

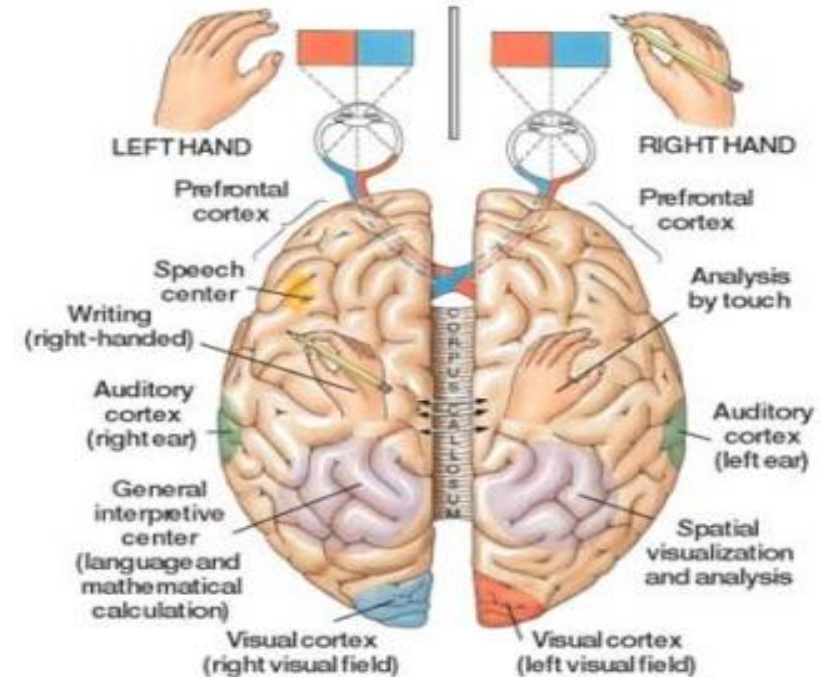
FUNCTIONAL CEREBRAL ASYMMETRIES IN CATS AND DOGS



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Lateralization-Brain Asymmetry

- Each hemisphere is specialized for certain functions
 - Some skills are strongly lateralized to one hemisphere
 - No function is 100% lateralized



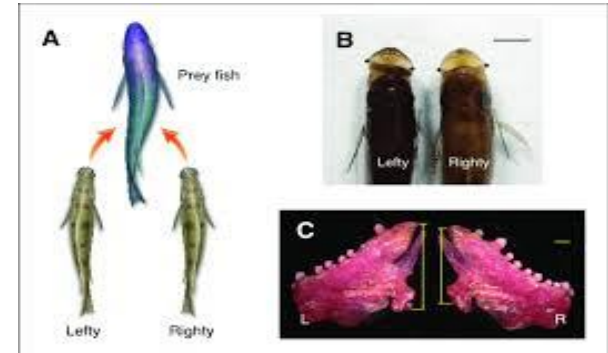
Handedness

- The dominance of one hand over the other while performing motor tasks
- A natural and non-invasive marker of functional asymmetry
- Lateralized behaviors (ex. Handedness-observable measure)



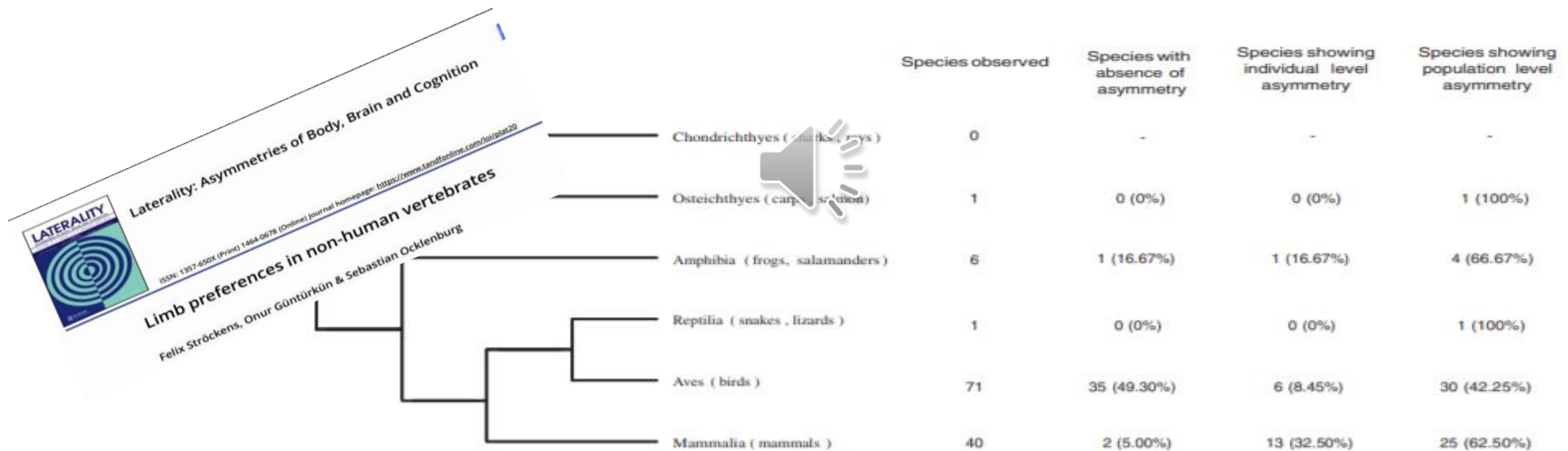
Brain Asymmetries in Animals

- Hemispheric asymmetries were thought to be uniquely human.
- People have a special evolutionary status
 - We learned to use tools about 2.5 million years ago
 - We can speak
 - Link between right handedness and speech centers



Brain Asymmetries in Animals

- Animals have asymmetric specialization
- It varies in strength and direction !!



isons. These studies analysed 119 different species, with 61 (51.26%) showing evidence for population-level asymmetries, 20 (16.81%) showing evidence for individual asymmetries, and 38 (31.93%) showing no evidence for asymmetry. The clades



Brain Asymmetries in Animals

- **Absence of asymmetry:** All members of the population prefer to use both limbs with equal probability.
- **Individual-level asymmetry:** There is no asymmetry at the population level.
- **Population-level asymmetry:** The majority of the population prefers to use either the left or the right limb.

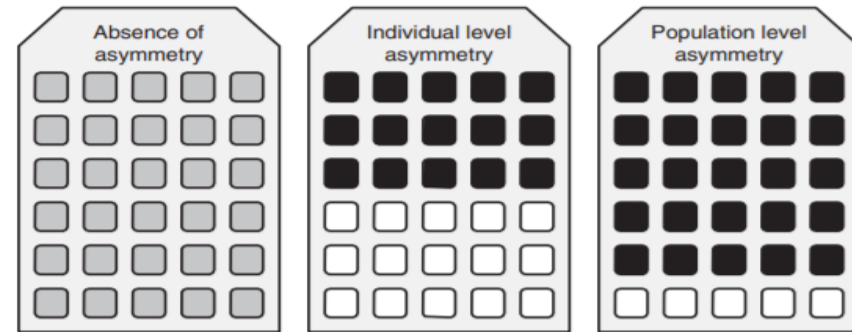


Figure 2. The three possible forms of limb preferences. Grey squares indicate individuals without a preference, black squares indicate individuals that prefer to use the right limb, and white squares indicate individuals that prefer to use left limb.



Advantages



- Saving energetic resources in cognitive tasks.
- Avoiding the duplication of functions in the two hemispheres
- Possibility to separately and simultaneously process external stimuli
 - Increasing the efficiency of the cerebral capacity.
 - **Example:** animals with laterally placed eyes, such as birds
 - When one hemisphere controls a specific behavior it is not competing with the other hemisphere to take control of that

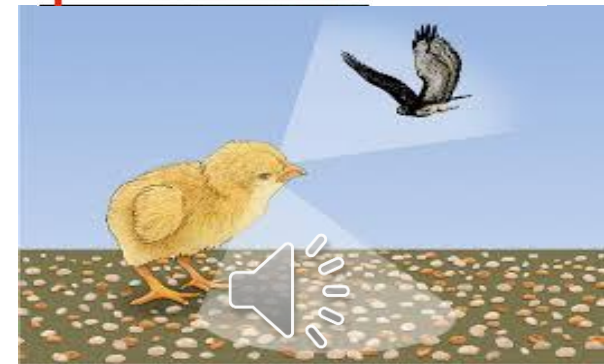
Increased activation of right sided retinal ganglion cells

Higher level of BDNF release in left tectum

Asymmetrical morphological differentiation of tectal neurons

Asymmetrical quantities of contralaterally projecting tectorotundal neurons

Asymmetries of visual representation at forebrain level



*Avian visual asymmetry results from an interaction between an epigenetic event (left-right differences

Measuring handedness

- **Hand preference:** the individual's subjectively preferred hand for manual activities
 - It is typically assessed using questionnaires.
- **Hand performance:** the individual's objectively measured skills in manual activities.
 - Pegboard Task

BOX 5.1
TEST YOUR OWN HAND PREFERENCE!

The Edinburgh Handedness Inventory⁷ (Table 5.1) is the handedness questionnaire most widely used in scientific research. Here, you can try it out yourself and calculate your laterality quotient (LQ) to determine your own hand preference.

brackets. Please try to answer all the questions, and only leave a blank if you have no experience at all of the object or task.
From Ref. 7.

TABLE 5.1 The Edinburgh Handedness Questionnaire⁷

	Left	Right
1	Writing	
2	Drawing	
3	Throwing	
4	Scissors	
5	Toothbrush	
6	Knife (without fork)	
7	Spoons	
8	Broom (upper hand)	
9	Striking match (match)	
10	Opening box (lid)	
Sum Left (L):		Sum Right (R):
R - L =		R + L =

Laterality Quotient (LQ): $LQ = [(R - L) / (R + L)] \times 100$

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Instructions:
Please indicate your preferences in the use of hands in the following activities by putting + in the appropriate column. Where the preference is so strong that you would never try to use the other hand unless absolutely forced to, put ++. If in any case you are really indifferent, put = in both columns. Some of the activities require both hands. In these cases the part of the task, or object, for which hand preference is wanted is indicated in

When you have filled in all boxes, calculate the sum of pluses you made for the left hand (L) and the sum of pluses you made for the right hand (R). Now you can calculate your LQ using the formula:
 $LQ = [(R - L) / (R + L)] \times 100$
First, calculate the dividend of the formula by subtracting L from R and then the divisor by adding R and L. Calculate the quotient and multiply it by 100 and you have calculated your LQ.



Pawedness in Animals

- Started with **Robert L. Collins** at the Jackson Laboratory in Bar Harbor, Maine (1965-1999).
- Mice show pawedness—e.g., a preference to use one paw over the other when handling food or manipulating objects.
- Collins invented a special feeding chamber



More examples:

Our Left-Handed Cousins

By Constance Holden | Jul. 23, 2001, 7:00 PM

Tool-using chimps mostly lefties, study finds

Evidence of 'handedness' offers insight into how primate brains evolved

Jump to discuss
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Below:  Discuss  Related



Researchers say they have the first good evidence that genes play a significant role in chimp handedness, just as they are believed to in humans. They also say that—as in humans—left-handedness is often associated with developmental anomalies.

William Hopkins and colleagues at the Yerkes Regional Primate Research Center in Atlanta determined handedness by watching chimps scoop peanut butter out of a tube. They then measured similarity in hand preferences between mothers and offspring in 134 family pairs.

The researchers report in the 4 July issue of *Psychological Science* that birth order had a major effect on handedness in this group, as well as in 155 pairs of maternal half-siblings (siblings who share the same mother). They classified first-born chimps and those born sixth or later as being at high risk for "developmental instability"—a term for various prenatal perturbations such as hormonal irregularities associated with both first pregnancies and late ones. These conditions seemed to make left-handedness more likely, even when the mother was right-handed: The team found that among the low-risk pairs, 86% of the offspring of right-handed females were right-handed; among the high-risk ones, the proportion was only 46%.

AP Associated Press

updated 8/15/2005 9:51:35 PM ET

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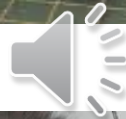
WASHINGTON — When it comes to fishing tasty termites out of their mounds, wild chimpanzees don't have the right stuff. Most, in fact, are southpaws.

A three-year study of 17 wild chimps in Gombe National Park, Tanzania, found that 12 of them used their left hands when using sticks to probe for termites. Four were right-handed and one was listed as ambiguously handed.

"Contrary to previous claims, wild chimpanzees show population-level handedness in tool-use," reported the research team led by William D. Hopkins of the Yerkes National Primate Research Center at Emory University in



Motor laterality in domestic animals



Why is it important?

- To learn more about our brains
- Studying animal models can provide unique insight into lateralization mechanisms.



Pawedness in Dogs

- Dogs show individual level of asymmetry
- Weak lateralization may be associated with chronic stress and stress reactivity in dogs (Branson and Rogers, 2006, Salgirli Demirbas et al.2019)
- Lateralization-guide dog training (Tomkins et al.2012)
- Temperament-FSA ??? (Schneider et al.2013)



Why is it important?

- Dog and human - common social evolutionary history
- Dog is the most suitable model for human
- In humans: Atypical asymmetries are associated with psychiatric disorders:
 - Schizophrenia (Hirnstain & Hugdahl, 2014)
 - Depression (Denny, 2009; Logue et al., 2015)
 - Bipolar disorder (van Dyckve et al., 2012)
 - Anxiety Disorders (Logue et al., 2015; Lyle, 2013)
 - Autism spectrum disorders (Rysstad & Pedersen, 2016)
- Lateralized behaviors can be used in welfare assessment
- Poor lateralization is associated with psychiatric disorders
- Dogs and humans share the same disorders
- Underlying brain pathologies almost the same
- Lateralization may be important in clinical behavior.



How Can We Test?



- Different methods are used to determine motor laterality.
- No consistency between methods in dogs
- Standard method: Kong test



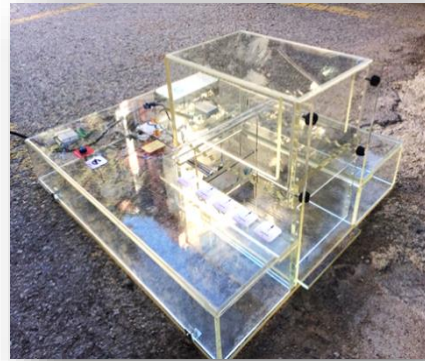
Alternative Method

- **KONG TEST**
 - **PROS:** Easy to apply, observe and assess
 - **CONS:**
 - Tendency of using the paw for fixing the big hole
 - Dogs use their non-dominant limb to stabilise the Kong™ ball and their dominant side for postural support (Wells et. al. 2016)
 - Difficult to count 50 paw uses
 - **QUESTION:** Is it possible to develop a food reaching task for dogs?



CanFoRe

- TÜBİTAK 1001 project
- «Relationship between FCA and stress in dogs»
- AÜ-METU-Ruhr University partnership
- Valuable contributions of Prof. Güntürkün and Dr. Oklenburg from Ruhr University Institute of Cognitive Neuroscience



Methodology

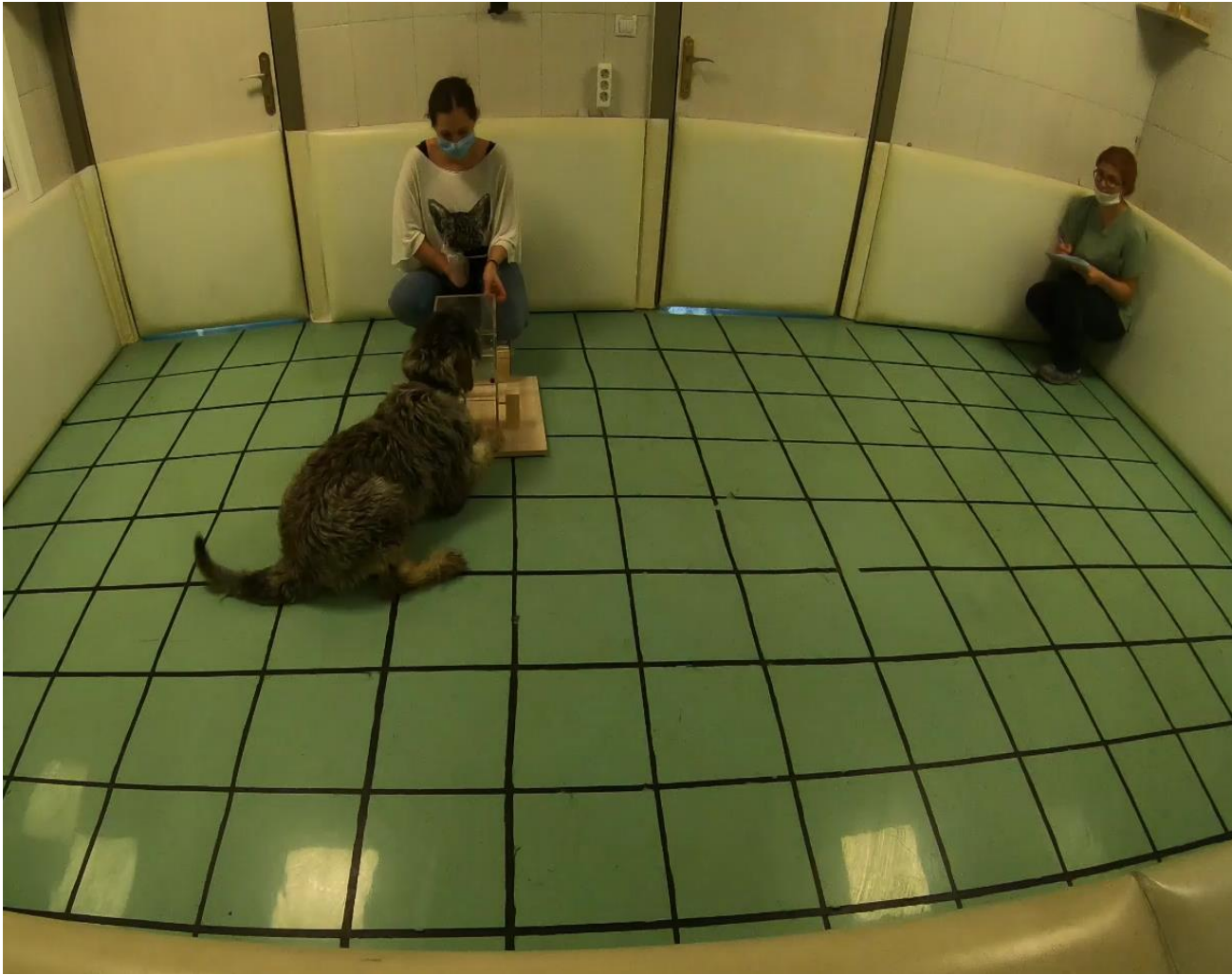
- 60 dogs (chronic stress-normal)
- **Methods:**
 - CanFoRe
 - Kong test
- House environment
- Foreign environment
- Open field test - acute stress



Preliminary Results

- ✓ This study is the first to design food reaching test for dogs.
- ✓ Preliminary results showed that CanFoRe is an applicable test for evaluating paw preferences of dogs.
- ✓ Moreover, it can be used for measuring paw preferences of dogs under acute stress situation.
- ✓ It can be used as self inhibition and problem solving tasks.

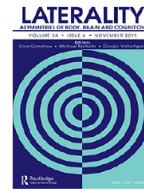




Assoc. Prof. Dr. Yasemin SALGIRLI DEMİRBAŞ

Pawedness in Cats

- Individual level of asymmetry
- Left handedness is 3-4 times more than people
- Female cats are more healthy, male cats are left-handed more



Laterality: Asymmetries of Body, Brain and Cognition



ISSN: 1357-650X (Print) 1464-0678 (Online) Journal homepage: <https://www.tandfonline.com/loi/plat20>

Paw preferences in cats and dogs: Meta-analysis

Sebastian Ocklenburg, Sevim Isparta, Jutta Peterburs & Marietta Papadatou-Pastou

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To link to this article: <https://doi.org/10.1080/1357650X.2019.1578228>



Published online: 10 Feb 2019.



Pawedness in Cats

- Why are we interested?
- Cats are natural predators
- Features of a good hunter:
 - Problem solving skills
 - Manipulation-paw usage
 - Strong paw preference gives advantage
- Cat-human relationship (sharing the same house-communication / imitation-feeding from a food bowl)



Animal Cognition
<https://doi.org/10.1007/s10071-020-01428-6>

ORIGINAL PAPER



Did we find a copycat? Do as I Do in a domestic cat (*Felis catus*)

Claudia Fugazza¹ · Andrea Sommesse¹ · Ákos Pogány¹ · Adám Miklósi^{1,2}

Received: 22 June 2020 / Revised: 20 August 2020 / Accepted: 5 September 2020
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Abstract

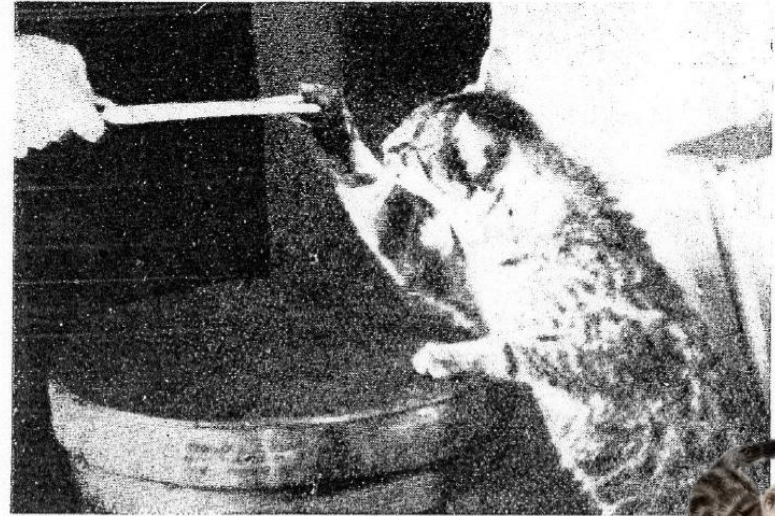
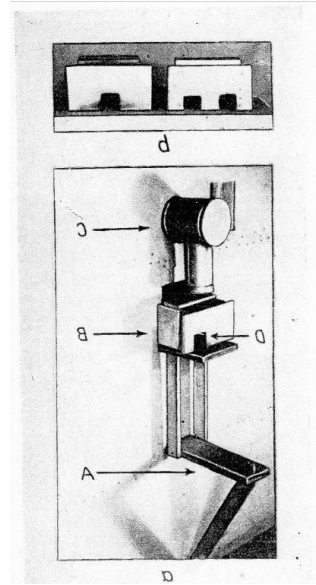
This study shows evidence of a domestic cat (*Felis catus*) being able to successfully learn to reproduce human-demonstrated actions based on the Do as I Do paradigm. The subject was trained to reproduce a small set of familiar actions on command “Do it!” before the study began. To test feature-contingent behavioural similarity and control for stimulus enhancement, our test consisted of a modified version of the two-action procedure, combined with the Do as I Do paradigm. Instead of showing two different actions on an object to different subjects, we applied a within-subject design and showed the two actions to the same subject in separate trials. We show evidence that a well-socialized companion cat was able to reproduce the actions demonstrated by a human model by reproducing two different actions that were demonstrated on the same object. Our experiment provides the first evidence that the Do as I Do paradigm can be applied to cats, suggesting that the ability to recognize behavioural similarity may fall within the range of the socio-cognitive skills of this species. The ability to reproduce the actions of a heterospecific human model in well-socialized cats may pave the way for future studies on cats’ imitative skills.

Keywords Social learning · Do as I do · Cat · Two-action method · Imitation · Response facilitation



How do we test?

- Food Reaching Test (FRT) (Graystyan ve Molnar,1954)



Cognition and Laterality

- Is there a relationship between paw preference strength and problem solving ability?
- 41 different cats-
Two different problems

Behavioural Brain Research 391 (2020) 112691



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journal homepage: www.elsevier.com/locate/bbr



Research report

The relationship between problem-solving ability and laterality in cats

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ARTICLE INFO

Keywords:
Paw preference
Cat
Laterality
Problem-solving ability
Functional cerebral asymmetry

ABSTRACT

The association between hemispheric asymmetries and cognitive ability is one of the key areas of comparative laterality research. In several animal species, individual limb preferences correlate with perceptual, cognitive, or motor abilities, possibly by increasing dexterity of one limb and minimizing response conflicts between hemispheres. Despite this wealth of research, the association between laterality and cognitive abilities in the cat (*Felis catus*) is not well understood. Therefore, it was the aim of the present study to investigate the relationship between laterality and problem-solving ability in cats. To this end, strength and direction of paw preferences in 41 cats were measured using two novel food reaching tasks in which the animals needed to open a lid in order to reach the food reward. We found that cats that showed a clear preference for one paw were able to open more lids successfully than ambilateral animals. Moreover, cats that preferred to interact with the test apparatus with their paw from the beginning, opened more lids than cats that first tried to interact with the test apparatus using their heads. Results also suggested a predictive validity of the first paw usage for general paw usage. It was also shown that the cats' individual paw preferences were stable and task-independent. These results yield further support to the idea that lateralization may enhance cognitive abilities.



Problem Solving Tests (FRTs)



The doors open to the same side



The doors open to the different sides





Results

- In cats, paw preferences and problem solving ability are interrelated.
- Cats that clearly preferred their single paw were able to successfully open more covers than ambilateral animals.
- Cats that prefer paws are more successful than those that prefer their heads.
- The first paw preference may be an indication of the cats' general paw preference.
- Paw preference is stable between tests



Other studies

- Strength of lateralization is important in temperament (self-confidence, social relationship)

Journal of Comparative Psychology
2016, Vol. 130, No. 4, 313–320

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Lateral Bias and Temperament in the Domestic Cat (*Felis silvestris*)

Louise J. McDowell, Deborah L. Wells, Peter G. Hepper, and Martin Dempster
Queen's University Belfast



Other Studies



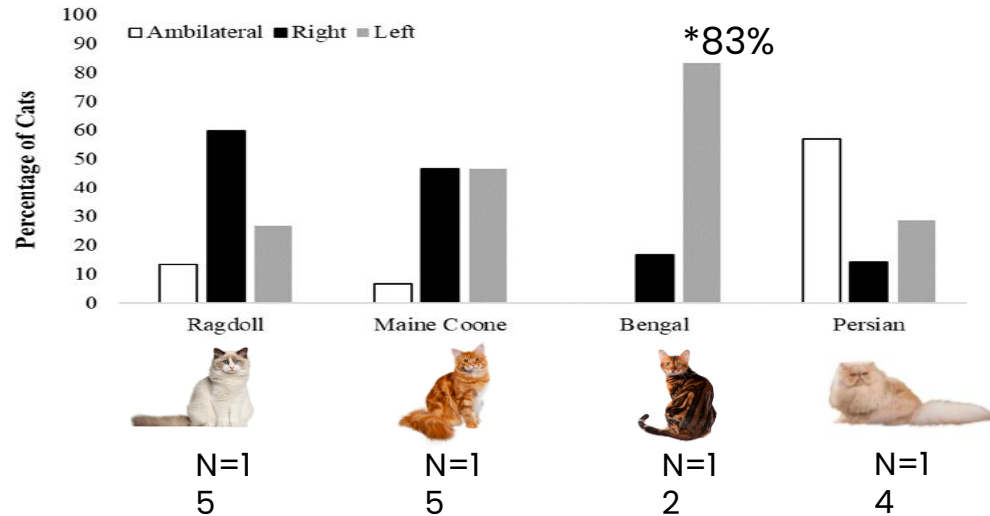
Article

Laterality as a Tool for Assessing Breed Differences in Emotional Reactivity in the Domestic Cat, *Felis silvestris catus*

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N=1
5



N=1
5



N=1
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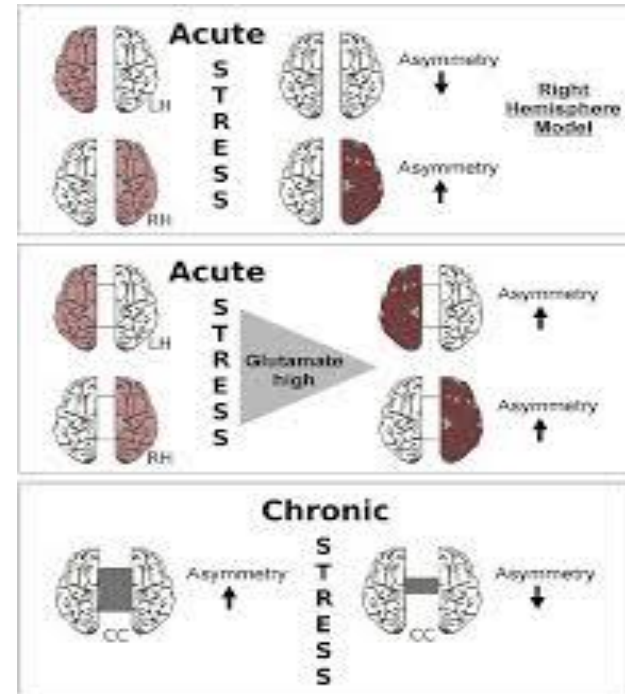


N=1
4



CONCLUSION

- Hemispheric asymmetries play an important role in almost all cognitive functions.
- Studying animals can provide unique insight into lateralization mechanisms
- The link between stress and lateralization
- The link between psychiatric disorders and lateralization
- The link between temperament and lateralization
- It can change the way pets are trained



THANK YOU

