

# Experimental Methods for Speech Perception Research Part 2

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April 3, 2017



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# Session Organization

- Setting up and running your experiment
- Experimental methods
- Examples of Experiments

# Setting Up the Experiment

## Design

- Observation of a particular behavior under a controlled situation, with minimal difference between conditions
- Manipulation of the situations where the behavior is observed and measured
- Any observed differences in behavior must result from the experimental manipulation
  - Independent variable: the variable manipulated by the experimenter
  - Dependent variable: the variable measured and recorded by the experimenter
  - An *effect* of our independent occurs if a change in our independent variable produces a change in the dependent variable

# Setting Up the Experiment

## Design

Are we less accurate at recognizing vocoded words than unprocessed words?

- Independent variable: the variable manipulated by the experimenter
  - Vocoding conditions, e.g., none vs. 8-channel noise vocoder; none vs. 16-, 8-, 4-channel noise vocoder
- Dependent variable: the variable measured and recorded by the experimenter
  - Word recognition accuracy

# Setting Up the Experiment

## Design

- Sources of variance
  - Individuals can vary in many ways, e.g., language background, experiences, IQ, sleep, hunger, etc.
  - Environment can vary, e.g., more sunlight, noise, time of day
- Try to control for as much as possible to avoid confounds
  - Participants, environment, materials

# Setting Up the Experiment

## Design - Subjects and Experimental Conditions

### **Independent groups**

- 2 groups of subjects – 2 different treatments or 1 treatment and 1 “control group”
- “Independent samples”: observations in each group are independent from each other, because they come from different subjects

### **Paired groups**

- 1 group of subjects – 2 experimental conditions
- “Paired sample”: the observation pairs in both groups are not independent because they are issued on the same subject

### **Repeated measures**

- 1 group of subjects – several measures
- “Repeated measures”: several on the same subject in each of the experimental conditions

### Independent Sample

cond. n° 1	cond. n° 2
$S_1$	$S_5$
$S_2$	$S_6$
$S_3$	$S_7$
$S_4$	$S_8$
...	...

### Paired Sample

cond. n° 1	cond. n° 2
$S_1$	$S_1$
$S_2$	$S_2$
$S_3$	$S_3$
$S_4$	$S_4$
...	...

### Repeated Measures

	cond. n° 1	cond. n° 2	cond. n° 3
$S_1$	$x_1^1, x_2^1, \dots$	$x_1^2, x_2^2, \dots$	$x_1^3, x_2^3, \dots$
$S_2$	$x_1^1, x_2^1, \dots$	$x_1^2, x_2^2, \dots$	$x_1^3, x_2^3, \dots$
$S_3$	$x_1^1, x_2^1, \dots$	$x_1^2, x_2^2, \dots$	$x_1^3, x_2^3, \dots$
$S_4$	$x_1^1, x_2^1, \dots$	$x_1^2, x_2^2, \dots$	$x_1^3, x_2^3, \dots$
...	...	...	...

S = subjects

Subject allocation across conditions in each design

# Setting Up the Experiment

## Design - Subjects and Experimental Conditions

### Repeated measures

- Reduce subject variance – several measures taken from the same subject in each of the experimental conditions
- Evenly distribute the effects of confounding factors (e.g., presentation order, materials)

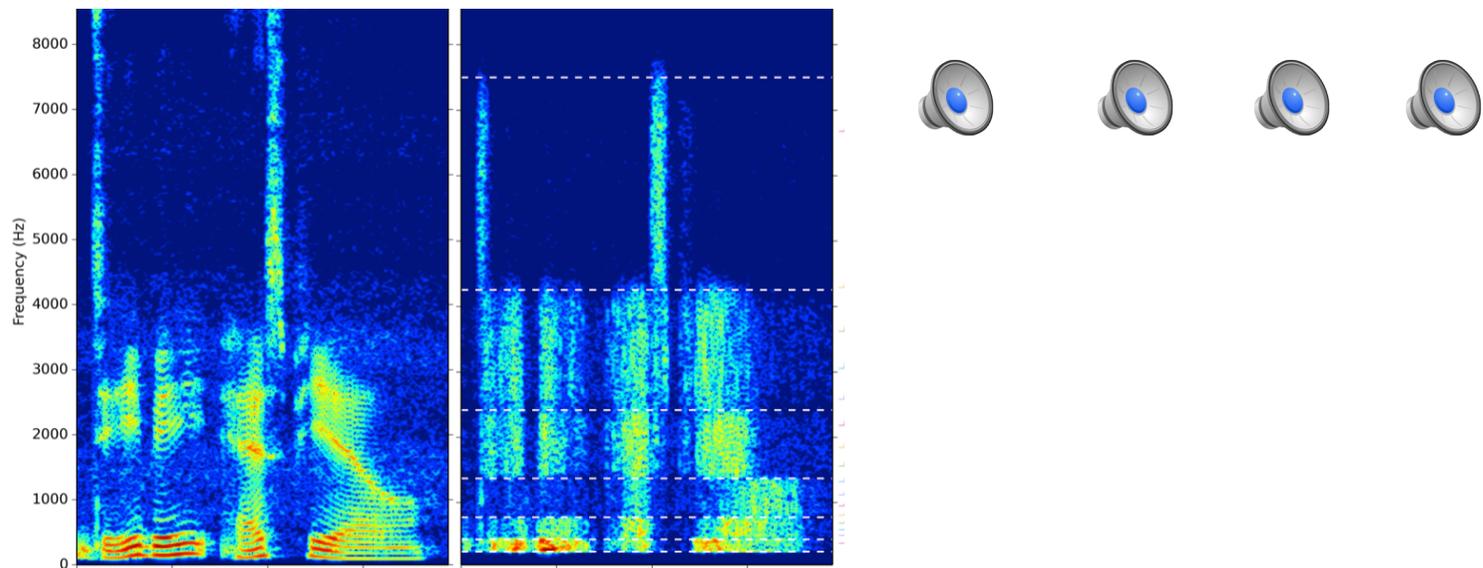
Subject 1	Vocoded <i>List A</i>	Unprocessed <i>List B</i>
Subject 2	Vocoded <i>List B</i>	Unprocessed <i>List A</i>
Subject 1	Vocoded <i>List A</i>	Unprocessed <i>List B</i>
Subject 2	Vocoded <i>List B</i>	Unprocessed <i>List A</i>

# Stimuli

- Naturally-produced
  - Recording talkers producing speech
  - Corpora
    - Linguistic Data Consortium –  
<https://www ldc.upenn.edu/language-resources/data>
- Modified
  - Change naturally-produced stimuli in some way
- Synthetic
  - Generated
- Audio-visual stimuli

# Presentation of Stimuli

- Adding noise or babble
- Degradation
  - Vocoding to simulate hearing with a cochlear implant (<http://www.tigerspeech.com>)



# Degraded Audio-Visual Speech



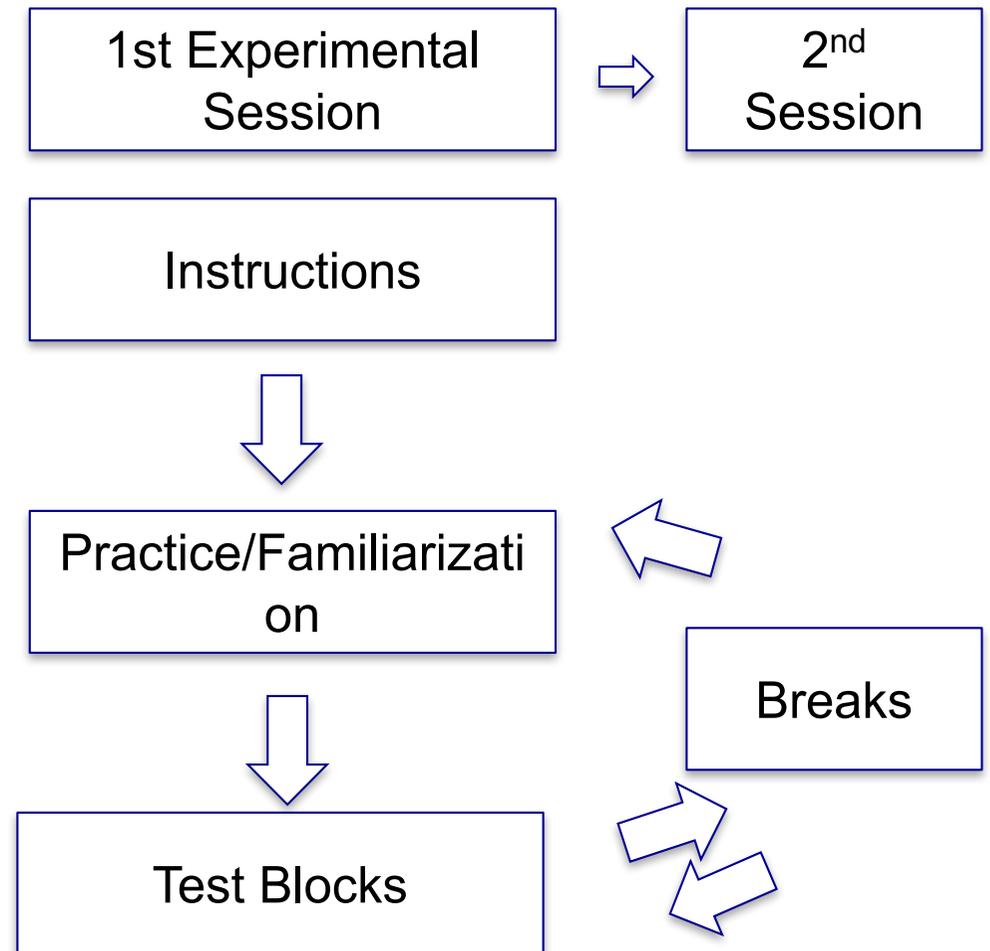
# Setting Up the Experiment

## Software for Running Experiments

- DMDX (free, Windows)
- E-Prime (pay, Windows)
- Presentation (pay, all platforms)
- Matlab, Psychtoolbox (pay, all platforms)
- Psyscope (free, Mac)
- PsychoPy (free, all platforms)
- Linger (free, all platforms)
- WEXTOR (free, runs on the web)
- MouseTracker (free, windows)
- VoiceKey program (free, Windows)
- Praat: Acoustic analysis software (free, all platforms)
- R: Statistics software (free, all platforms)

# Setting Up the Experiment Design

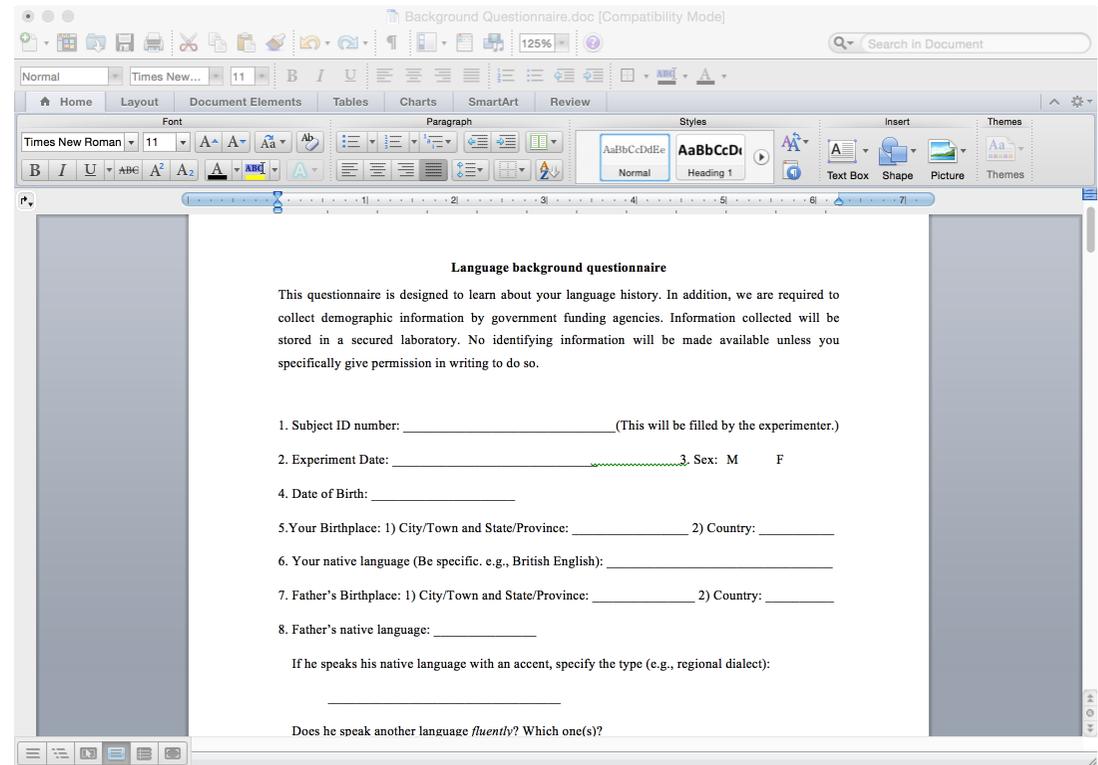
- Instructions
- Practice
- Feedback
- Blocks
- Breaks
- Sessions



# Running an Experiment

## Design & Data Collection

- Paperwork
  - Human Subjects Protections – Study Information, Consent Form
  - Questionnaires
  - Compensation
- Hearing Assessments



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**Language background questionnaire**

This questionnaire is designed to learn about your language history. In addition, we are required to collect demographic information by government funding agencies. Information collected will be stored in a secured laboratory. No identifying information will be made available unless you specifically give permission in writing to do so.

1. Subject ID number: \_\_\_\_\_ (This will be filled by the experimenter.)

2. Experiment Date: \_\_\_\_\_ 3. Sex: M F

4. Date of Birth: \_\_\_\_\_

5. Your Birthplace: 1) City/Town and State/Province: \_\_\_\_\_ 2) Country: \_\_\_\_\_

6. Your native language (Be specific. e.g., British English): \_\_\_\_\_

7. Father's Birthplace: 1) City/Town and State/Province: \_\_\_\_\_ 2) Country: \_\_\_\_\_

8. Father's native language: \_\_\_\_\_

If he speaks his native language with an accent, specify the type (e.g., regional dialect):  
\_\_\_\_\_

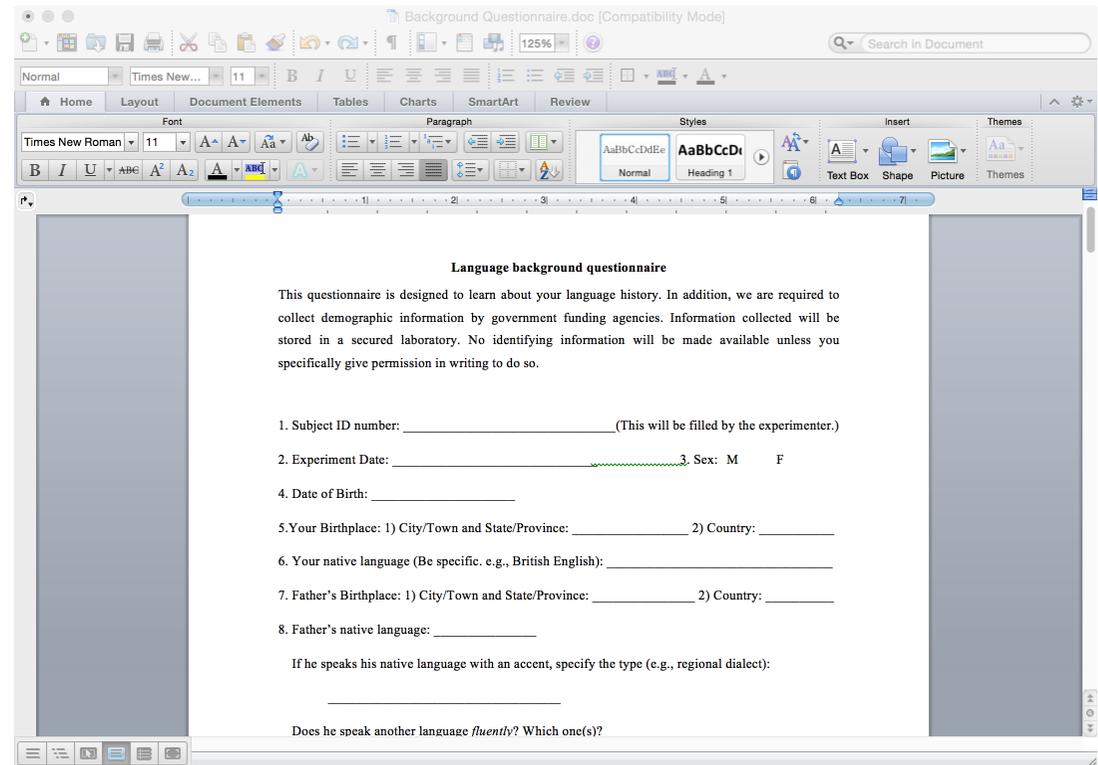
Does he speak another language *fluently*? Which one(s)?

# Running an Experiment

## Design & Data Collection

### Questionnaires

- Language Background – Different Listener Groups
  - Age
  - Native and second language(s)
  - Region of origin and residential history
  - Hearing impairment, use of any hearing device (if so, when, etc.)
  - Musicians
  - Education



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# Running an Experiment

## Design & Data Collection

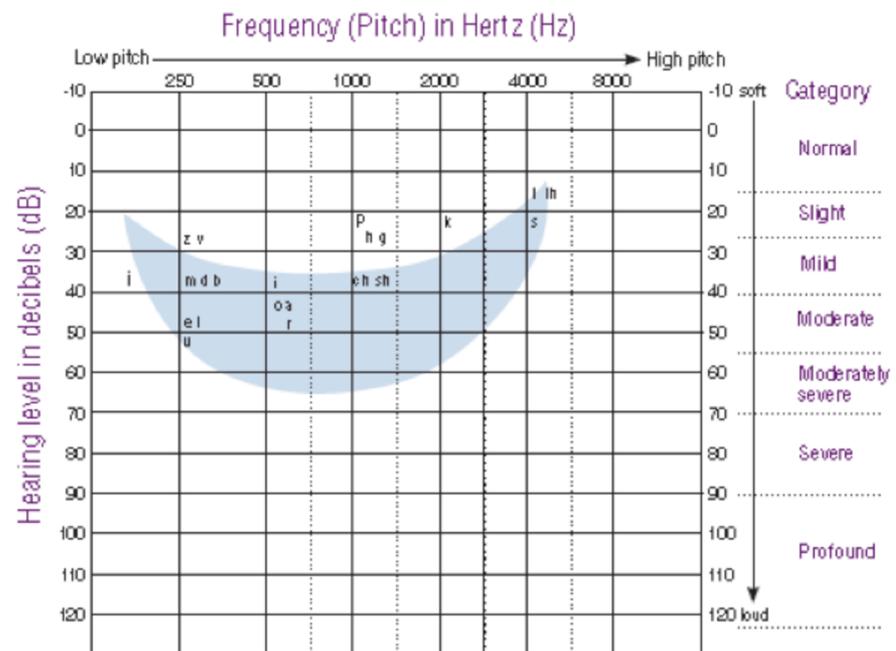


### Questionnaires

- Hearing questionnaires
  - Speech, Spatial and Qualities of Hearing Scale - SSQ (Gatehouse & Noble, 2004)
- Cognitive assessments
  - Mini-mental State Examination - MMSE (Folstein et al., 1975)

### Hearing Assessment

- Hearing thresholds at 1000 Hz, 2000 Hz, 4000 Hz, 8000 Hz, 500 Hz, and 250 Hz



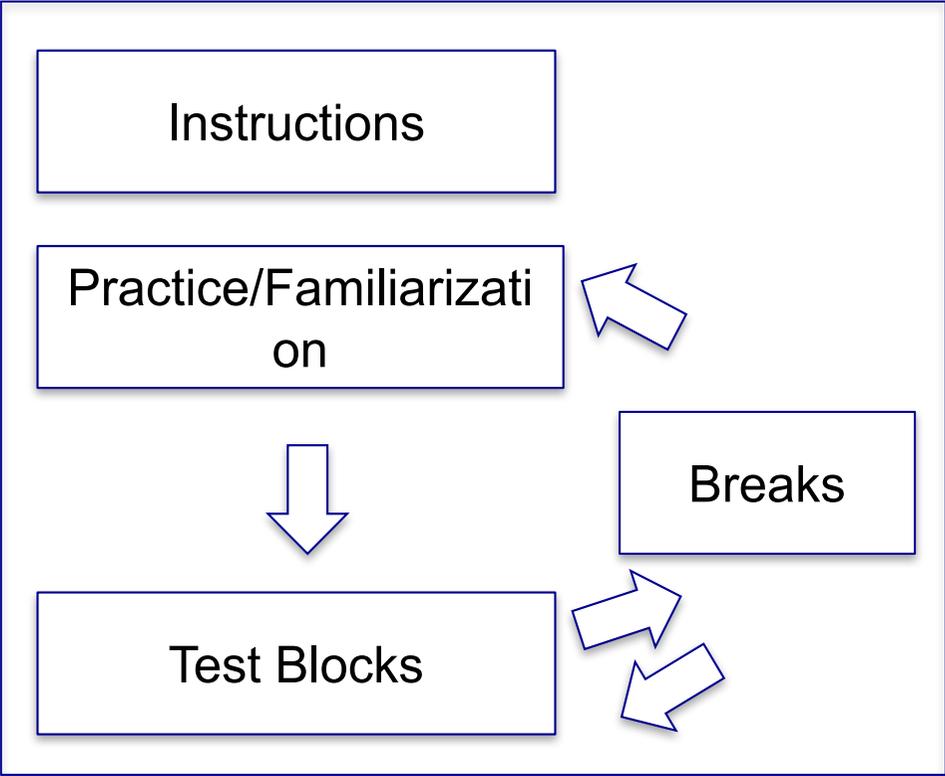
1st Experimental Session



2<sup>nd</sup> Session

Paperwork  
(Study Info, Consent Form)

Hearing Assessment



Language Background  
Questionnaire

Compensation



# **More Methods: Spoken Word Recognition**

# Spoken Word Recognition

- Some basic questions
  - How are words organized in memory and how are they accessed by human listeners?
  - What information does the lexicon have about words?
- Some observations
  - Word recognition occurs rapidly
  - Word recognition can take place with only partial input
  - High frequency words are recognized easier, faster, and with less input than low frequency words
  - Context facilitates word recognition

# **Sentence/Word Recognition Task**

# Word Recognition

Word recognition tasks are used to explore how words are processed and represented in the mental lexicon

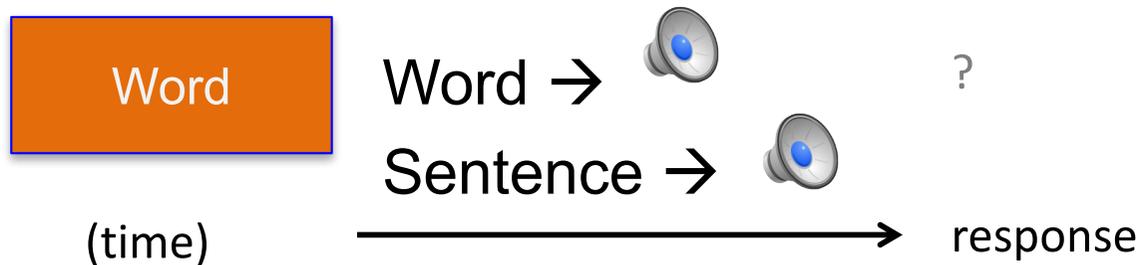
These basic tasks have been important in investigating some important issues in spoken word recognition

- The influence of language background and experience on spoken word recognition
- The effects of lexical (e.g., lexical frequency) and contextual variables (e.g., semantic information) on spoken word recognition
- The influence of different sources of variability (e.g., talker variability, speaking rate) on spoken word recognition
- The impact of noise or competing talkers on spoken word recognition

# Word Recognition

*Identify the word(s)*

- *Materials:* Sentences, parts of sentences, words
- *Trial:* 1 item
- *Task:* Identify the word or sentence



# Word Recognition

- *Responses:*
  - Write out on keyboard, oral response
- *Measures:*
  - Accuracy

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# Word Recognition

- *Design Considerations:*
  - Modality
  - Characteristics of talkers
  - Lexical and/or contextual characteristics
  - Degradation
- Many variations of this basic task
  - Oral responses
  - Word shadowing

# Gating Task

# Gating

Gating tasks (Grosjean, 1980) are used to explore how words are processed

- The amount of acoustic–phonetic information needed to identify a stimulus, such as a syllable, a word, a group of words, etc.
- The influence of phonetic, lexical and contextual variables in word recognition
- The underlying processes leading to recognition (competition, etc..)

# Gating

*Identify word from segments of increasing duration*

- *Materials:* Segments of words; words
- *Trial:* Words presented in segments of increasing duration
- *Task:* Identify the word

# Gating

- Measure the point at which different words are recognised and how this is affected by factors such as context.
  - Word initial cohort: all words matching some portion of the input are activated
  - They are deactivated as more input becomes available, up to the point of “uniqueness”, where only one word remains

# G Ga Gat Gating

[k] → crime, cat, kettle, cold, cure,  
commander, catalog, catalyst, canon,...

[kae] → cat, catalog, catalist, kettle? ...

[kaet] → cat, catalog, kettle?, catalist, ...

[kaet<sup>◀</sup>] → catalog, kettle?, catalyst ...

[kaet<sup>◀</sup>l] → catalog, catalyst

[kaet<sup>◀</sup>lo] → catalog

[kaet<sup>◀</sup>log]

# **Lexical Decision**

# Lexical Decision

Lexical decision tasks are used to explore how words are processed and represented in the mental lexicon

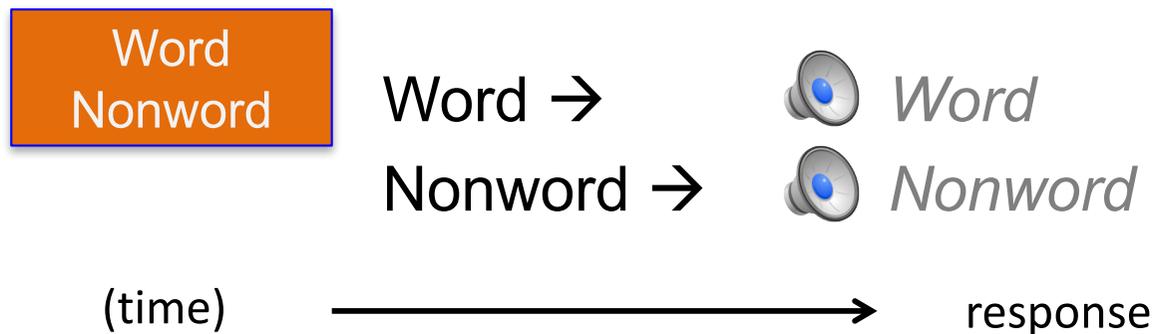
In the literature, these tasks have been useful in study a variety of issues

- The influence of language experience on spoken word recognition
- The effects of word frequency on word recognition
- Neighborhood effects (competitors)
- The role of specific phonetic features in spoken word recognition
- Talker variability and perceptual adaptation and adjustment

# Lexical Decision

## *Word or Nonword?*

- *Materials:* Words and nonwords
- *Trial:* 1 item, may be presented in isolation or preceded by some other (priming/contextual) information
- *Task:* Determine if the item is a word or nonword (as quickly as possible)

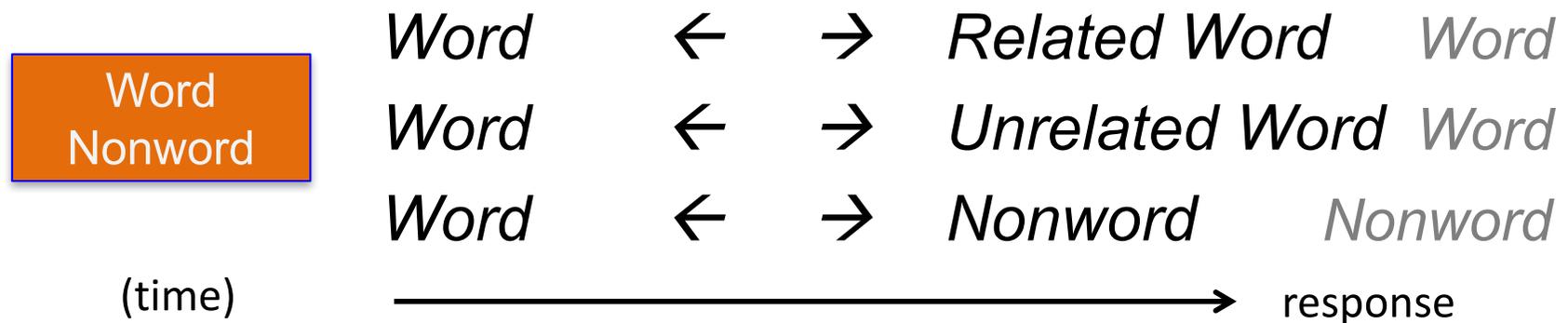


# Priming

- Often combined with priming
  - Exposure to one stimulus influences how people respond to another stimulus → Preactivation of a word yields faster RT the next time you encounter this word
  - form priming is used to examine the phonological structure of the lexicon
    - Sensitive to repetitions of identical primes and to similar items  
*DOCTOR ... doctor*
  - semantic priming is used to examine the semantic structure of the lexicon
    - Faster decision for a word which was previously activated by a semantically related word → semantic priming  
*DOCTOR ... nurse*

# Lexical Decision + Priming

- *Trial*: 2 items separated by some amount of time
- *Task*: Make a lexical decision to the second item in the pair (word ~ nonword)
- *Responses*: Button box
- *Measures*: Accuracy, RT



# Lexical Decision + Priming

- Design: cross-model form priming
  - auditory prime: real word produced by a female Midland or Northern speaker of American English
  - visual target: real or nonword that matches, mismatches, or is unrelated to the auditory prime
- Prime-target pairs:
  - Matching: “bat” - bat
  - Mismatching: “bet” - bat or “fetch” - fatch
  - Unrelated: “swim” - bat



sad

Word

Nonword



man

Word

Nonword



lep

Word

Nonword



bedge

Word

Nonword



ham

Word

Nonword



dad

Word

Nonword



seck

Word

Nonword



fad

Word

Nonword



dem

Word

Nonword



tan

Word

Nonword

# Lexical Decision

- *Design Considerations:*
  - Priming
  - Voices used
  - Modality
  - Lexical and/or contextual characteristics
- Many variations of the basic lexical decision task

# **Recognition Memory Tasks**

# Recognition Memory

Word recognition tasks are used to explore how words are processed and represented in the mental lexicon

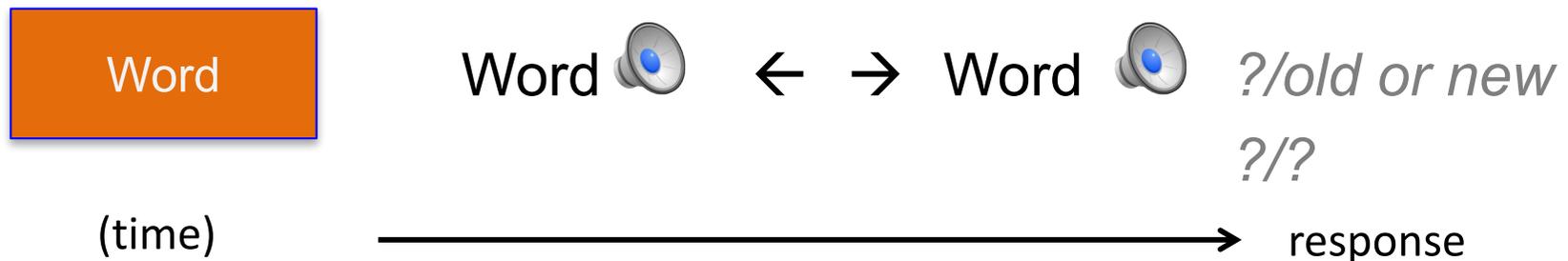
Similar to the other designs, this task is useful in exploring a number of important issues in spoken word recognition

- The influence of language experience on spoken word recognition and the nature of listeners' lexical representations
- The effects of word frequency on word recognition
- Neighborhood effects (competitors)
- Talker variability and memory for talkers and talker characteristics
- Phonetic variability

# Recognition Memory

## *Identify the word*

- *Materials:* Words, sentences
- *Trial:* 1 item; *Blocks:* Study and Test phase/Continuous
- *Task:* Identify the word (Study phase); Judge if word was old or new (Test phase – explicit); Identify the word (Test phase – implicit)



# Recognition Memory

- Priming – Sensitive to repetitions of identical primes and to similar items
- *Responses:*
  - Write out on keyboard, button press
- *Measures:*
  - Accuracy
  - Response time

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# Recognition Memory

- Design: implicit recognition memory task
  - Real words produced by male native and nonnative speakers of American English
  - Study/test phase: identify the word
- Word pairs:
  - Same talker repetitions: can – can
  - Different talker repetitions: feed – feed
  - New words: pen

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Break

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# Recognition Memory

- *Design Considerations:*
  - Characteristics of talkers
  - Lexical and/or contextual characteristics
  - Degradation
  - Time between items
  - Lists
- Some variations of this task

# **Demos of “Real” Experiments**

# Demos

- Lexical decision
- Sentence recognition and adaptation
- Sample Stimuli: Sentences with native and foreign accents