Concepts and Categories

Functions of Concepts

- By dividing the world into classes of things to decrease the amount of information we need to learn, perceive, remember, and recognize: **cognitive economy**
- They permit us to make accurate **predictions**
- Categorization serves a **communication** purpose

Is there a preferred level of conceptualization?

Superordinate level

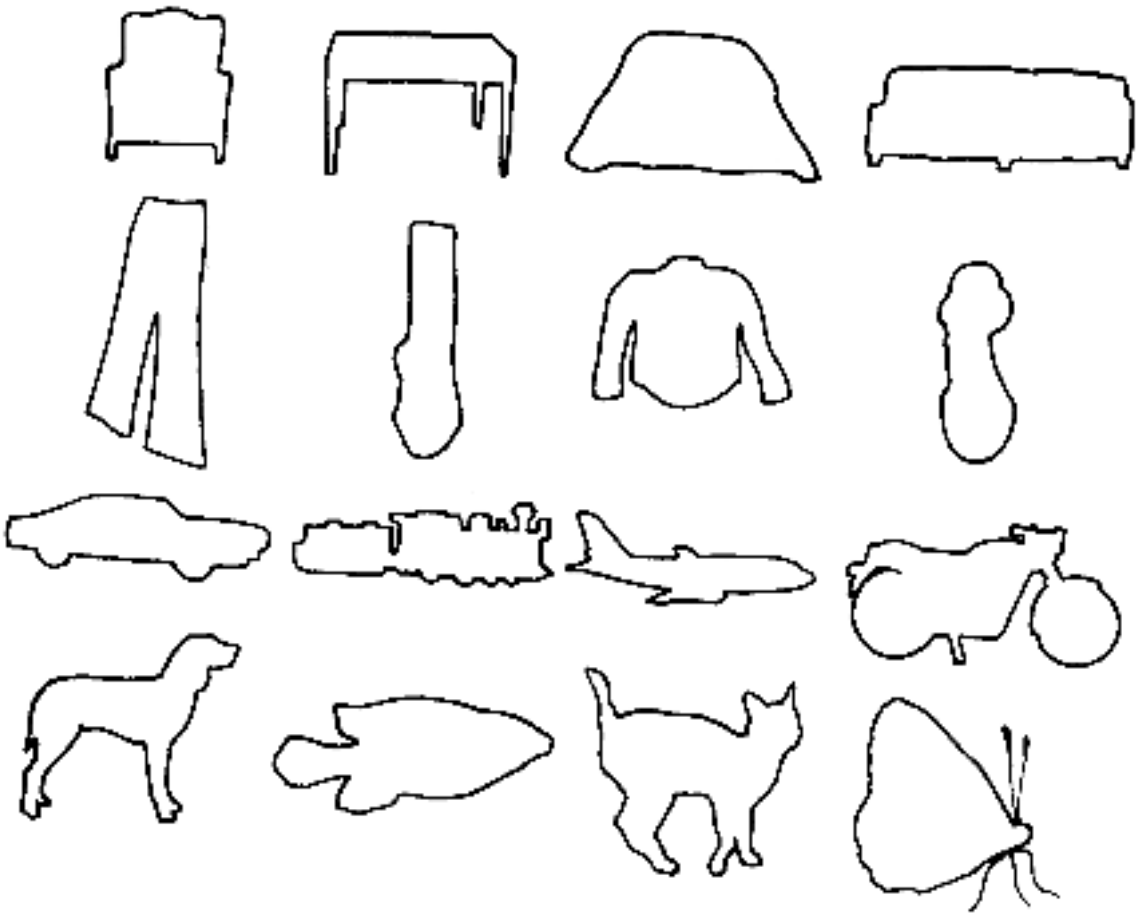
Preferred level
BASIC LEVEL

Subordinate level

most abstract level at which objects have similar shapes

What's special about the basic level

1) Most abstract level at which objects have similar shapes



What's special about the basic level

2) Development

First words are learned at the basic level (e.g., doggy, car, ball)

3) Language

Natural level at which objects are named

Languages first acquire basic level terms

most general

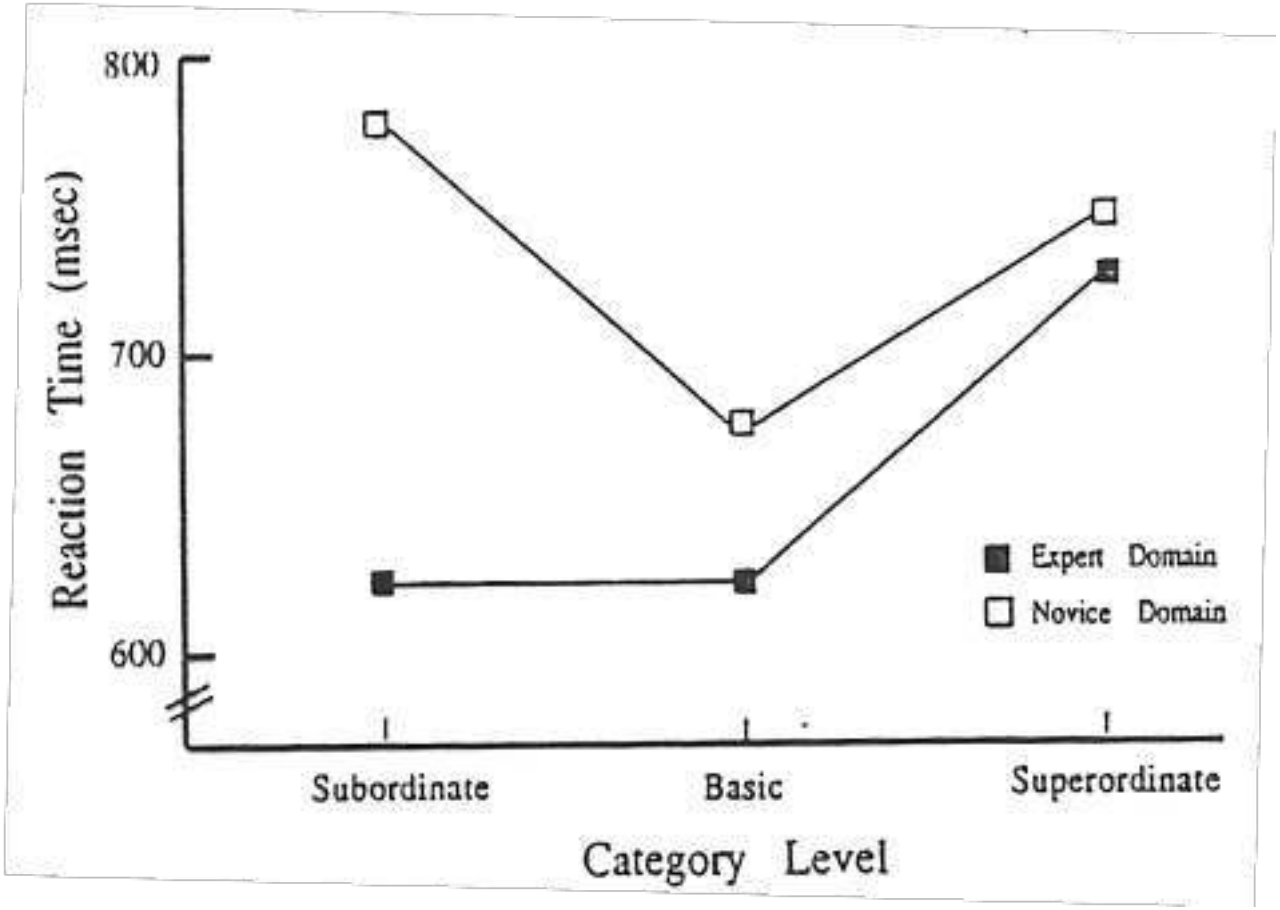
maximize accuracy
little predictive power

BASIC

most specific

maximize predictive
power little accuracy

Basic Level and Expertise



Dog and bird experts identifying dogs and birds at different levels

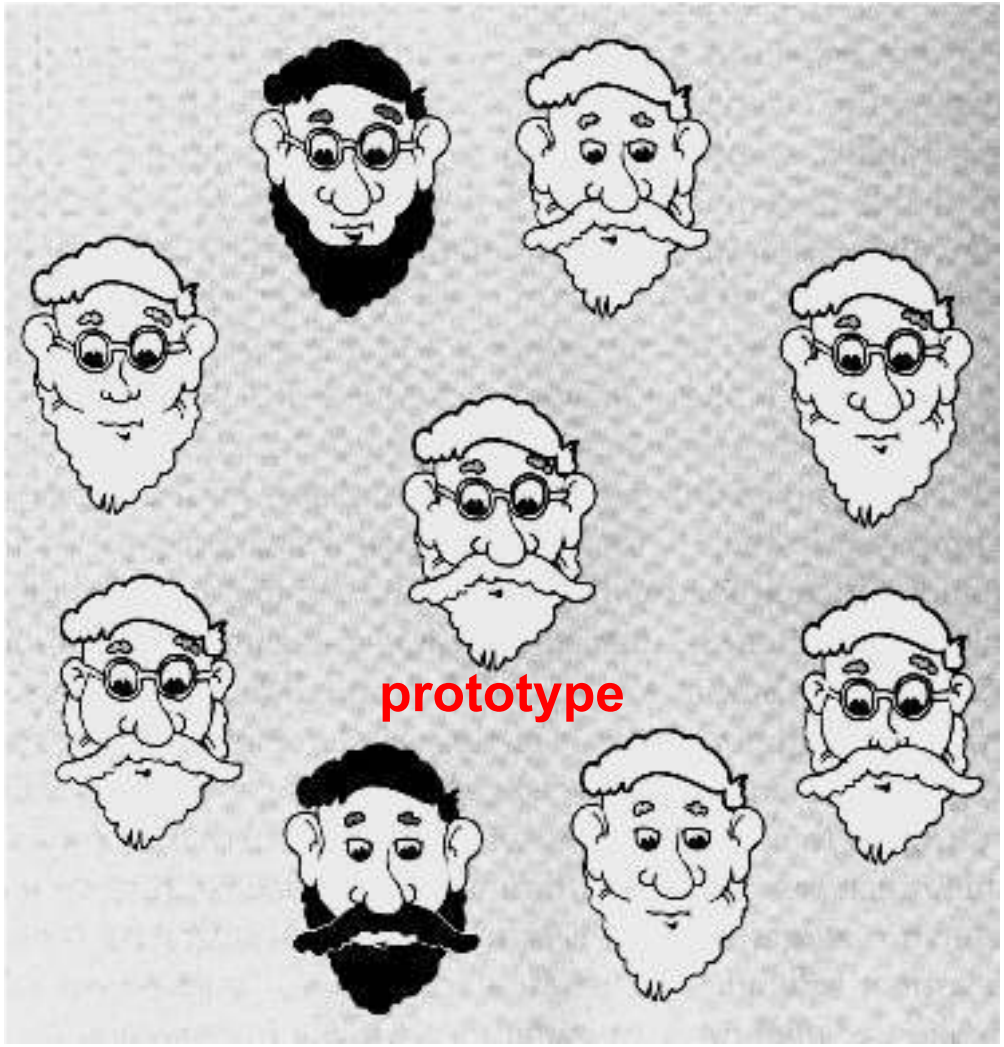
Experts make subordinate as quickly as basic categorizations

Organization of Concepts

Representation and Classification

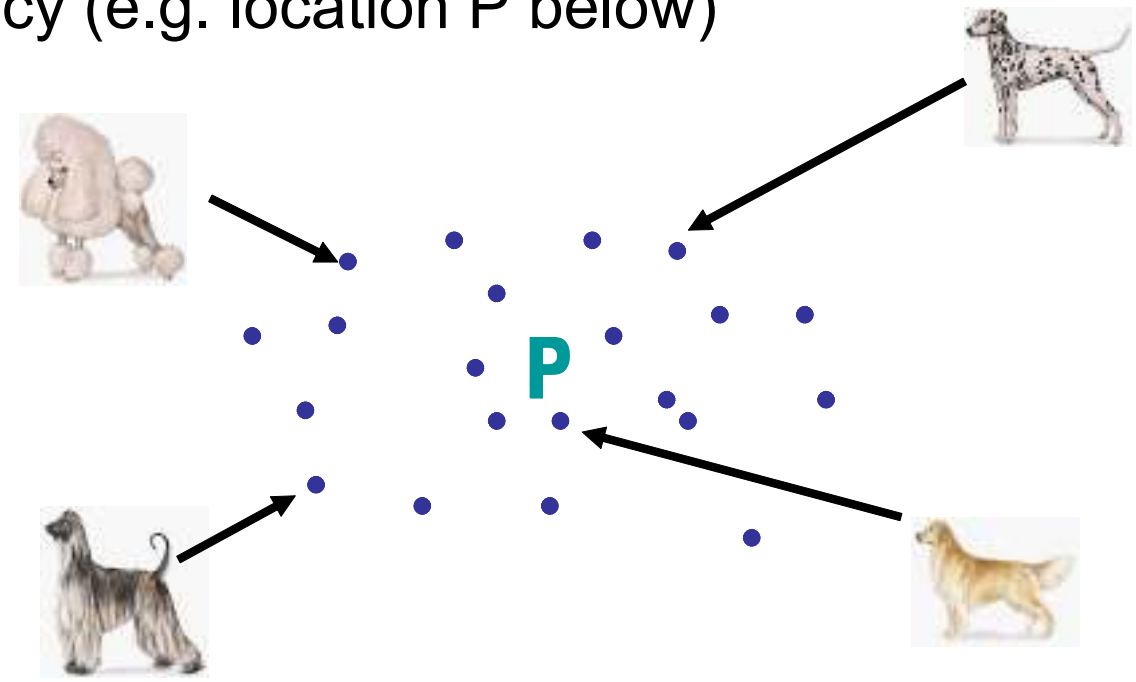
- How do we represent concepts? How do we classify items?

- Example representations:
  - **Prototype (原型)**
  - **Exemplar (范例)**
  - **Schemas (概要)**


prototype

Prototypes and Multidimensional Spaces

- A Concept is represented by a prototypical item = central tendency (e.g. location P below)



A new exemplar is classified based on its **similarity** to the prototype

Typicality Effects

- Typical
  - Is robin (知更鸟) a bird?
  - Is dog a mammal?
  - Is diamond a precious stone?

- Atypical
  - Is ostrich a bird?
  - Is a whale a mammal?
  - Is turquoise (绿松石) a precious stone?

slower verification times for atypical items

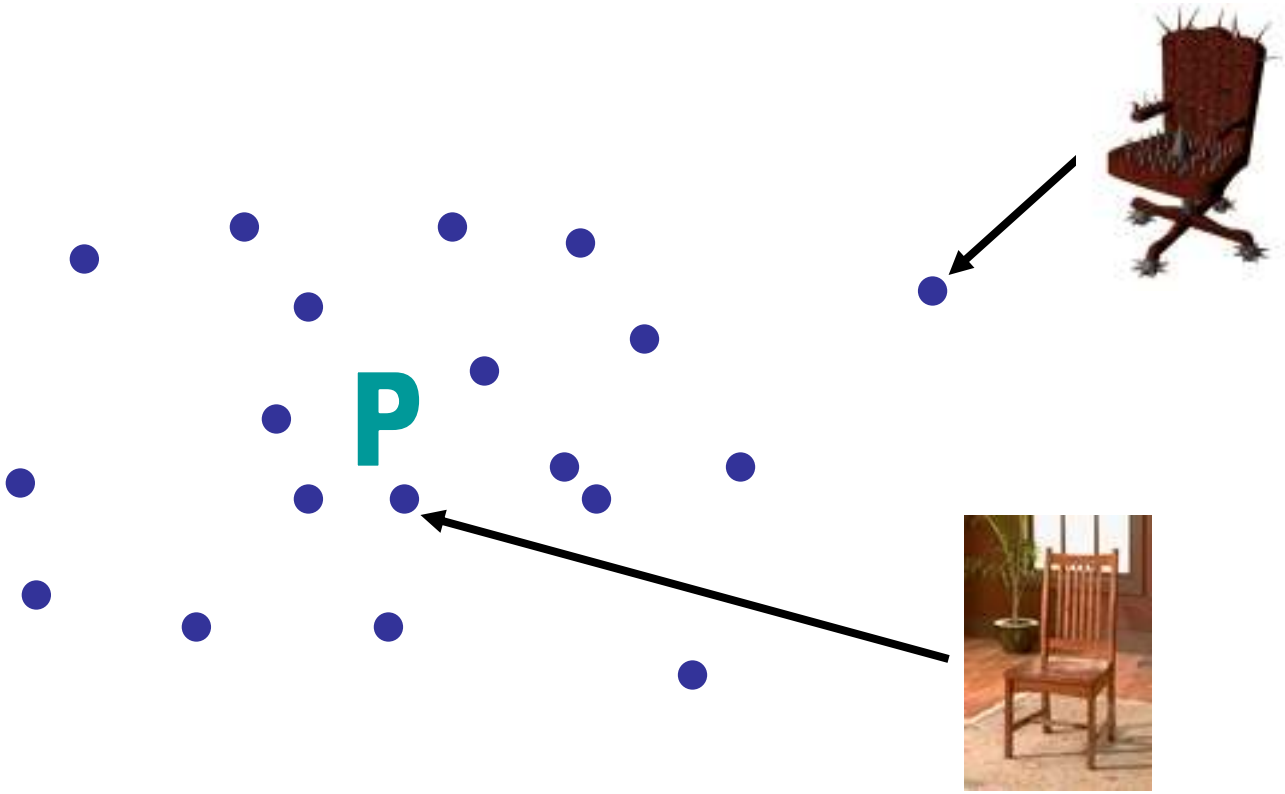
Is this a “chair”?

Is this a “cat”?

Is this a “dog”?

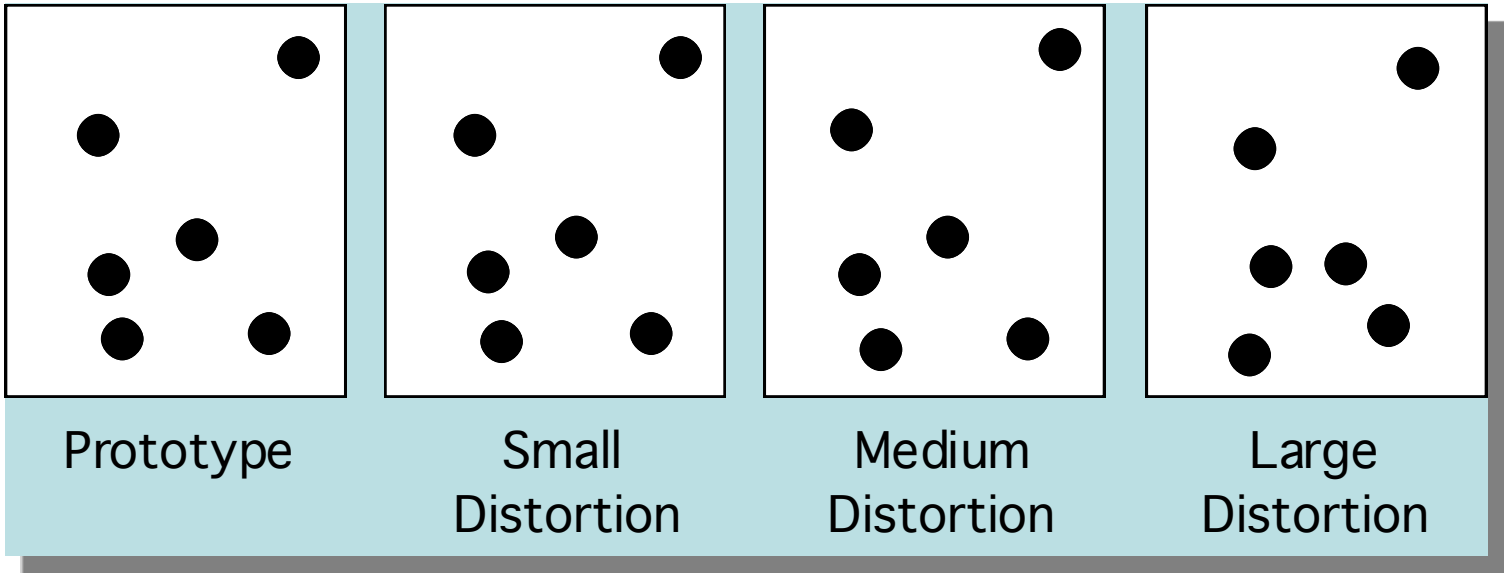
Graded Structure

- Typical items are similar to a prototype
- Typicality effects are naturally predicted



Classification of Prototype

- Prototype are often easy to classify and remember *even* if the prototype is never seen during learning
- Posner & Keele DEMO:



Problem with Prototype Models

- All information about individual exemplars is lost
  - category size
  - variability (变化性) of the exemplars
  - correlations among attributes

Variability of exemplars

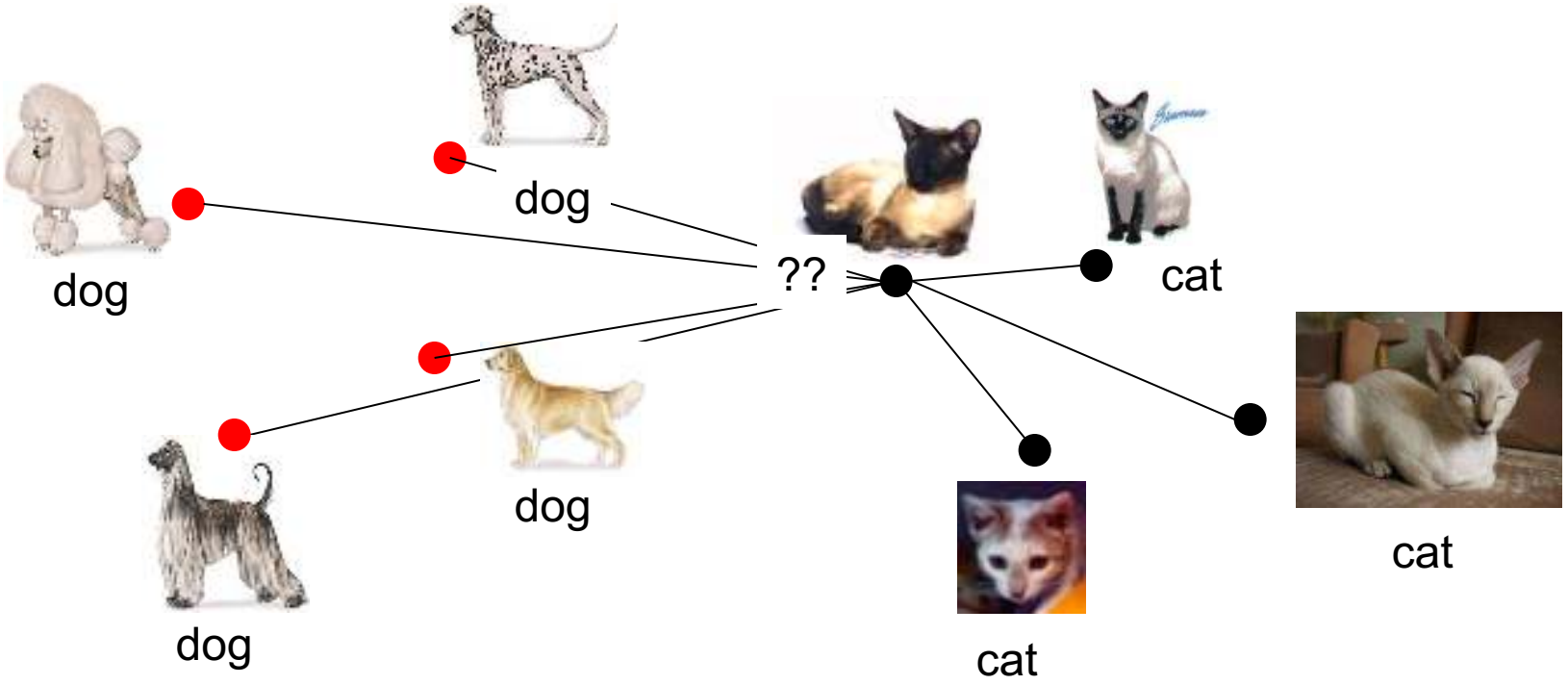
Rulers and pizza example

Most pizzas are 12 inches wide but can vary from 2 to 30 inches
Most rulers are 12 inches across and can vary much less than pizzas

Experiment: when participants are asked whether a new object 19 inches wide is a pizza or a ruler, most participants said it probably corresponded to a pizza. A prototype theory cannot explain this finding because 19 inches is equally distant to both the pizza and ruler prototype (both 12 inches). However, in an exemplar theory, the 19 inch overlaps with more pizza exemplars because there are more pizza exemplars experienced (and represented in memory) that are around 19 inches wide.

Exemplar Representations

- Category representation consists of storage of a number of category members
- New exemplars are compared to known exemplars – most similar item will influence classification the most



Exemplar Models

- Model can explain
  - Prototype classification effects
    - ✓ Prototype is similar to most exemplars from a category
  - Graded typicality
    - ✓ How many exemplars is new item similar to?
  - Effects of variability

- Overall, compared to prototype models, exemplar models better explain data from categorization experiments (Storms et al., 2000)

Schemata

- **Schemas** are large, complex units of knowledge that encode properties which are typical of instances of general categories and omit properties which are not typical of the categories

- Useful for encoding regularities in categories – express what category members have in common

Remembering Objects from a Graduate Office

chair ✓

desk ✓

skull ✓

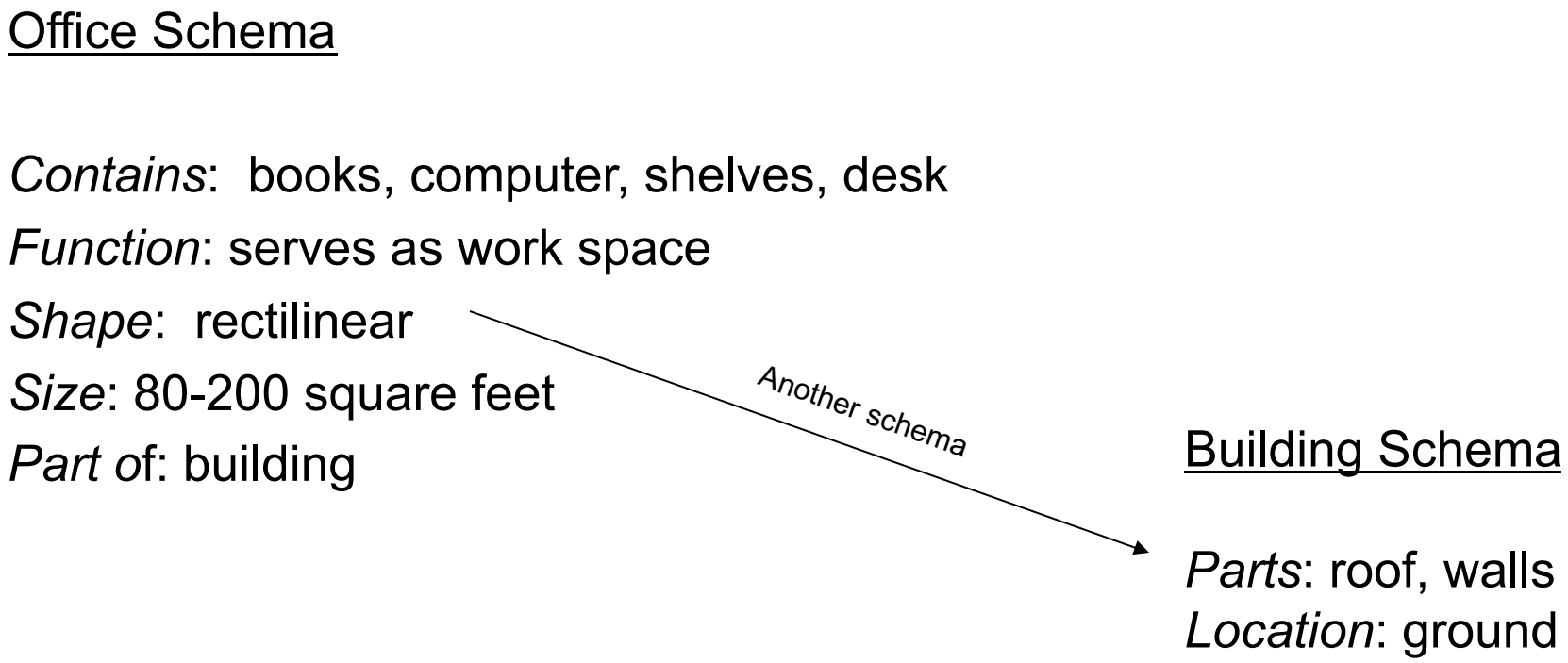
books ✗

(30% of subjects falsely remember books)

Brewer & Treyens, 1981

Representing Schemas

One way to represent schemas is with a *slot-filler* structure, where slots are attributes that are filled in with values that category members of the category *typically* have on various attributes



Multimodal theories of Category Knowledge

- Perceptual symbols theory (Barsalou, 1999)
- Concepts are represented by perceptual symbols
- Perceptual symbols are records of the neural states that underlie perception
- A representation is a simulation of experience

Prediction of Perceptual Symbol Theory

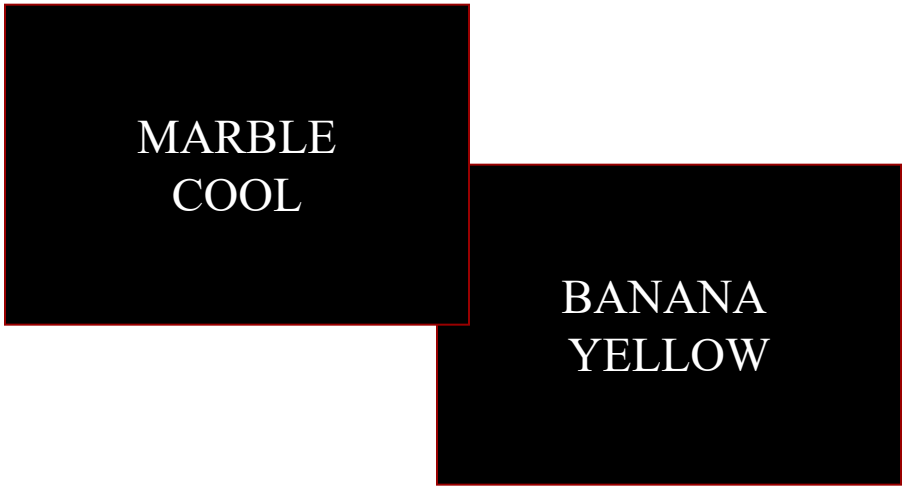
- Should find a modality switch effect for concepts
- Property verification with modality specific properties (banana-yellow, marble-cool)
- Six modalities: vision, sound, touch, taste, smell, motor

Pecher, Zeelenberg, & Barsalou, 2003

Experiment: Modality switch

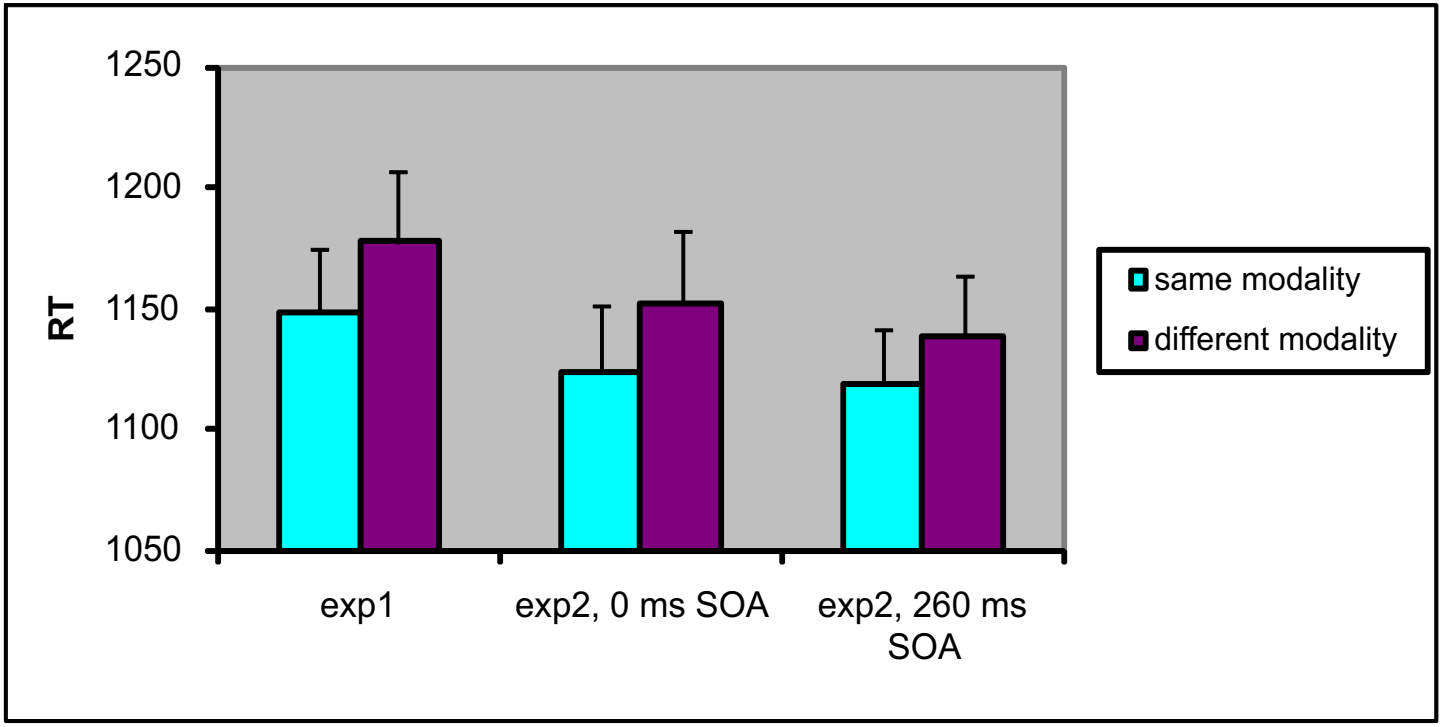
Same modality condition:

Different modality condition:



Pecher, Zeelenberg, & Barsalou, 2003

Results of Experiment



Exp 1: sentence presentation

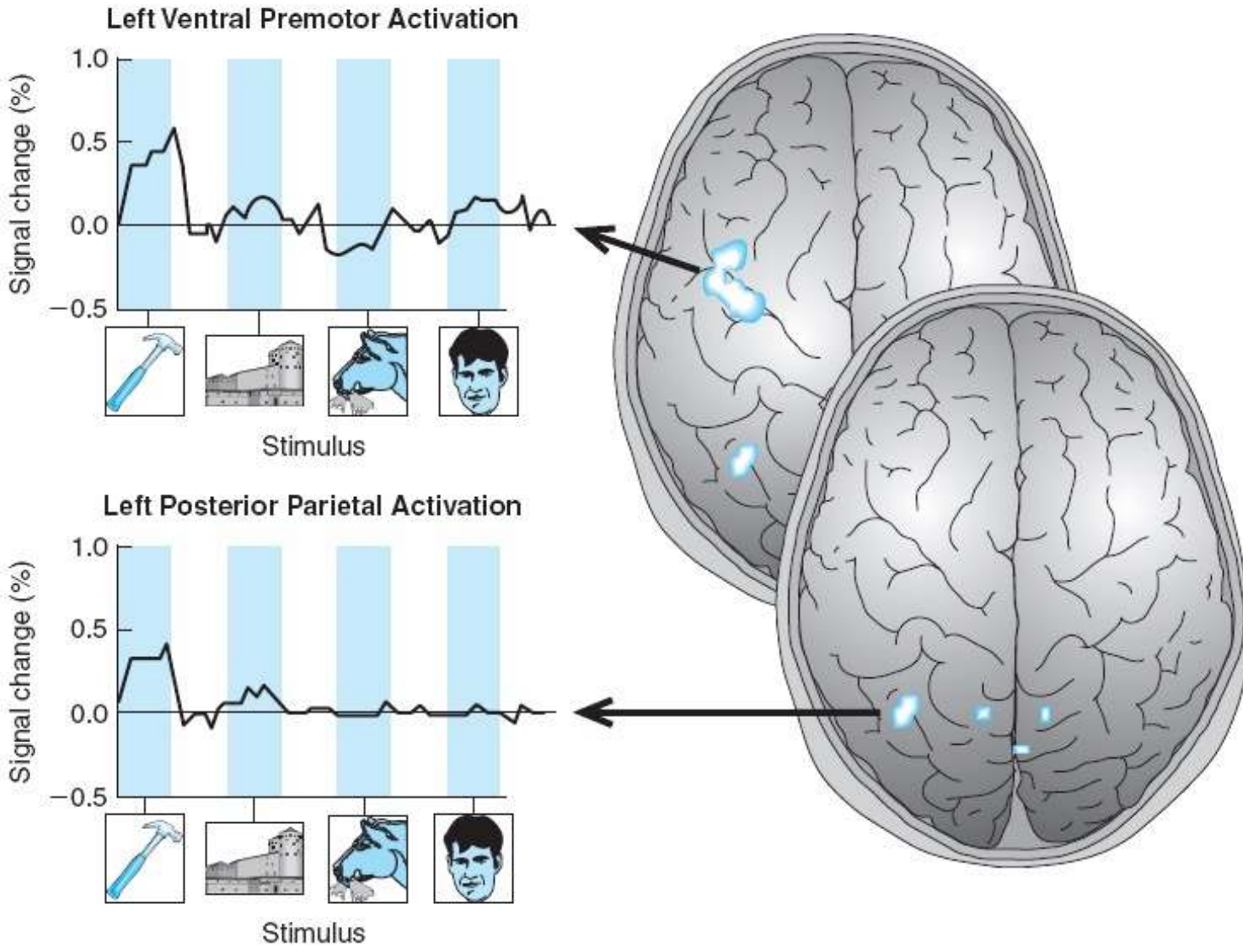
Exp 2: word pair presentation

Pecher, Zeelenberg, & Barsalou, 2003

Neural Evidence for Multimodal Mechanisms

- Investigators found that when participants viewed manipulable objects such as hammers, a circuit in the brain that underlies the grasping of manipulable objects became active

- This circuit did not become active when buildings, animals, or faces were observed



Neuroimaging support for category knowledge

The left-hemisphere grasping circuit (for right-handed participants) became active only while participants viewed pictures of tools, not while they viewed pictures of faces, animals, or buildings.

Chao & Martin, 2000

Some Applications of Concept Learning Research

- 20 Questions:
  http://20q.net/

- Google Sets:
  http://labs.google.com/sets