Away from Categories

Slides Adopted from
A. Efros, CMU, Spring 2012

Understanding an Image

slide by Fei Fei, Fergus & Torralba

Object naming -> Object categorization

slide by Fei Fei, Fergus & Torralba

Object categorization

sky

building

flag

face

banner

wall

street lamp

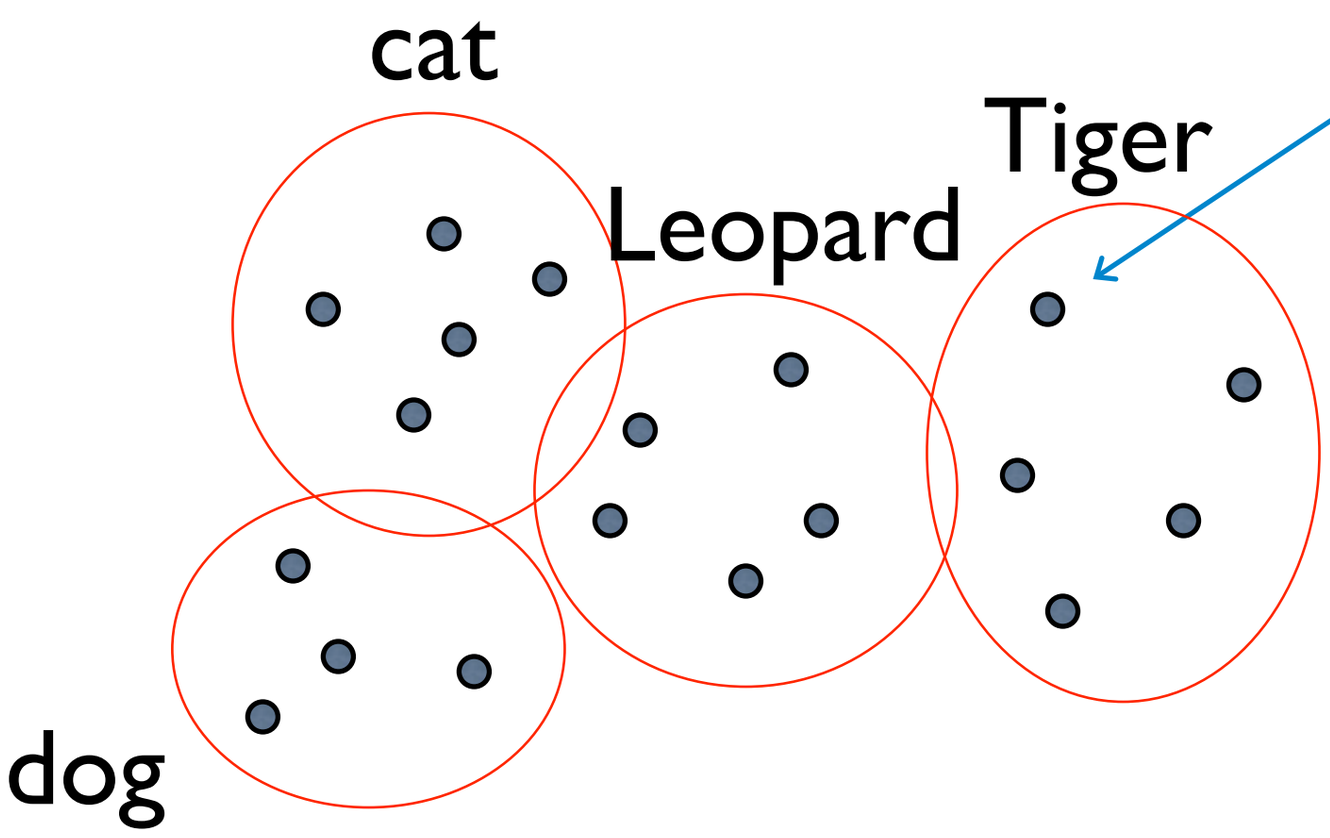
bus

bus

cars

Why Categorize?

1. Generalization
2. Knowledge Transfer
3. Communication



Classical View of Categories

- Dates back to Plato & Aristotle
  1. Categories are defined by a list of properties shared by all elements in a category
  2. Category membership is binary
  3. Every member in the category is equal

Problems with Classical View

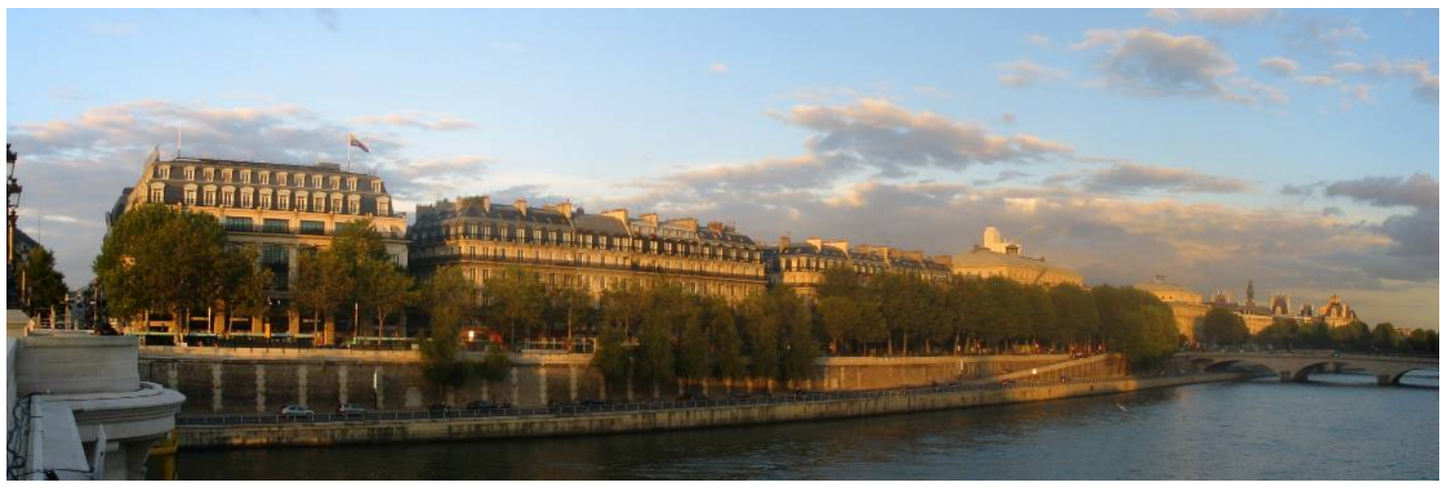
- Humans don't do this!
  - People don't rely on abstract definitions / lists of shared properties (Wittgenstein 1953, Rosch 1973)
    - e.g. define the properties shared by all "games"
    - e.g. are curtains furniture? Are olives fruit?
  - Typicality
    - e.g. Chicken -> bird, but bird -> eagle, pigeon, etc.
  - Language-dependent
    - e.g. "Women, Fire, and Dangerous Things" category is Australian aboriginal language (Lakoff 1987)
  - Doesn't work even in human-defined domains
    - e.g. Is Pluto a planet?

Problems with Visual Semantic Categories

- A lot of categories are functional

Chair

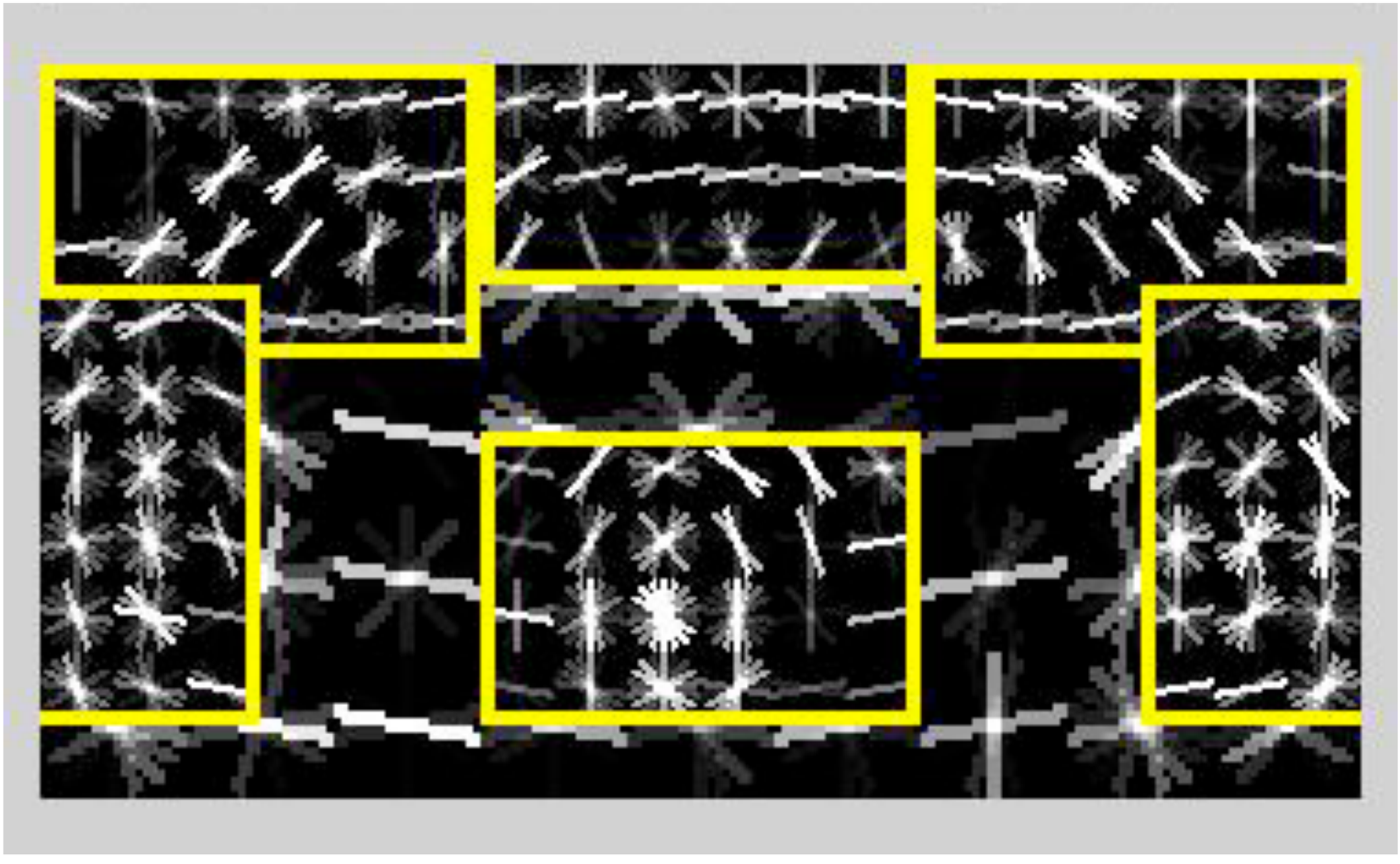
- World is too varied



- Categories are 3D, but images are 2D

car

Typical HOG car detector

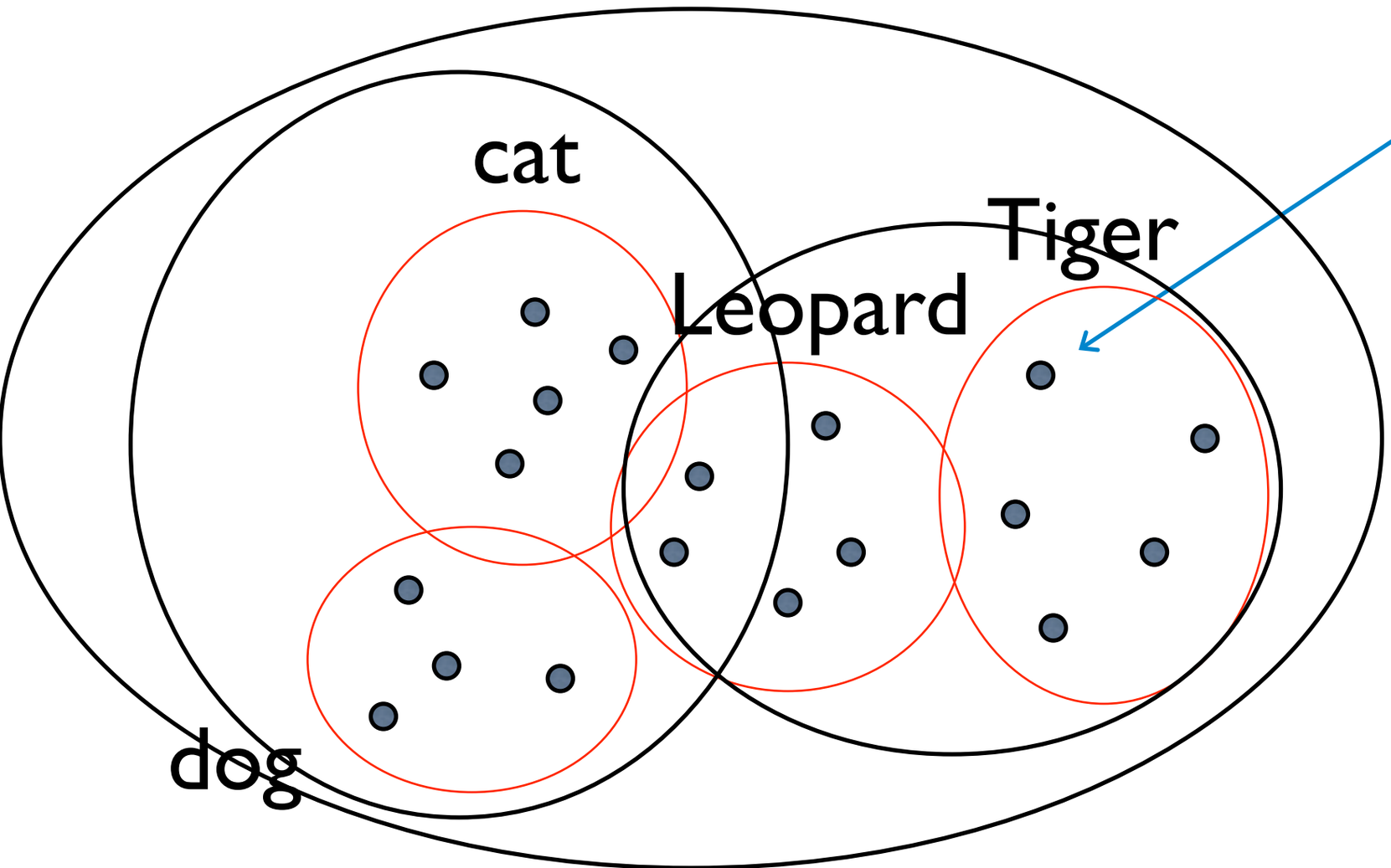


Felzenszwalb et al, PASCAL 2007

Solution: hierarchy?

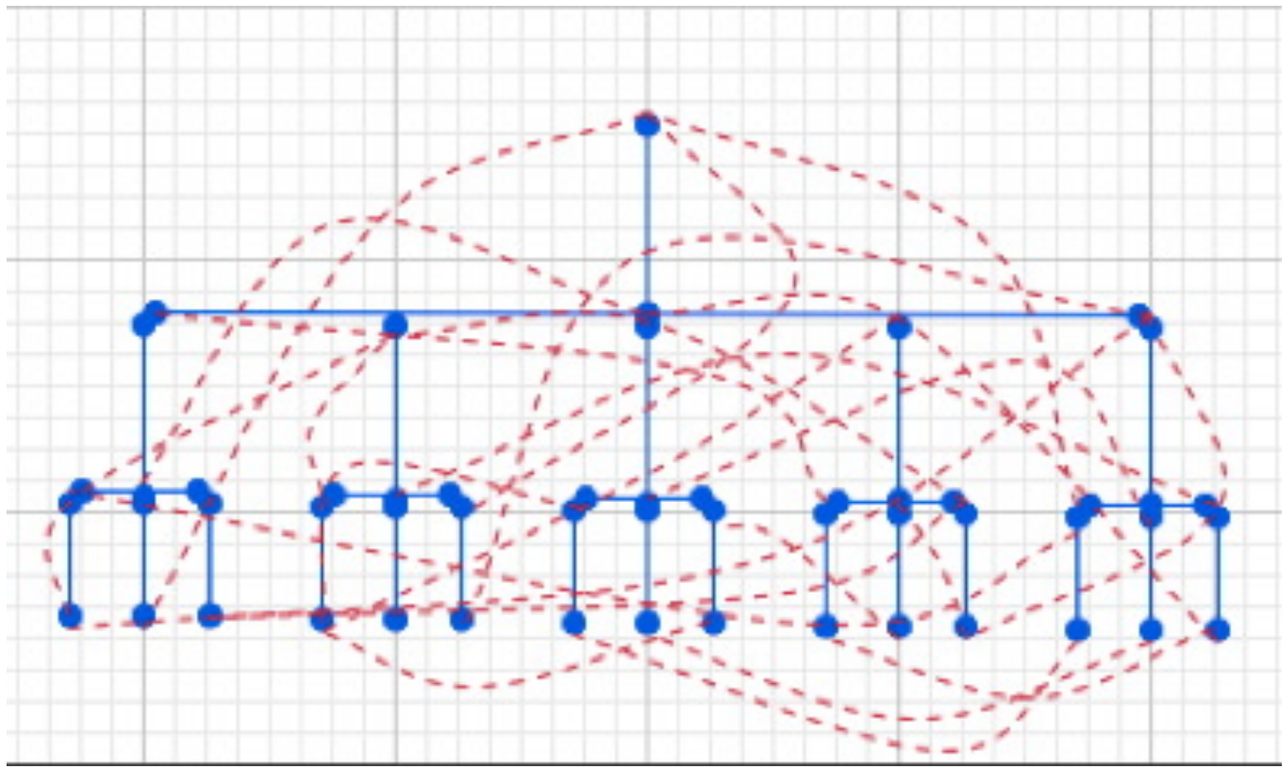
Ontologies, hierarchies, levels of categories (Rosch), etc.

WordNet, ImageNet, etc etc



Still Problematic!

– Intransitivity
  • e.g. car seat is chair, chair is furniture, but …
– Multiple category membership
  • it's not a tree, it's a forest!



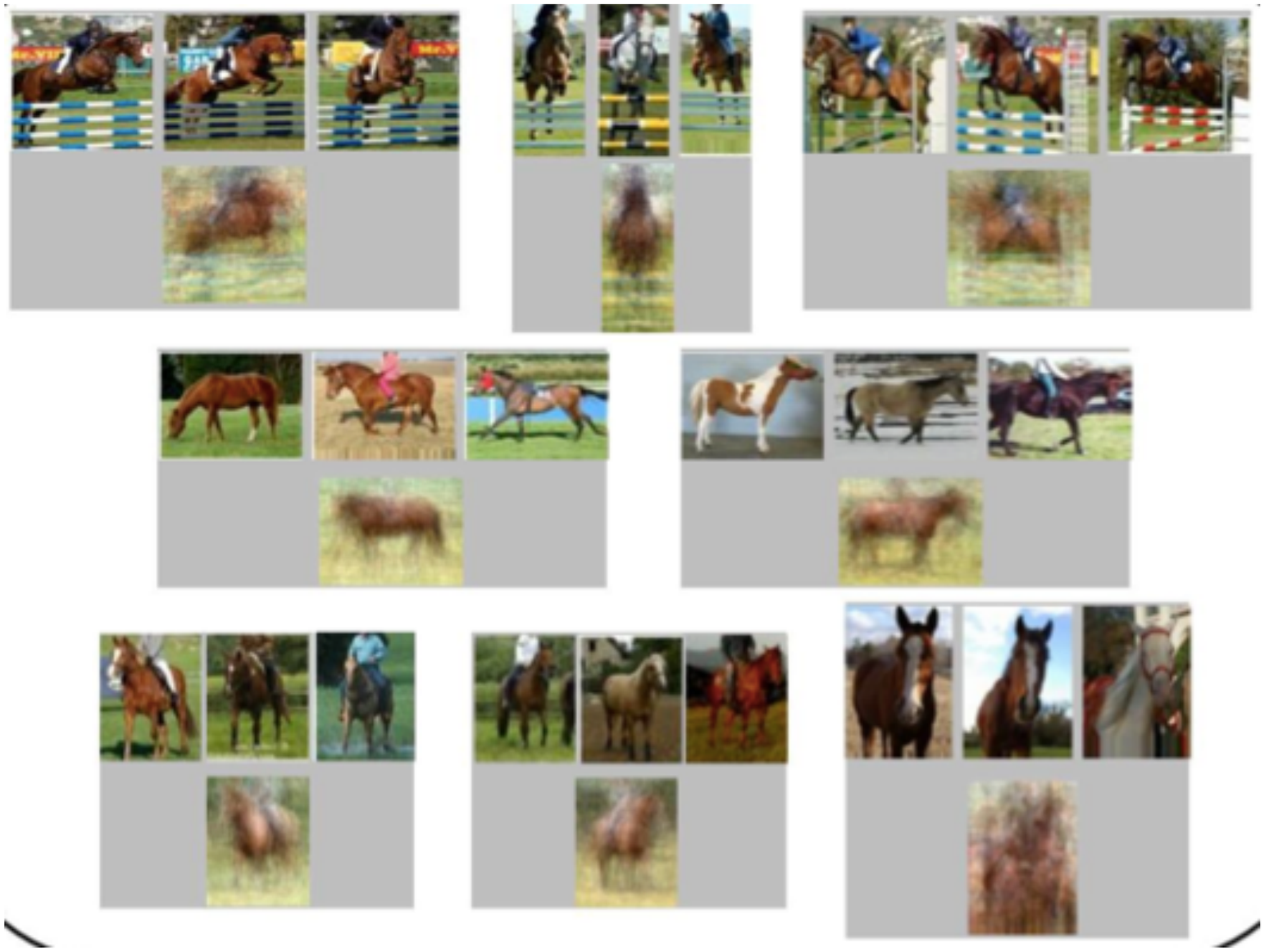
Clay Shirky, "Ontologies are Overrated"

Two Solutions:

- Ditch semantics:
  - –Categories based on Visual Shapes

- Ditch categories altogether:
  - – exemplar-based models

Visual Subcategories



Two Solutions: the Other Extreme

- Ditch semantics:
  - Unsupervised object discovery

- Ditch categories altogether:
  - exemplar-based models

Fundamental Problem with Categorization

Making decisions too early!

We should only categorize at run-time, once we know the task!

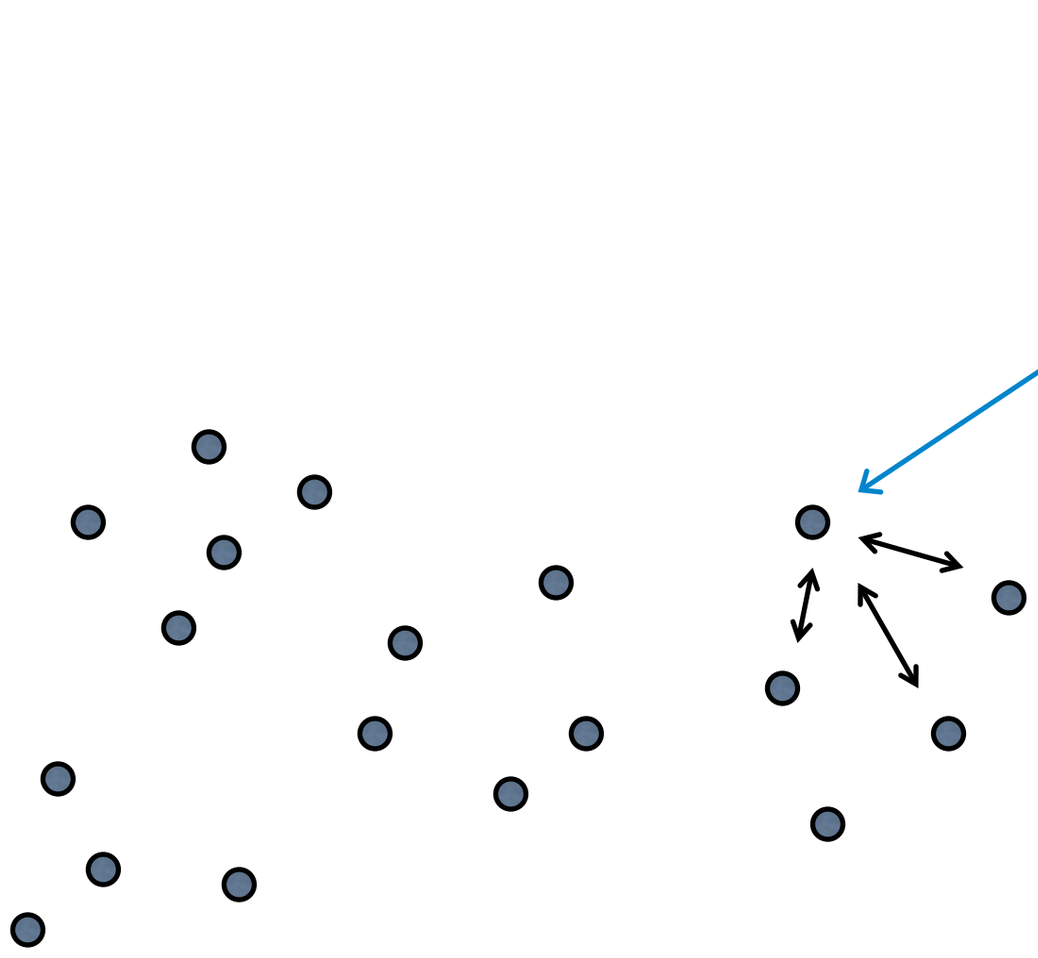
The Dictatorship of Librarians

categories are losing…

vs.

On-the-fly Categorization?

1. Knowledge Transfer
2. ~~Communication~~



Association instead of categorization

Ask not "what is this?", ask "what is this <u>like</u>"

– Moshe Bar

- Exemplar Theory (Medin & Schaffer 1978, Nosofsky 1986, Krushke 1992)
  - categories represented in terms of remembered objects (exemplars)
  - Similarity is measured between input and all exemplars
  - *think* non-parametric density estimation

Extreme of Visual Subcategories

- Every example is a category by itself!
- No more generalization…no more parametric models!

We do not need to recognize the exact category

- A new class can borrow information from similar categories

Slide by Torralba

Prototype or Sum of Exemplars ?

- Prototype Model

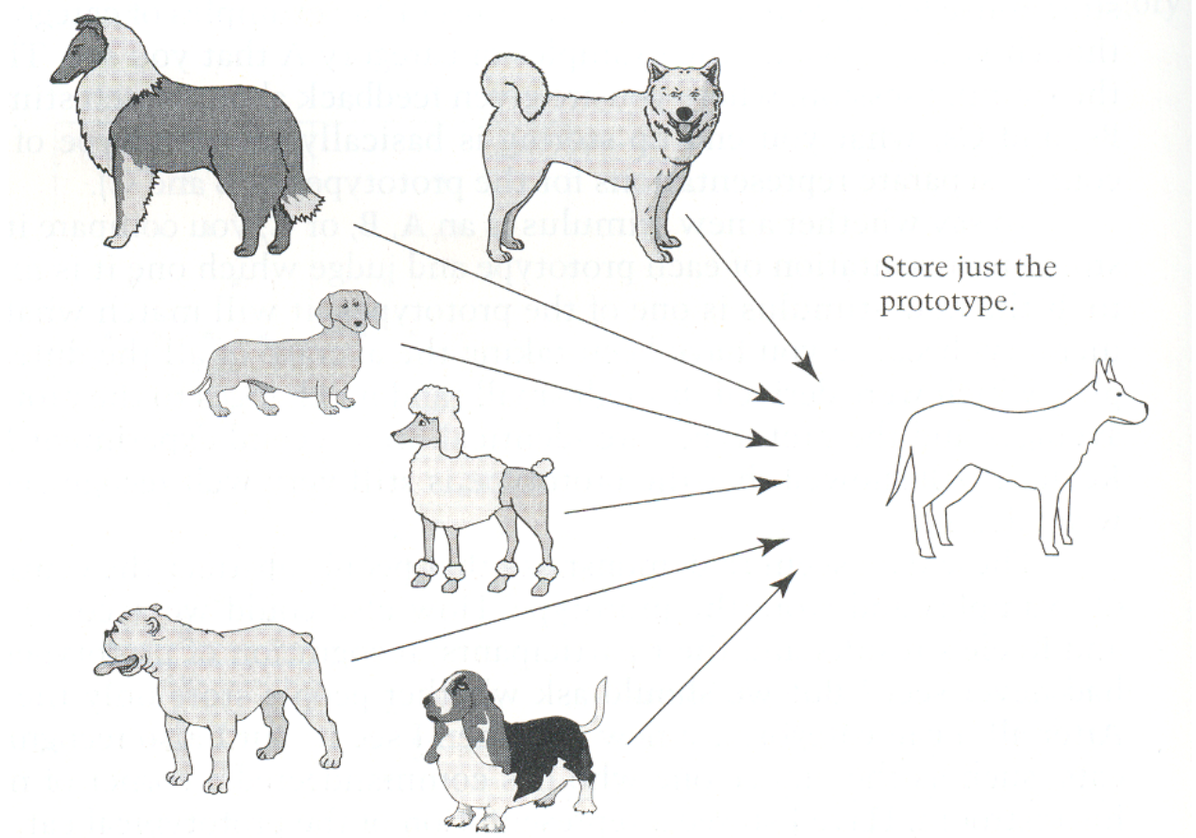


Figure 7.3. *Schematic of the prototype model. Although many exemplars are seen, only the prototype is stored. The prototype is updated continually to incorporate more experience with new exemplars.*

- Category judgments are made by comparing a new exemplar to the prototype.

- Exemplars Model

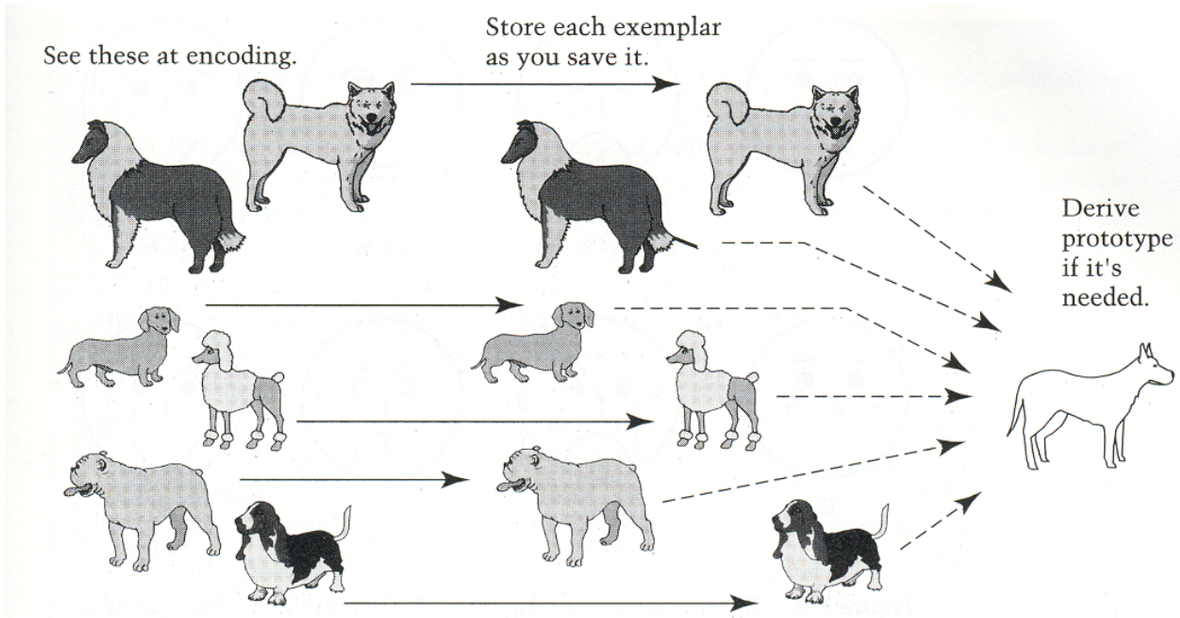


Figure 7.4. *Schematic of the exemplar model. As each exemplar is seen, it is encoded into memory. A prototype is abstracted only when it is needed, for example, when a new exemplar must be categorized.*

- Category judgments are made by comparing a new exemplar to all the old exemplars of a category or to the exemplar that is the most appropriate

Slide by Torralba

Systematically

Can we even manage so many examples ?

What's the Capacity of Visual Long Term Memory?

What we know…

Standing (1973)

10,000 images

83% Recognition

… people can remember thousands of images

High Fidelity Visual Memory is possible (Hollingworth 2004)

What we don't know…

… what people are remembering for each item?

According to Standing

"Basically, my recollection is that we just separated the pictures into distinct thematic categories: e.g. cars, animals, single-person, 2-people, plants, etc.) Only a few slides were selected which fell into each category, and they were visually distinct."

"Gist" Only

Sparse Details

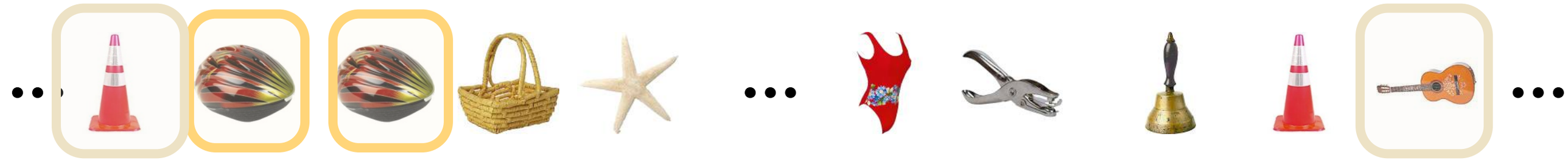
Highly Detailed

Slide by Aude Oliva

Massive Memory I: Methods

1-back

1024-back



Showed 14 observers 2500 **categorically unique objects**

1 at a time, 3 seconds each

800 ms blank between items

Study session lasted about 5.5 hours

Repeat Detection task to maintain focus

Followed by 300 2-alternative forced choice tests

Slide by Aude Oliva


KEEP THIS COUPON
NO STANDING
CHUNKY
TIME
Slide by Aude Oliva

how far can we push the fidelity of visual LTM representation ?

Same object, different states

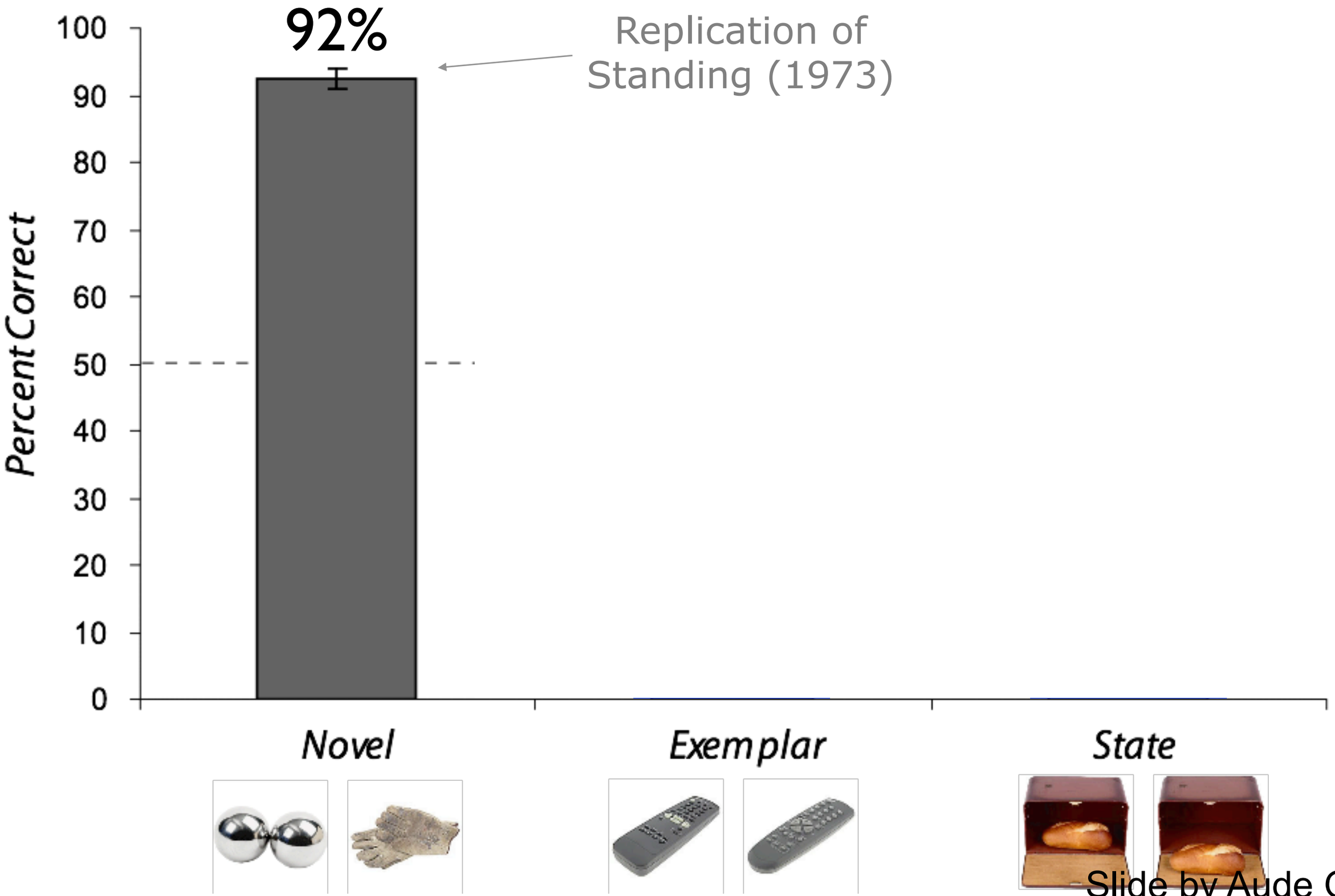







Slide by Aude Oliva

Massive Memory I: Recognition Memory Results



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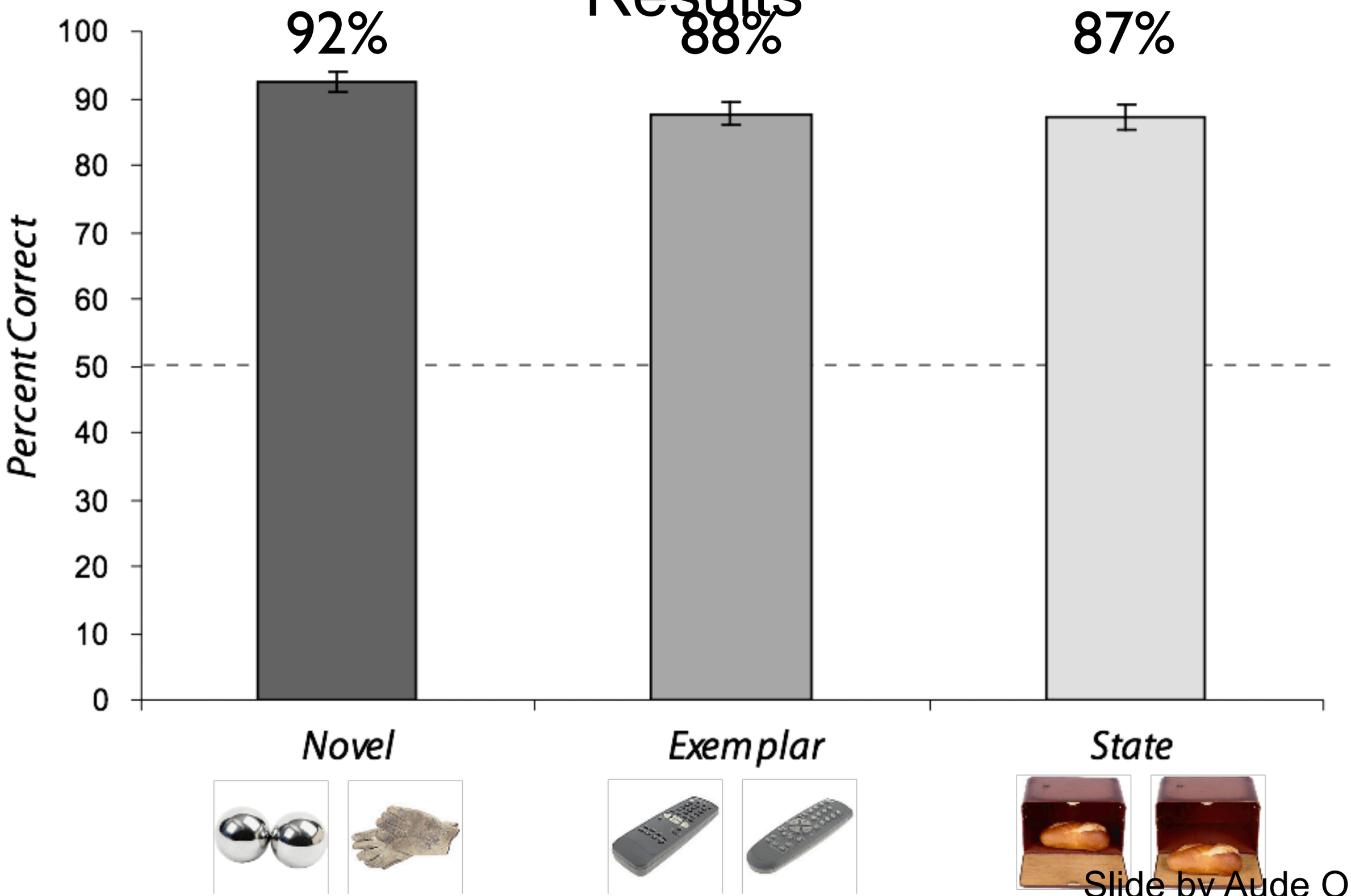

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