Experimental and Computational Methods in Linguistic Research

Spring 2025

Instructor: Sanghee Kim

Week 2

Roadmap

- Lexical access
- Experimental method and design
- Sign-up sheet

Lexical access

Lexical access

- How do we understand words?
- How are words represented in our mind?

Through meaning?

- ‘cat’
- ‘cat’ → Joy (my brother’s cat)
- ‘cat’ → feline family
- ‘cat’ → …

WordNet

- https://wordnet.princeton.edu/
- WordNet® is a large lexical database of English. Nouns, verbs, adjectives and adverbs are grouped into sets of cognitive synonyms (synsets), each expressing a distinct concept. Synsets are interlinked by means of conceptual-semantic and lexical relations

- https://wordvis.com/
- https://hyperdic.net/en

Through meaning?

- To what extent do you think humans use representations like WordNet to access word meaning? What's similar? What's different?

Tip of the tongue

- “Could you go grab me that .. that .. ch …” (pointing at the blackboard).
- Chalk!
- How did lexical access happen?

Through sound?

- ‘cat’ → ‘caterpillar’
- ‘cat’ → ‘catalogue’
- ‘cat’ → …

Through meaning?

- To what extent do you think humans use acoustic/phonological cues – specifically the sound overlap in the beginning of a word – to access words?

Lexical access

- **Lexeme**: basic abstract unit of meaning (CAT).
- **Lemma**: the form used to access the lexeme entry – varies across languages, e.g., ‘cat’ (EN), ‘chat’ (FR), ‘gata’ (SP), ‘kat’ (DU)…
- **Lexicon**: the vocabulary, *dictionary,* or an inventory of lexemes.

Bigger question

- How are words accessed from our mental lexicon?

- Through meaning? Through sounds?

Additional questions

- Is the process of lexical access universal across languages?
- Do speakers of multiple languages have the same access mechanism?

Experimental method and design

What are we trying to investigate?

- To what extent does semantic and phonological relatedness affect word access?

Methods

- What are possible experimental methods to examine how lexical access happens in the mind?

Measures

- Offline vs. Online?

Online measures

- *Real-time* aspects of language processing

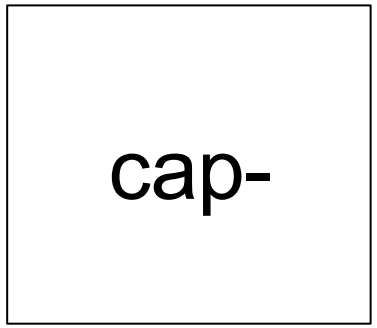
- Processes underlying human language processing are very rapid (on the order of milliseconds) and often not accessible to introspection.

- Psycholinguistic theories make explicit claims about the relative timing; hence, on-line methods often play a crucial role in allowing us to compare competing theories.

Offline methods

- E.g., questionnaires and surveys
- Experimental paradigms often combine both off-line and on-line measures.
- Because people engage in real-time (on-line) processing before reaching their off-line interpretation, these off-line interpretations can yield insights into the nature of on-line processing as well.

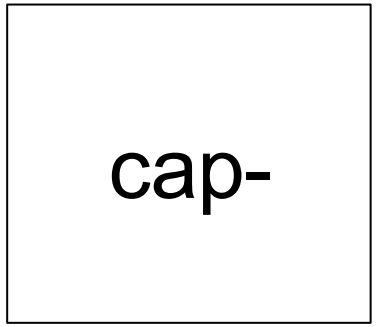
(audio)



How do we know what word has been activated/accessed in the mental lexicon?

Lexical decision task

(audio)



Is ‘prison’ a real word?

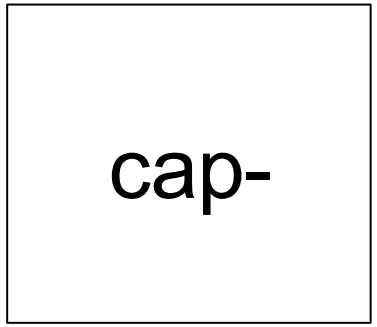
Is ‘ship’ a real word?

Captivate
Capacity
Capitulate
Capital
Capsize

We can measure **reaction times** (ms).

Lexical decision task

(audio)



Captivate
Capacity
Capitulate
Capital
Capsize

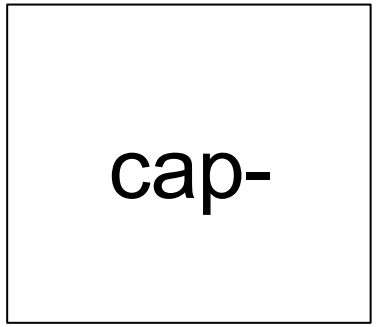
Is ‘prison’ a real word? [condition A]

Is ‘ship’ a real word? [condition B]

If reaction times are faster in condition A, what does this suggest?

Lexical decision task

(audio)



Is ‘prison’ a real word? [condition A]

Is ‘ship’ a real word? [condition B]

Captivate
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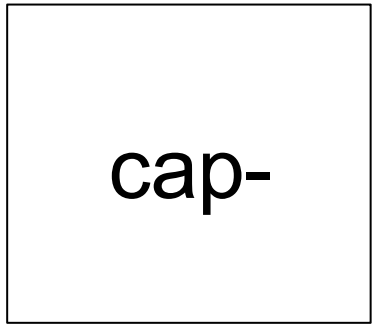
If reaction times are faster in condition A, what does this suggest?

Lexical decision task

(audio)



Is ‘prison’ a real word? [condition A]

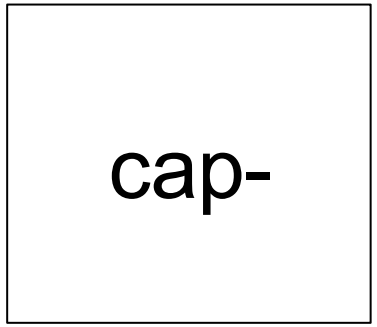
Is ‘ship’ a real word? [condition B]

Captivate
Capacity
Capitulate
Capital
Capsize

If reaction times are faster in condition B, what does this suggest?

Lexical decision task

(audio)



Is ‘prison’ a real word? [condition A]

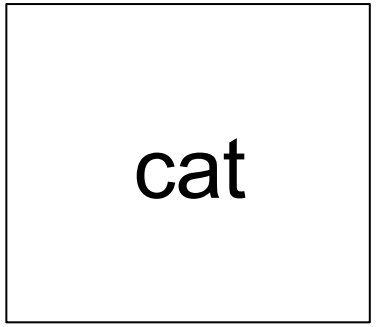
Is ‘ship’ a real word? [condition B]

Captivate
Capacity
Capitulate
Capital
Capsize

If reaction times are faster in condition B, what does this suggest?

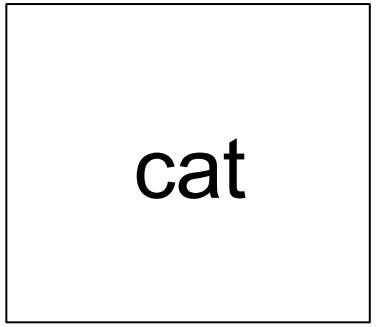
Revisiting our research question

- How is ‘cat’ accessed from our mental lexicon?
- To what extent does semantic and phonological relatedness affect word access?

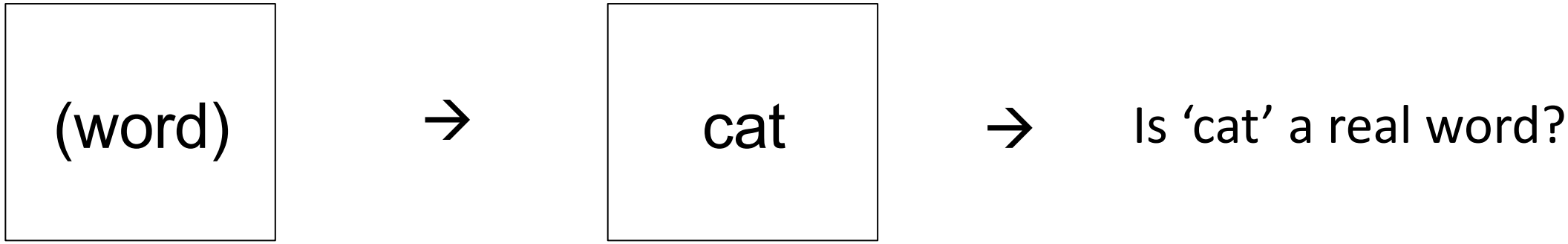


Lexical decision task

We will change the order of presentations for this task.

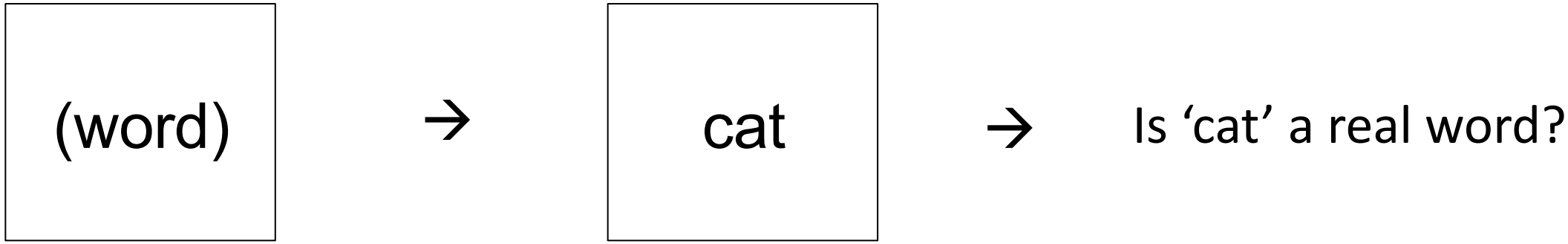


Lexical decision task



Recall our question: To what extent does semantic and phonological information affect lexical retrieval?

Lexical decision task



‘competitor’ ‘target’

What kinds of competitor do we need?

Lexical decision task: Experimental design

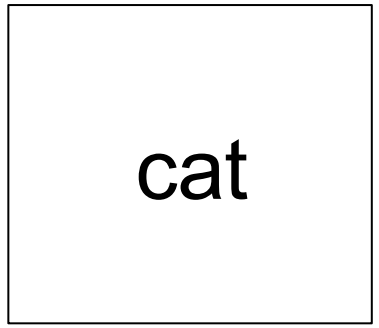
[condition A] phonologically related word

[condition B] semantically related word

[condition C] unrelated

nonce word

→



Examples?

Lexical decision task: Experimental design

phonologically related word: ‘caterpillar’

semantically related word: ‘dog’

Unrelated: ‘yacht’

nonce word: ‘sploons’

→

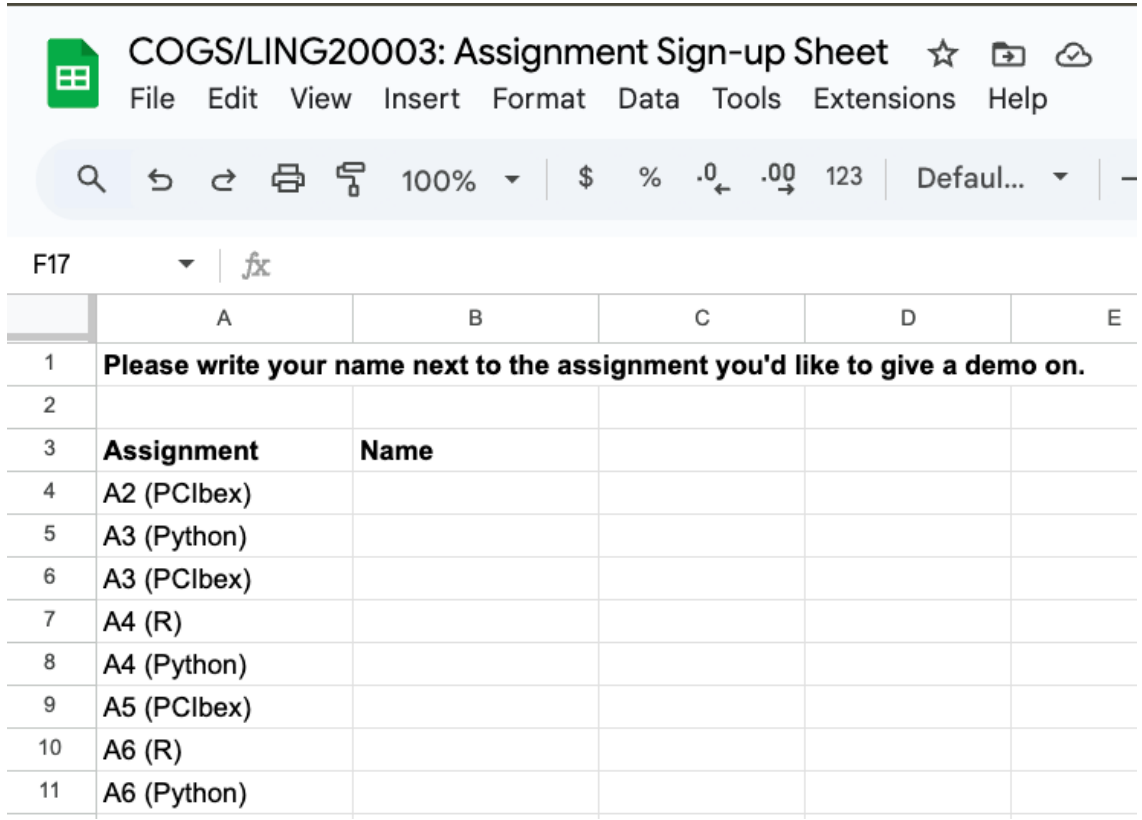
cat

What would the reaction times suggest?

Lexical decision task: Design and materials

- (material worksheet)

Sign-up sheet



COGS/LING20003: Assignment Sign-up Sheet

File Edit View Insert Format Data Tools Extensions Help

100% $ % .0 .00 123 Defaul...

F17

	A	B	C	D	E
1	**Please write your name next to the assignment you'd like to give a demo on.**				
2					
3	**Assignment**	**Name**			
4	A2 (PCIbex)				
5	A3 (Python)				
6	A3 (PCIbex)				
7	A4 (R)				
8	A4 (Python)				
9	A5 (PCIbex)				
10	A6 (R)				
11	A6 (Python)				

- Please fill it in by this Friday.
- You can find the link on Canvas (https://docs.google.com/spreadsheets/d/1_jsgi-N09OyolJhvVRX9ddG8RXTXTGrZAmp-Ars-TIw/edit?usp=sharing)

Roadmap

- Considerations for experimental design and procedure
- Setting up an experiment on (PC)Ibex (Farm)

So far

- **Research question**
  - To what extent does semantic and phonological relatedness affect word access?

So far

- **Procedure**
  - Competing word → Target word → Lexical decision task
- **Materials** (1 example)
  - {‘category’, ‘dog’, ‘yacht’} – ‘cat’

- *What else needs to be spelled out? What else do we need?*

(PC)Ibex (Farm)

What is it?

- Internet-based experiment (IBEX)
- Ibex Farm → PCIbex (Penn Controller Ibex)
- Ibex Farm and PCIbex syntax are interchangeable
- The platform is now provided by PCIbex

- Controllers and arguments
- Combining multiple controllers
- Using controllers to create a lexical decision task

Key concepts

- https://github.com/addrummond/ibex/blob/master/docs/manual.md

Introduction tutorial

- https://farm.pcibex.net/r/vMnmBH/

Material and design

Spelling out the materials

- **Materials** (1 example)
  - {‘category’, ‘dog’, ‘yacht’} – ‘cat’

- *What kind of target words should we use?*

Spelling out the materials

- **Materials** (1 example)
  - {‘category’, ‘dog’, ‘yacht’} – ‘cat’

- *What kind of competing words should we use?*

Spelling out the materials

- **Materials** (1 example)
  - {‘category’, ‘dog’, ‘yacht’} – ‘cat’

- *How many sets of words should we create?*

Experimental design

- We are **manipulating** one **factor**, i.e., the relatedness between the competitor word and the target word.

- We have three **conditions** (or three **levels**):
  - Phonologically related word
  - Semantically related word
  - Unrelated word

Experimental design

- We are implementing a **single-factor design**, where there is one **independent variable**.
    - An independent variable is the variable manipulated by the researcher; the **dependent variable** is the variable that is measured.
    - What is the dependent variable in a lexical decision task?
        - Response/reaction time (RT)

Experimental materials (stimuli)

Target word

Competitor word

- Task: Come up with 2 **items**.
- How many number of words is this?

Experimental materials (stimuli)

- Usually, for practical reasons, the experimental materials are organized in long format.

  - Example: ItemNo (item number), Condition, Target, Competitor
  - **Item (number)**: the unique number given to the unique pair of words. So {‘category’, ‘dog’, ‘yacht’} and ‘cat’ should be assigned the same item number.

Experimental materials (stimuli)

- Example (.csv file)

Experimental materials (stimuli)

- *What kind of target words should we use?*
  - E.g., 1-syllable word
- *What kind of competing words should we use?*
  - Consider the experimental design (and additional constraints)
- *How many sets of words should we create?*
  - Rule of thumb: 6 unique items per condition
  - E.g., 3 conditions * 6 items = 18 sets of words = 18*4 words

Procedure

Spelling out the procedure

- **Procedure**
  - Competing word → Target word → Lexical decision task

- *For how long do we present the competing and target words?*

Spelling out the procedure

- **Procedure**
  - Competing word → Target word → Lexical decision task

- *How much time is given for transitioning from the competing word to the target word?*

Spelling out the procedure

- **Procedure**
  - Competing word → Target word → Lexical decision task

- *How much time is given for transitioning from the target word to the lexical decision task?*

Spelling out the procedure

- **Procedure**
  - Competing word → Target word → Lexical decision task

- *How much time is given for participants to complete the task? Or, do we want to give them a time limit?*

Spelling out the procedure

- **Procedure**
  - Competing word → Target word → Lexical decision task

- *Let's say we will present the competing word for 50 ms*

Assignment 2

- Setting up a lexical decision task on PCIbex
- Due next Thursday