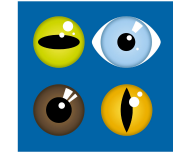


Digital Humanism fellowship Conference, Vienna, 16.-17.11.2023



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Cognitive Biology



BugnyarLab



Thomas Bugnyar

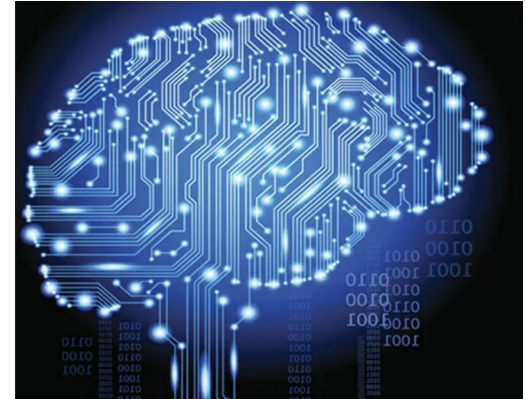
# Evolution of Intelligence

# Evolution of Systems

- AI analogue to biological evolution
- Co-evolution (Lee 2020)
- Different phases (Laland 2017, Lee 2020)

## Ages in evolution of mankind

- Genetic
- Genetic-cultural
- Cultural
- Synthetic



<https://www.foxbusiness.com/features/ai-brain-mapping-closer-to-reality-than-you-think>



<https://news.berkeley.edu/2017/09/18/coevolution-of-human-and-artificial-intelligences>

# Understanding Traits

Evolution

Process

Outcome

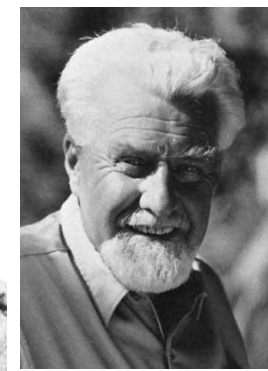
time

today



- **Mechanism**
- **Function**
- **Ontogeny**
- **Phylogeny**

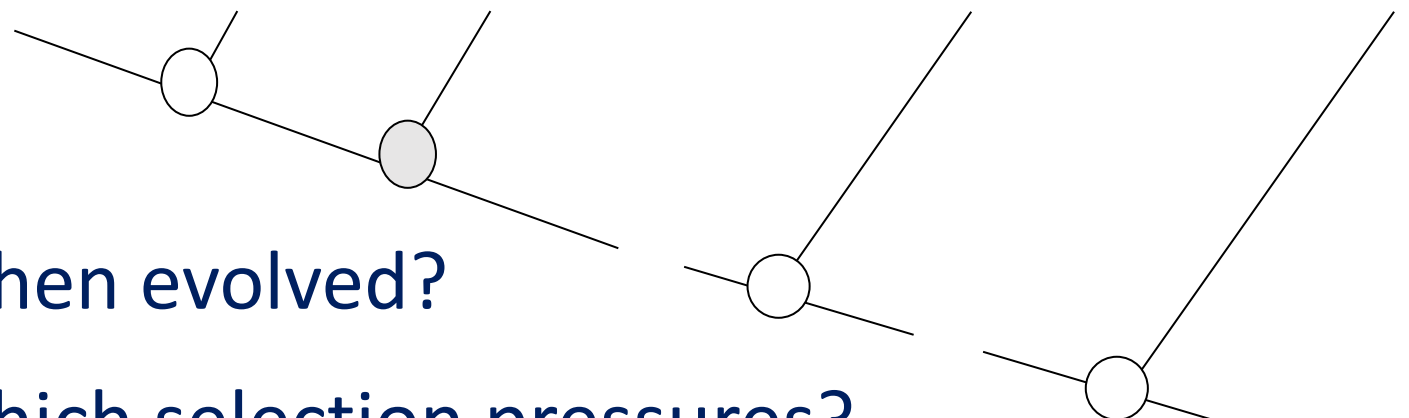
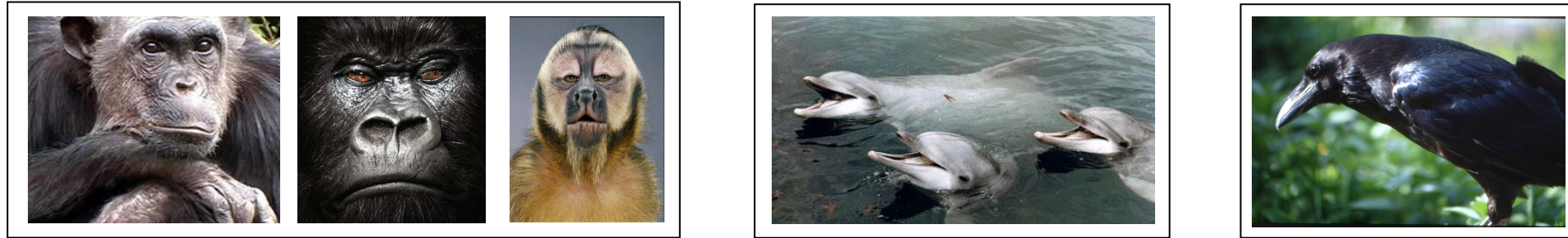
- Observations and experiments
- Comparative approach



Tinbergen's 4 Whys

Niko Tinbergen  
Konrad Lorenz  
Karl von Frisch

# Comparative Approach



When evolved?

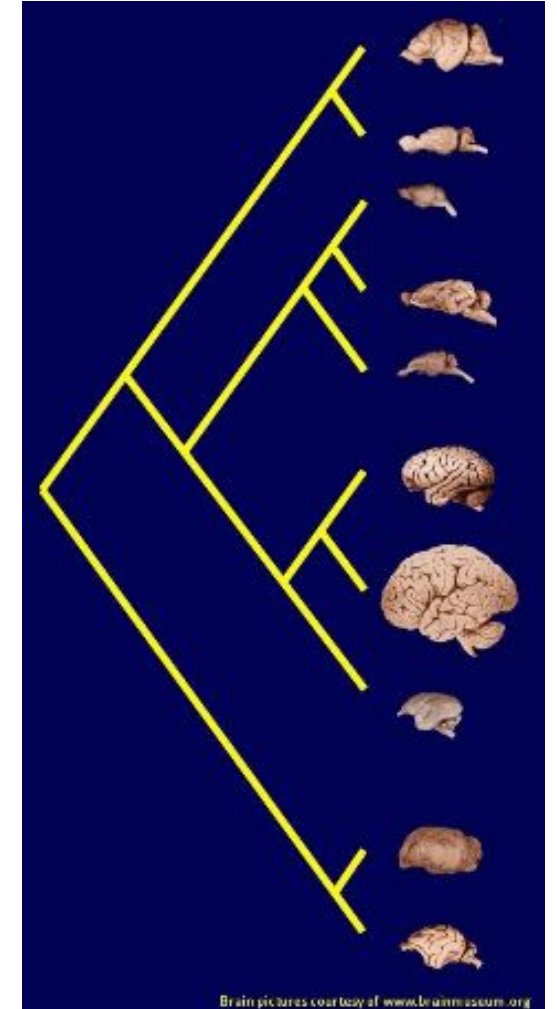
Which selection pressures?

~300 Mio Years

- **Convergent evolution:** similar adaptations due to similar selection pressures

# Biological Perspective of Intelligence

- **Cognition: information processing**
  - Product of evolution
  - Function: decision making, control behavior
  - Neuronal basis: brain
  - Benefits of large brains: flexibility
  - Costly development and sustenance
  - Processing capacities are adaptations to species' socio-ecological environment
- Which challenges select for which skills?



# Which Challenges Select for Which Skills?

## Searching and/or Accessing Food



Orientation  
Memory  
Planning



Imagination  
Means-end  
Causality

## Social Life



Social knowledge  
Intentionality  
Attribution

# Corvids

- Large-brained song birds (120 species)
- Worldwide distribution
- Omnivorous diet: seed-fruit-insect-carrion
- Complex social life



# Unequal Distribution of Food

- **Food caching in corvids**
- **Species differences**
  - Many caches, mainly seeds, long term (up to 6 months)
  - Few caches, various food, short term (hours-days)





# Memory

- Food caching in corvids
- Species differences
  - Many caches, mainly seeds, long term (up to 6 months)
  - Few caches, various food, short term (hours-days)



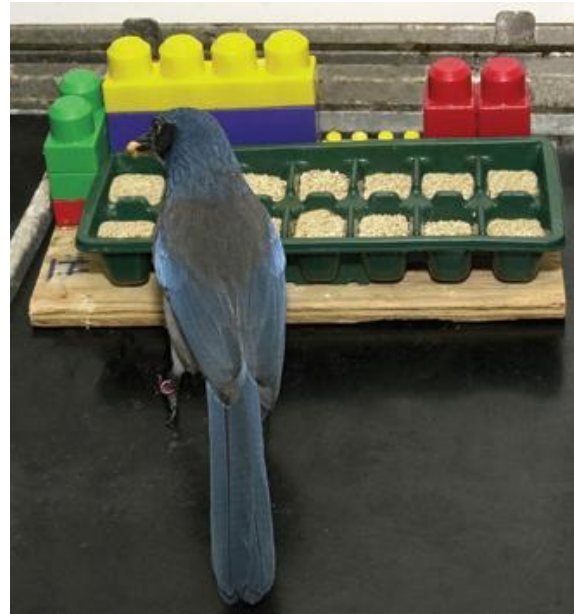
- Long- and short-term cachers differ in **spatial memory** along several dimensions



Balda & Kamil (1988)

# Memory

- Food caching in corvids
- Species differences
  - Many caches, mainly seeds, long term (up to 6 months)
  - Few caches, various food, short term (hours-days)

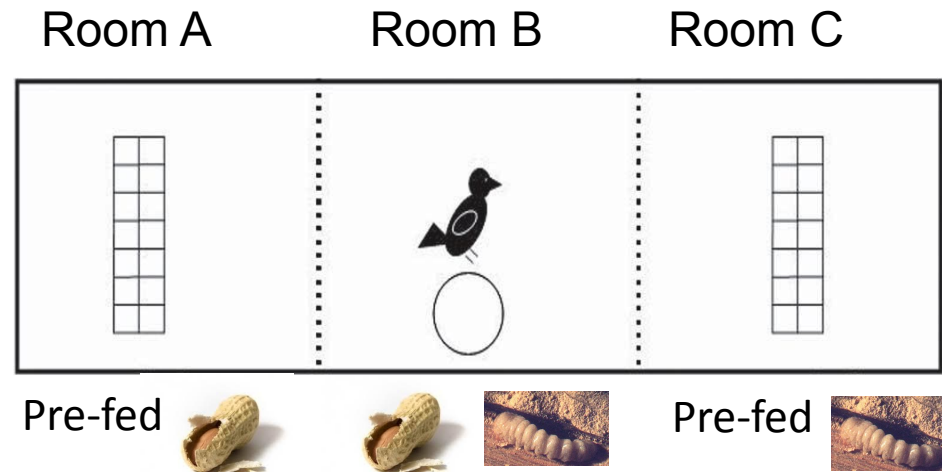
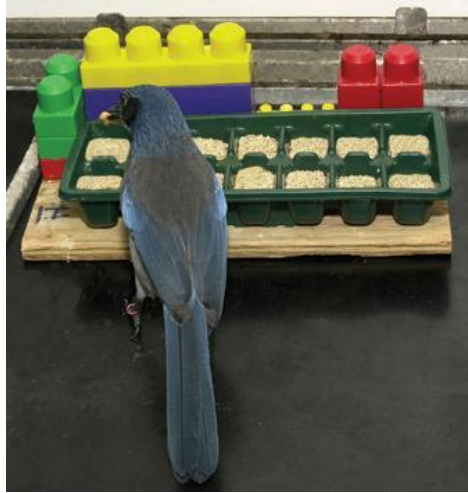


Clayton & Dickinson  
(1998)

- Short-term cachers encode 'where', 'what' and 'when'
- **Episodic(-like) memory**



# Episodic System: Retro- & Prospection

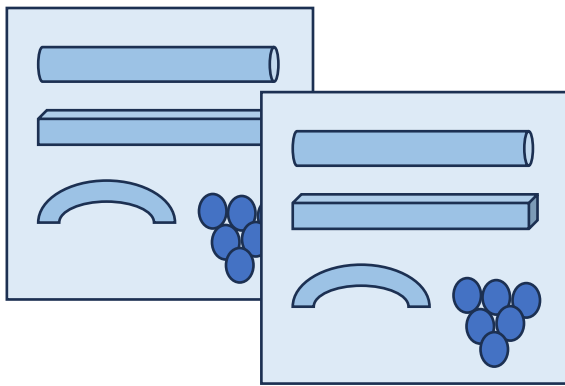
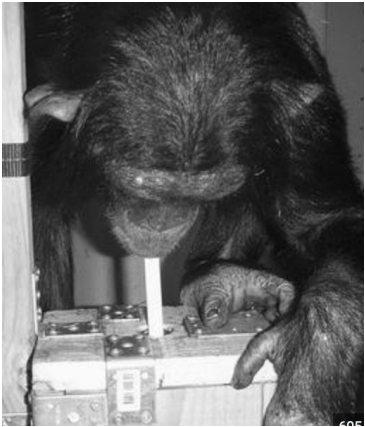


Raby et al. (2007)

- Simulate potential scenarios at retrieval
- Independent of current motivational state
- **Short-term cachers capable of mental time travel**

# Comparison with Primates

- **Future planning in apes**
  - Reports of preparing tools, hours before use
  - Experiments on selecting tools for future use



Osvath (2007), Osvath & Osvath (2008)

# Tool Use for Extractive Foraging

- Setting objects in relation
- Species differences
  - Obligatory tool users, i.e. New Caledonian crows (NCC)
  - Facultative (proto-)tool users



- Causal understanding?
  - Tests for tool selectivity
  - Modification, manufacture

# Tool Use for Extractive Foraging

- Setting objects in relation
- Species differences
  - Obligatory tool users, i.e. New Caledonian crows (NCC)
  - Facultative (proto-)tool users



Weir et al.  
(2002)

- NCC select and keep tools (e.g. Klump et al. 2019)
- Manufacture hook tool by modifying non-functional material (wire)

# Tool Use for Extractive Foraging

- Setting objects in relation
- Species differences
  - Obligatory tool users, i.e. New Caledonian crows (NCC)
  - Facultative (proto-)tool users



- Rooks learn to use tools
- Generalize to other tasks, including bending wire to hooks

Bird & Emery (2009a,b)



# Which Challenges Select for Which Skills?

## Searching and/or Accessing Food



Orientation  
Memory  
Planing



Imagination  
Means-end  
Causality



## Social Life

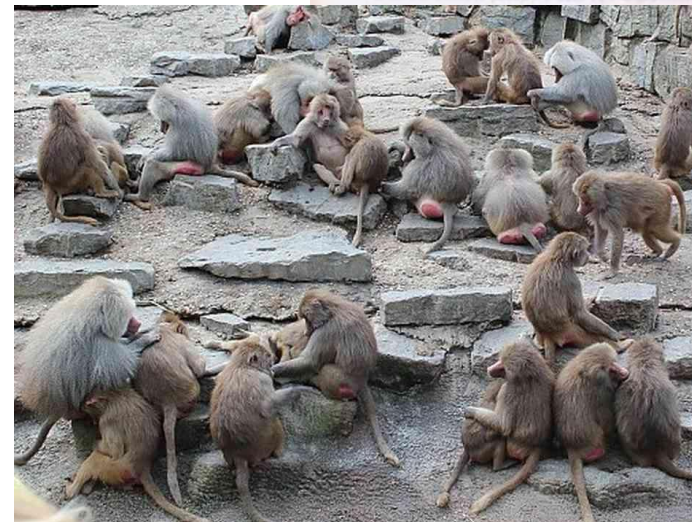
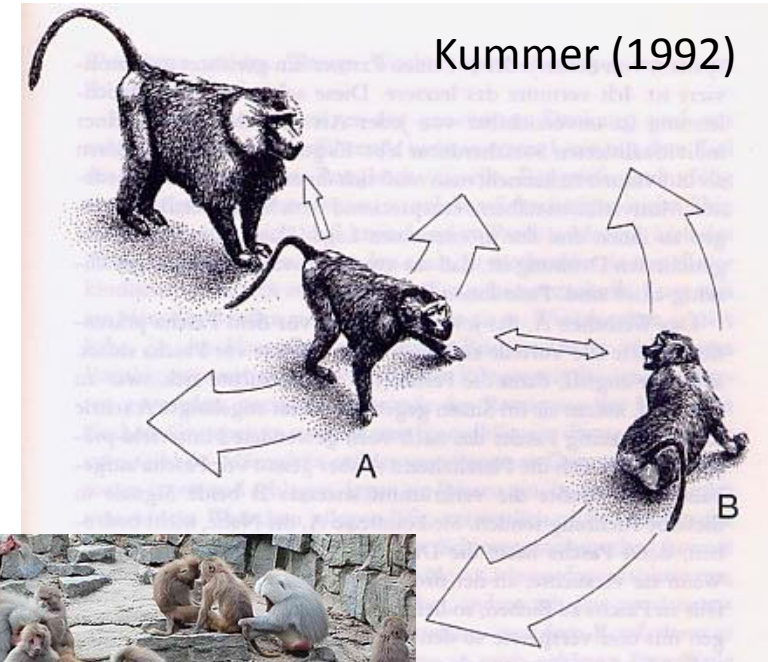


Social knowledge  
Intentionality  
Attribution



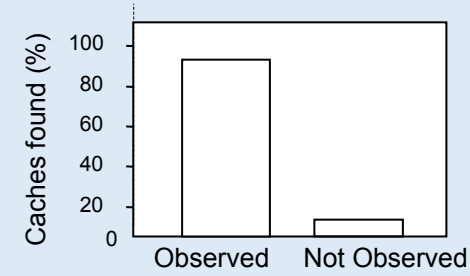
# Cognitive Challenge of Social Life

- **Conspecifics are intentional beings**
  - Behavior difficult to predict
  - Individuals difficult to manipulate
- **Groups structured by individualized relationships**
  - Social knowledge
  - Tactical manipulation: cooperation, deception
  - Attribution of mental states



# Competition over Food Caches

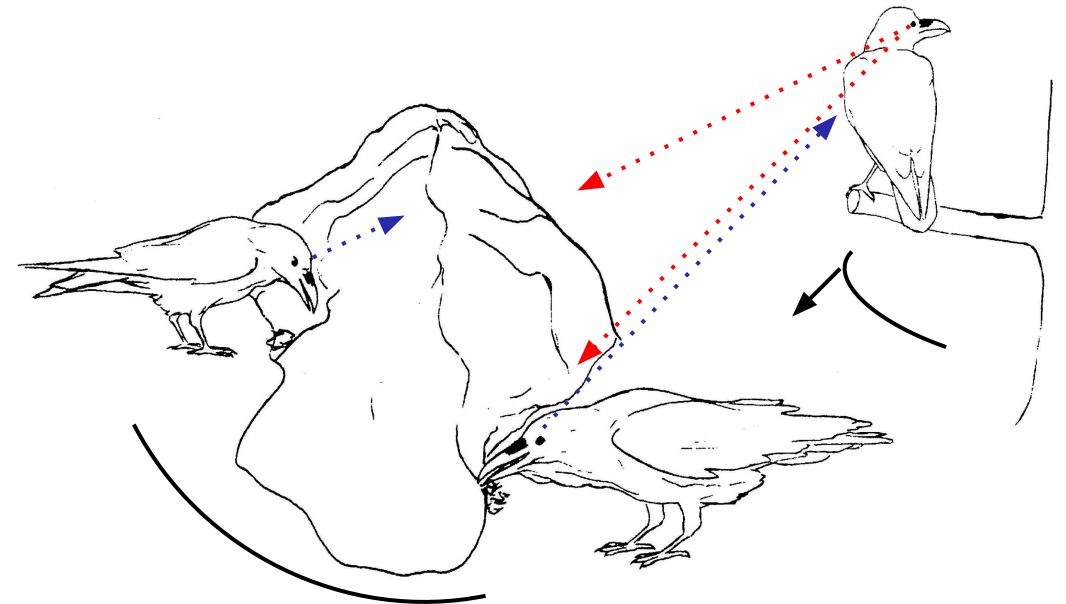
- **Observational spatial memory**
- Pilfering of observed caches



- Cognitive arms-race between cachers and pilferers, roles not fixed

- **Tactical deception**

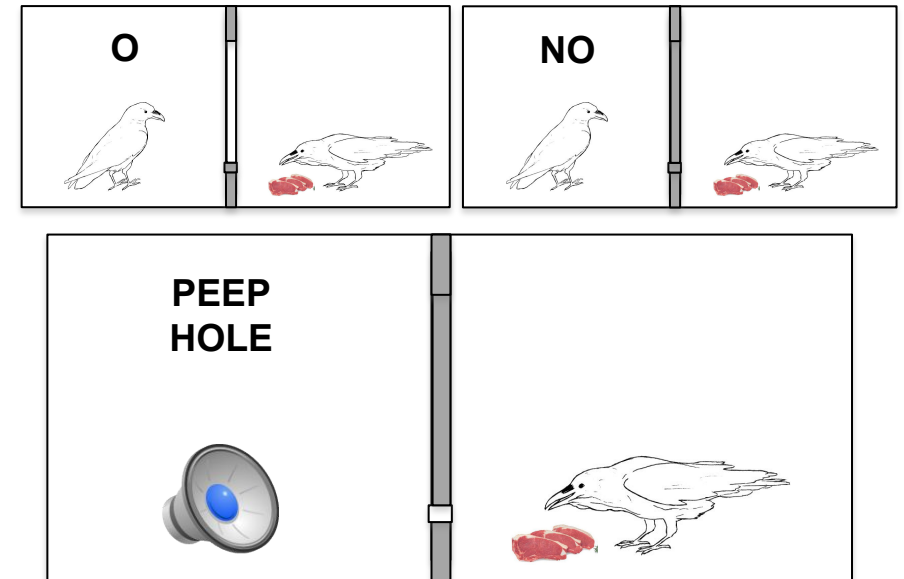
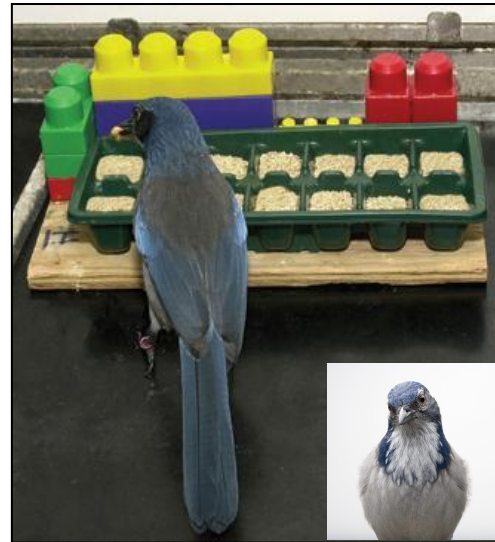
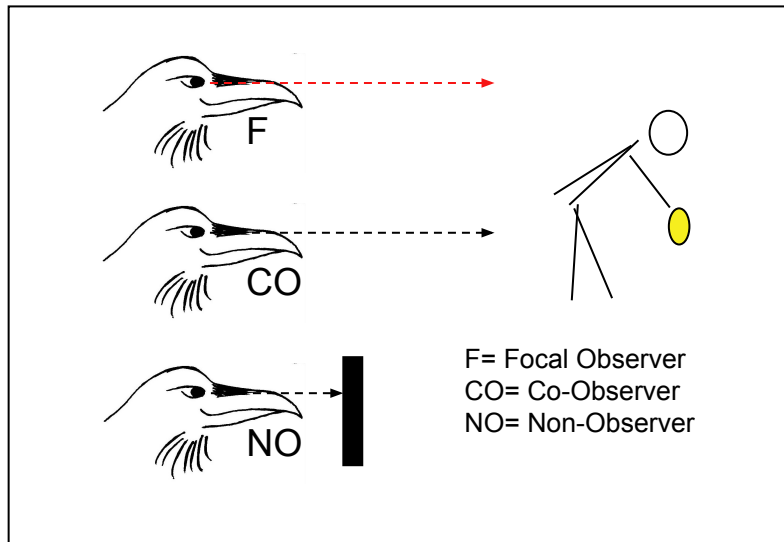
- Conceal information
- Distract attention



Bugnyar & Kotrschal (2002)

# Mind Reading?

- Discriminate 'knowers' from 'guessers'
- Remember who was present at caching



Bugnyar & Heinrich (2005, 2006) Dally et al. (2005, 2006)

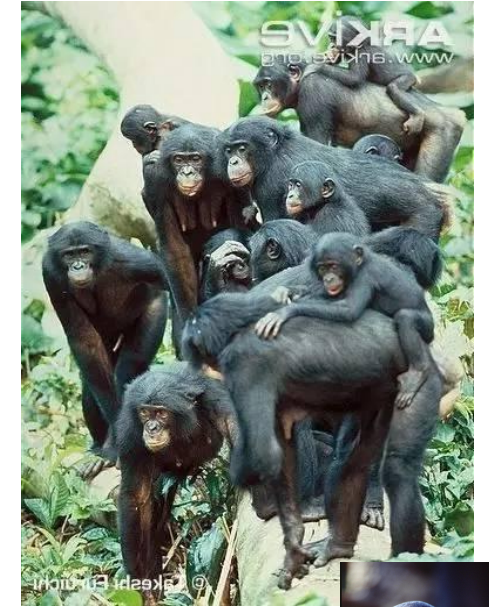
Bugnyar et al. (2016)

- **Attribute visual access to unseen competitors**

# Which Challenges Select for Which Skills?

Searching and/or Accessing Food

Social Life



Orientation  
Memory  
Planing



Imagination  
Means-end  
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Social knowledge  
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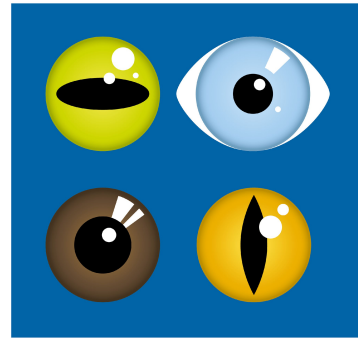




# Thanks!



Cameron Buckner




BugnyarLab



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Questions?



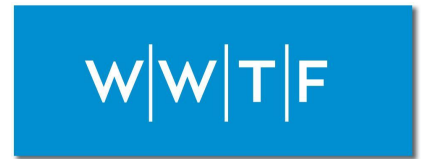
Vienna Doctoral  
Cognition · Behavior · Neuroscience  
from Biology to Psychology and

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# FWF

Der Wissenschaftsfonds.



VIENNA SCIENCE AND TECHNOLOGY FUND

# Social Life and Cognition

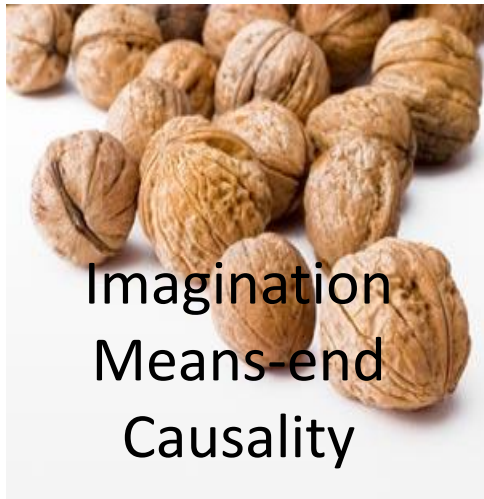
- Memory-based competition over cached is driving force for higher cognitive abilities in some corvids
  - Control intentions
  - Withhold/provide false information
  - Judge perspective, attribute knowledge
  - Who-component in episodic system
- **Difference between species?**
- Convergence to primates



# Summary: Foraging & Cognition



- Predictions supported in corvids
  - Long-term cachers excellent spatial memory
  - Short-term cachers episodic-like memory, potentially episodic planning
  - Hints for convergent evolution to primates



- Comprehension of extractive foraging less clear
  - Non-tool users learn and generalize similarly fast than obligate tool users

