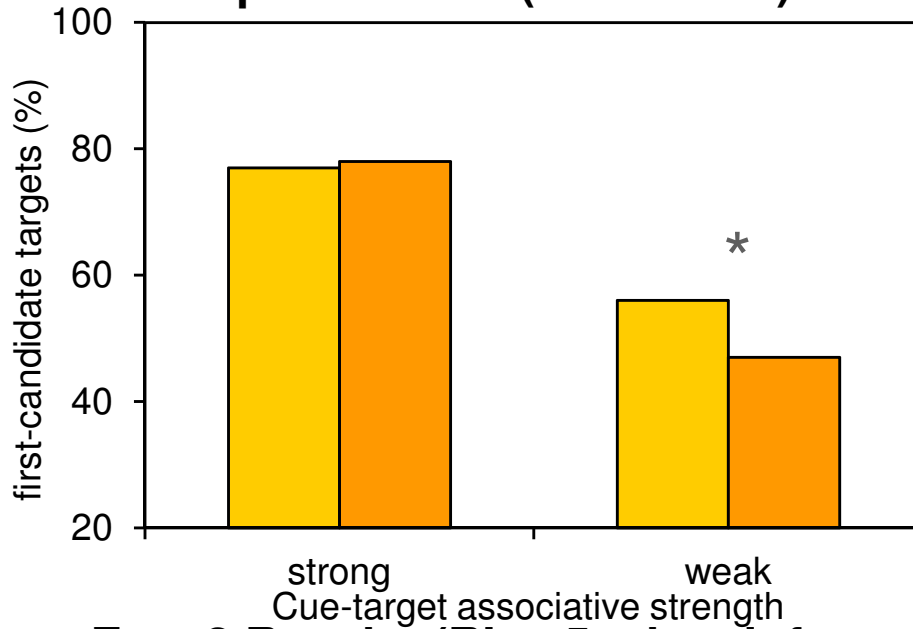
## Choice of retrieval strategy

- Participants studied one of 2 lists. **List structure** (majority-strong or majority weak) manipulated between participants.
- **Cued recall test** using RAR-QAP procedure.

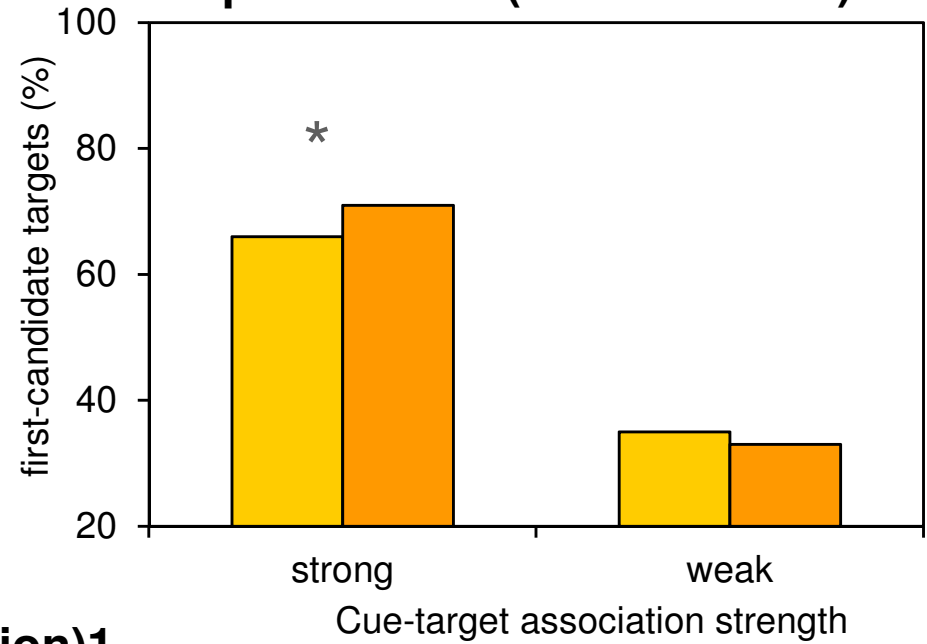


# Choice of retrieval strategy

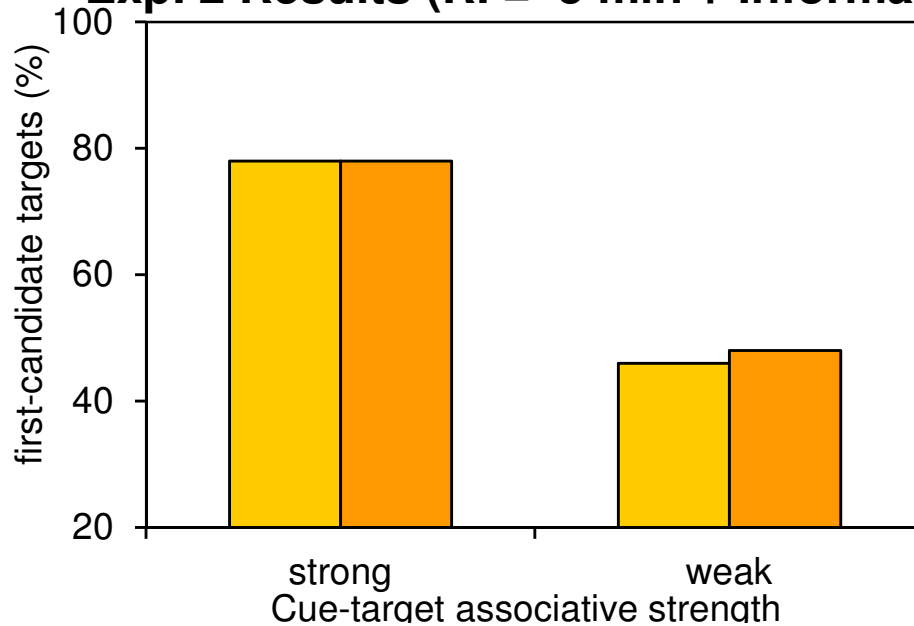
## Exp. 1 Results (RI = 5 min)



## Exp. 3 Results (RI = 24 hours)



## Exp. 2 Results (RI = 5 min + Information)1



majority weak

majority strong

## Choice of retrieval strategy

### Two modes of candidate production:

- **Direct retrieval** – "homing in" on the episodic memory representation, using relatively specific and constraining retrieval cues.
- **Generate-recognize** – "casting a wide net" using less specific episodic cues and relying more on semantic-associative cues to generate a set of candidates from which the target can be identified.

**QUESTION:** Are these two modes under strategic control? **YES!**



## Conclusion

- Quality control in memory recall involves:
  - post-production monitoring and control processes that identify and screen out false information. *[back-end]*
  - control over the production process, so that less false information is produced in the first place. *[front-end]*

## Application

- The META-RAR framework and accompanying RAR-QAP methodology are useful in guiding an integrated examination of both types of metacognitive control, and their performance consequences.
  - Cue reinstatement (Halamish & Goldsmith, in preparation)
  - Testing as a mean of studying (Thomas & McDaniels, 2012)
  - Experience with proactive interference (Wahlheim & Jacoby, 2011)

Thank you!



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