Welcome to BIO D53

Special Topics in Animal Behaviour

Instructor: Sean McCann
TA: Catherine Scott

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My motivations for studying animal behaviour

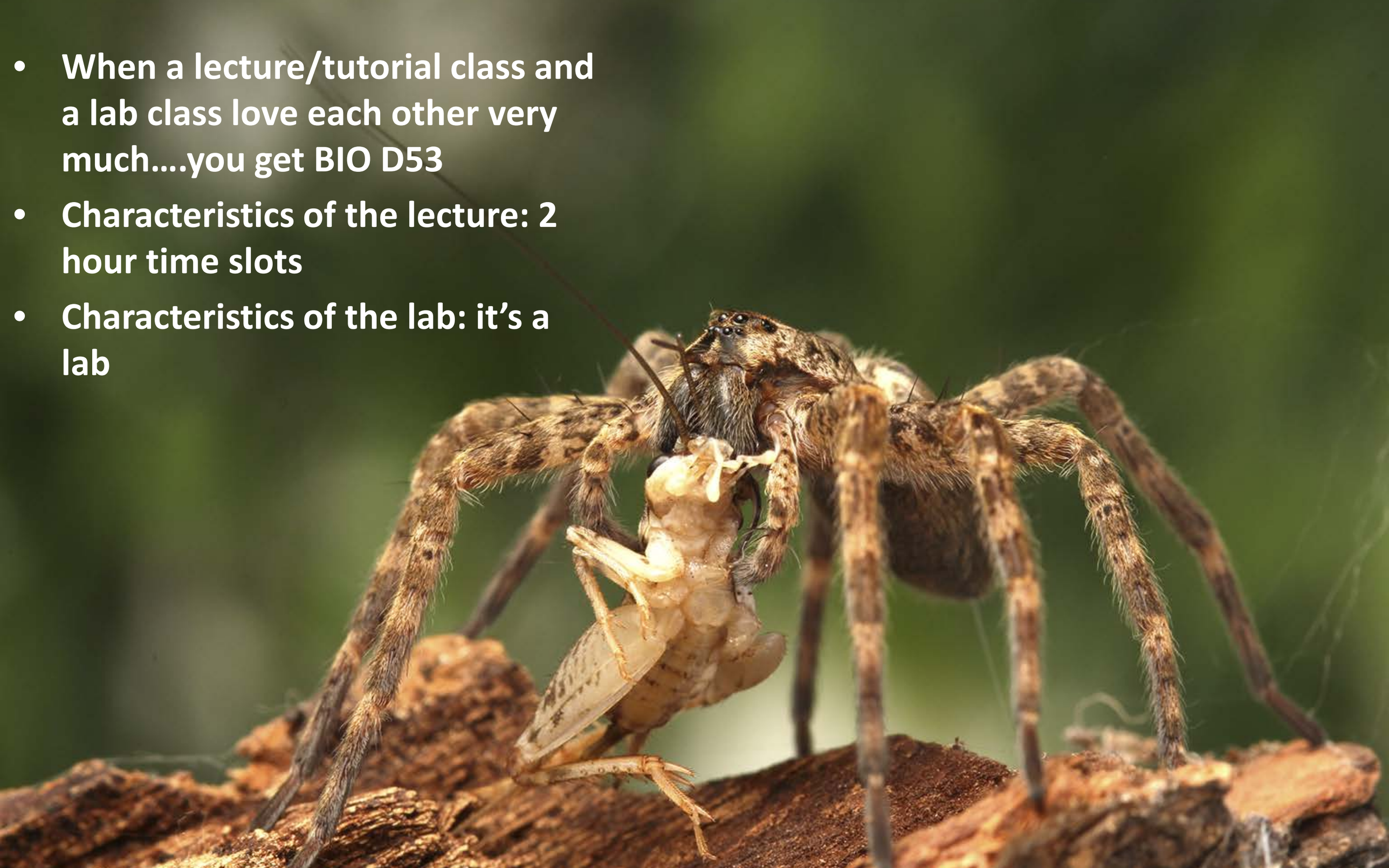
BIO D53: A vision for this class

A working lab

- We will model our class on a working lab, a team setting out to achieve learning and research objectives
- Curiosity will drive us, and if we make mistakes we will learn from them as much as from our successes

- Whether you join a research lab or any other workplace, you will need to learn, work as a team, apply your learning to achieve
- The model of a working academic lab is a low-pressure way of practicing these skills
- We will do our best to support and encourage each other, because we are all in the same boat

- When a lecture/tutorial class and a lab class love each other very much….you get BIO D53
- Characteristics of the lecture: 2 hour time slots
- Characteristics of the lab: it’s a lab



What does it look like?

Date	Monday 12-2 pm	Date	Thursday 1-3 pm
January 2	• Intro to class • theoretical and practical underpinnings of animal behaviour research • Assignment: Backgrounder • Meet in BV363	Jan 5	• Introduction to spider biology • Observational studies and manipulative experiments • Skills intensive: informal communications • Meet in BV363
January 9	• Library tutorial on research methods, reference management and Zotero • Lab introduction • Meet in BV363	Jan 12	• Lab: Introduction to spiders and predation observations • Meet in SW 332
January 16	• Behaviour and sexual selection • Paper discussion • Lab prep • Meet in BV363	Jan 19	• Lab: mating behaviour observations • Assignment: summary of observations • Meet in SW 332
January 23	• Predation behaviour and issues with studying it • Statistical review	Jan 26	• (Lab) competition between predators: Does size matter? • Meet in SW 332

What does it mean?

	• Lab introduction • Meet in BV363		
January 16	• Behaviour and sexual selection • Paper discussion • Lab prep • Meet in BV363	Jan 19	• Lab: mating behaviour observations • Assignment: summary of observations • Meet in SW 332
January 23	• Predation behaviour and issues with studying it • Statistical review • Quiz on widows and behavior • Meet in BV363	Jan 26	• (Lab) competition between predators: Does size matter? • Meet in SW 332
January 30	• Lecture: Red throated Caracara behaviour • Animal behaviour fieldwork • Lab maintenance • Meet in BV363	Feb 2	• Lecture: Insights from the field on black widow behavior • Meet in BV363
February 6	• Instinctual and learned behaviours • Paper discussion • Quiz on predation, widows and fieldwork • Lab prep • Meet in BV363	Feb 9	• Lab: falling posture instinct in spiders • Assignment: storyboard for short video • Meet in SW 332
Feb 13	• Skills intensive: Working	Feb 16	• Lab: skills intensive recap:

Lecture Material

- Topics of interest will be covered: most have to do with phenomena or techniques concerning that week's lab
- Should not last longer than 1 h

Literature discussion

- We will dive critically into design, methods and implications of papers
- Students will be expected to argue from paper

Skills Intensives

Skills Intensives

- Hands-on learning of skills related to animal behaviour, statistics, software or career skills
- Taken together prepare one for professional/academic environment
- Good for you (I swear!)

Assignments

- Not intended to be very difficult -> no term paper
- Usually given in lab time
- Due dates to be posted on Blackboard

Quizzes

- Short tests…In lieu of a midterm, these will reflect the style and difficulty of the final
- Will take place on Mondays -> 5 in total


Syllabus!

Class meeting times

See attached Timetable (below) for a schedule of topics, meeting places and laboratory exercises

Mondays:	Generally in lecture hall (BV 363), may be followed by prep time in laboratory
Thursdays:	Generally in laboratory (SW 332*): subject to modification, consult timetable (below)

***Note that SW332 is NOT listed in the calendar as a meeting place; but the class format has been changed to allow more hands-on activities and so will include short labs instead of tutorials. Please come to SW332 when indicated on the timetable**

Course Description

This course is a special topics course intended for 3rd and 4th year students as an introduction to behavioural research in the laboratory environment. I hope to stimulate a classroom attitude of collegiality and teamwork that parallels an actual working behavioural lab. Activities are divided into topical lectures, paper discussions, skills intensives, and most importantly, laboratory investigations.

This course will cover diverse topics that are applicable to a wide range of animal taxa. Laboratory work will primarily be with spiders, mainly different species and populations of widow spiders (genus *Latrodectus*). These will be our main study model for many reasons: (1) spiders are good models for investigating a wide range of behavioural processes, (2) they are currently being reared in the lab at UTSC, so we can have access to animals throughout the term and (3) their behavioural responses are such that we will be able to collect meaningful data in a relatively short time period.

Learning outcomes

At the end of the course, students should have knowledge of and be comfortable with
-evaluating primary research and understanding the theoretical reasoning and methodology employed
-designing and conducting experimental and observational protocols
-writing up sections of research papers and proposals, to a publishable standard
-Explaining statistical and methodological methods clearly, employing appropriate language and rigor
-basic techniques for husbandry and experimental manipulation of invertebrates
Students will also have a comprehensive and practical knowledge of *Latrodectus* (and selected other species) behaviour, from lectures, readings and laboratory experiments.

Course Format

Lectures

Some material is best presented as a talk; there will be some traditional lecture format sessions throughout the course. Notes should be taken, as my slides tend to include images, figures, and illustrations more than written material. You are responsible for all material presented in lectures for tests, hence careful notetaking is recommended. Slides from the lectures will be made available for review on the class BlackBoard after scheduled class sessions (PDF format). All questions during lecture are welcomed, as animal behaviour is fascinating and complex, and should stimulate much discussion

Laboratory Exercises

The laboratory will take up a significant amount of our effort, in terms of time and thought invested. Mainly our lab activities will take place on Thursdays, but see the course schedule for some exceptions. We may be headed to the lab following class activities on Mondays as well, should our subsequent work demand it.

Biosafety and Laboratory protocols

Latrodectus spiders produce a neurotoxic venom, though with the care we will emphasize throughout the course, the chances of receiving a bite are vanishingly small. Appropriate training and supervision with handling spiders will be provided. Because lab time is limited, certain class meetings will divide time between lecture hall and laboratory, in order to accommodate laboratory preparation.

Skills Intensives

Throughout the course, we will hold “skills intensives” where we dig down into particular everyday skills used by working scientists. These may surprise you!

Literature Discussion

We will have several literature discussions; students are expected to read assigned material prior to the class meeting in which the discussion is held. Literature discussions may take the form of led discussions or group-based brainstorming activities. The literature chosen will reflect current issues in animal behaviour research, as well as material with a direct bearing on our research goals.

Class policies

AccessAbility

Students with diverse learning styles and needs are welcome in this course. In particular, if you have a disability/health consideration that may require accommodations, please feel free to approach me and/or the AccessAbility Services as soon as possible. AccessAbility Services staff (located in Rm SW302, Science Wing) are available by appointment to assess specific needs, provide referrals and arrange appropriate accommodations 416-287-7560 or email ability@utsc.utoronto.ca. The sooner you let us know your needs the quicker we can assist you in achieving your learning goals in this course. Of particular concern to this course is any clinical diagnosis of insect allergy or arachnophobia. Both of these may severely impact the prospects of success in the course unless special arrangements are made early.

Academic Honesty

As academics, we strive to maintain an exemplary level of honesty and transparency in our work. This means that we must follow certain guidelines at all times when conducting any scholarship. Helpfully, UTSC has an Office of Research Integrity, and they have spelled out a comprehensive Code of Behaviour on Academic Matters, which all students, teachers, and research staff are expected to uphold. This document should be reviewed and followed to the letter. Specific instruction on several topics related to this Code will be provided during class meetings.
In particular, all student assignments and classwork will be subject to the following criteria:

- all ideas or words in assignments quizzes and tests should be the student's own, or if not, should be explicitly stated as a quotation or paraphrase, with acknowledgement provided to the originator of those ideas or words

-Student's work should never contain false or misleading references

-When written work arises as a result of group discussions, collaboration in the discussion is expected, but students are expected to write up the results on their own, in their own words

-Imagery or artwork used in any academic communication should be used in accordance with the copyright stipulations of the artist, and all imagery not originating with the student should be attributed

If you are not sure what constitutes plagiarism, see:
www.utoronto.ca/academicintegrity or
www.writing.utoronto.ca/advice/using-sources
or talk to Dr. McCann, or visit the Writing Centre

Laboratory and classroom safety

Safety is of paramount importance in both the laboratory and classroom environment. The wellbeing of students and staff is foremost, followed by the wellbeing of our laboratory animals. To this end, we will seek to keep both the classroom and the laboratory free of any obstructions, hazards and spills of any kind. Emergency instructions from laboratory personnel, floor fire wardens, emergency responders and administrative staff should be followed promptly. If we have issues with allergies on the part of class participants, we will seek to minimize exposure to allergens.

Black widow spiders (Fig. 1) used in our laboratory present a risk to any personnel in contact with them, and we must abide by a biosafety protocol filed by Dr. M. Andrade governing their safe handling and care. During our lab work, any and all escapes must be promptly reported to the instructor or TA. Safe containment and escape protocols will be taught in the first laboratory session, and these protocols shall be followed during all subsequent spider activities.

Our laboratory policy requires the wearing of lab coats, long pants, and gloves; additional precautions and PPE (Personal Protective Equipment) will be stipulated prior to any laboratory session requiring them. Lab coats will be provided.

Chemical use in the lab will be limited, but appropriate PPE, handling instructions and all relevant MSDS will be provided for any chemical use. A laboratory emergency response plan will be posted in a prominent location in the laboratory at all times.

Working with animals

Spiders and insects, being arthropods, are exempt from inclusion in University of Toronto Animal Care and Use Committee policies; however, all animals we work with in the laboratory are to be treated with respect and consideration. Euthanasia will be conducted only as needed, and we will seek to minimize potential stress and suffering of the research animals.

Some of the animals we work with will be on loan from Dr. M. Andrade's research group, and may be critical to other research goals. Hence, excess mortality and injury to these animals is unacceptable. Laboratory practices that jeopardize the wellbeing of these animals (or personnel in the laboratory) will not be tolerated, and may result in a warning. Failure to heed such a warning may result in a suspension of lab privileges for the subsequent week, with a loss of marks attendant with an unexcused lab absence.

Our class will be responsible for care and maintenance of our own research and feeder animals, and we will take time every week to confer about issues related to their care and propagation. This is crucial to the success of our work, and will be a regular part of laboratory activities. All students are expected to participate to the maximum degree possible with maintenance of the laboratory and research animals.

Assignments, participation, quizzes, lab notebooks and final exam

These five elements will make up your grade. The final exam will be cumulative, and will cover all material we cover during the course. The style of the final exam will be very similar in format to the quizzes, so the final will hold no surprises.

Item	Percentage of grade
Participation*	10
Assignments	20
Quizzes	25
Lab notebooks	15
Final exam	30

*Participation mark depends on both classroom and laboratory participation.

Participation in laboratory activities not only includes participation in experiments and observations, but also contributing to the maintenance and running of the lab, which will be tracked via a sign-up sheet. The duties on this roster will not be onerous, but will ensure that we have a safe, effective and fun lab space to work in.

Assignments may consist of questionnaires, sample problems, discussion paragraphs, written up sections of experimental results, or something completely different. They are not expected to be onerous, but will challenge your creativity and scientific acumen.
Late assignments will not be accepted without a note from a physician or by previous arrangement. There will be no exceptions made to this rule.

Quizzes are simply that, short tests involving multiple choice or short answer questions based on material from previous weeks. Taken in aggregate, the quizzes will reflect the difficulty and style of the final exam (although the final will obviously be longer).

Lab notebooks will be marked by Catherine Scott, and she will have specific recommendations as to the level of detail required. At minimum, they should closely document the experimental goals, the setup and design of the experiment, any and all results, notes on errors, and general impressions of each replicate you perform. You will receive detailed instruction on expectations in class.

Questions?

Take a break!

Theoretical and historical underpinnings of behavioural ecology research

Some antecedent disciplines…

Animal behaviour researchers come in several flavours…

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Behavioural Ecologist/Sociobiologist 1970s-present	The most common appellation for modern behavioural researchers in Biology departments

Animal Behavior research: more than just ecology and evolution

- Public health and infrastructure: epidemiology, pharmacology, engineering
- Economic: wildlife management, fisheries
- Academic: anthropology, philosophy
- Other: “citizen science”, hunting/fishing, subsistence, recreation

Origins of Animal Behaviour research

Formal study of animal behaviour

- Sciences of many kinds can often be traced back to Aristotle
- Like many ancient Greeks, compiled information, and philosophized about how we think and know (epistemology)
- Aristotle's "4 Causes (αἰτία)" bear some import in modern thought

Four “Causes”

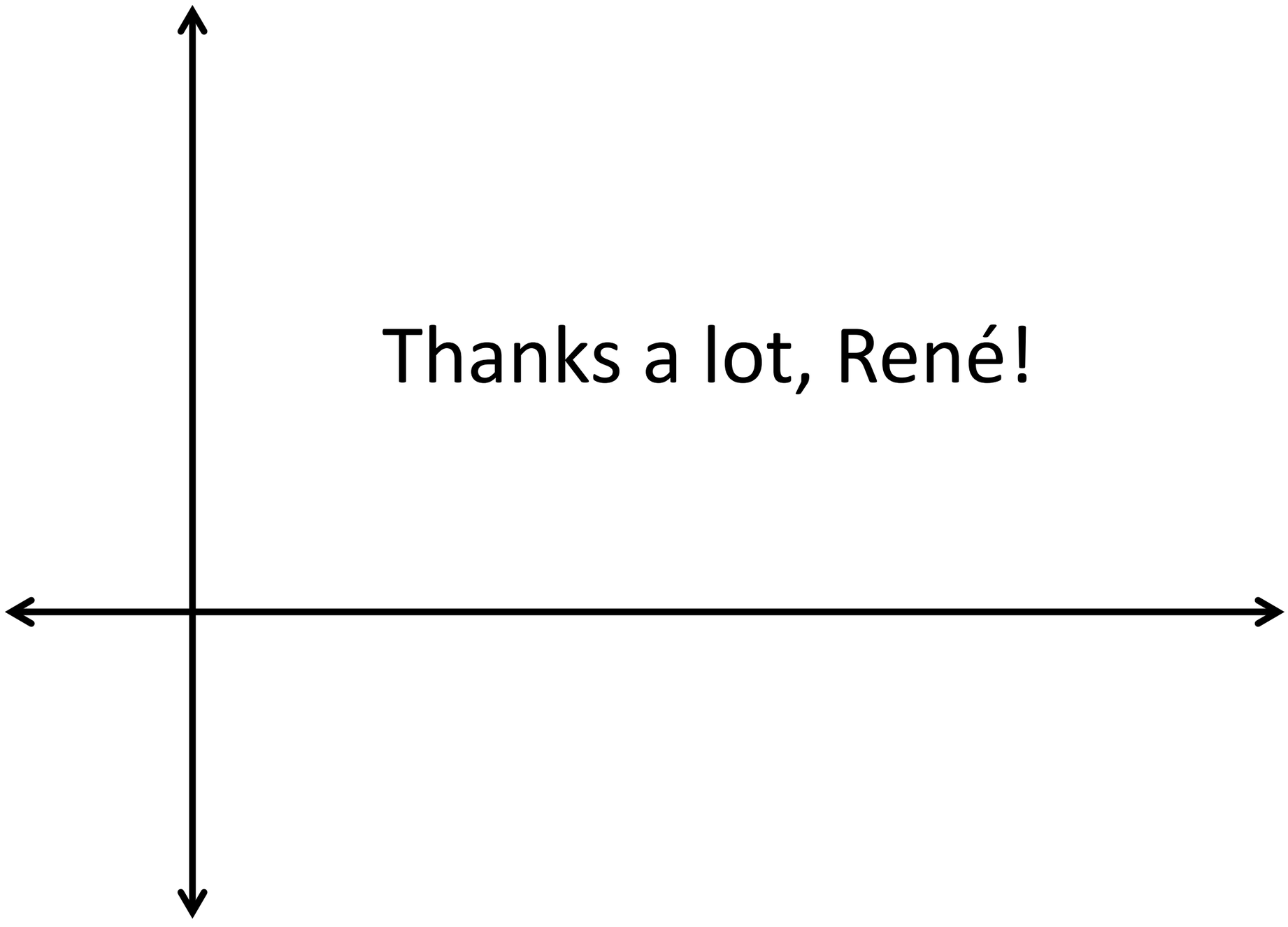
Four answers to the question “why?”

Αἰτία (“cause”	Explanation
Material	What makes up the material of the object in question
Formal	Relationships (mathematical or otherwise) surrounding the object’s organization
Efficient	Things apart from the object affecting it (the cause of a table is a carpenter)
Final	The sake of an object, thing or being: what is it *for*? Ultimate causation.

Fun Facts about Aristotle

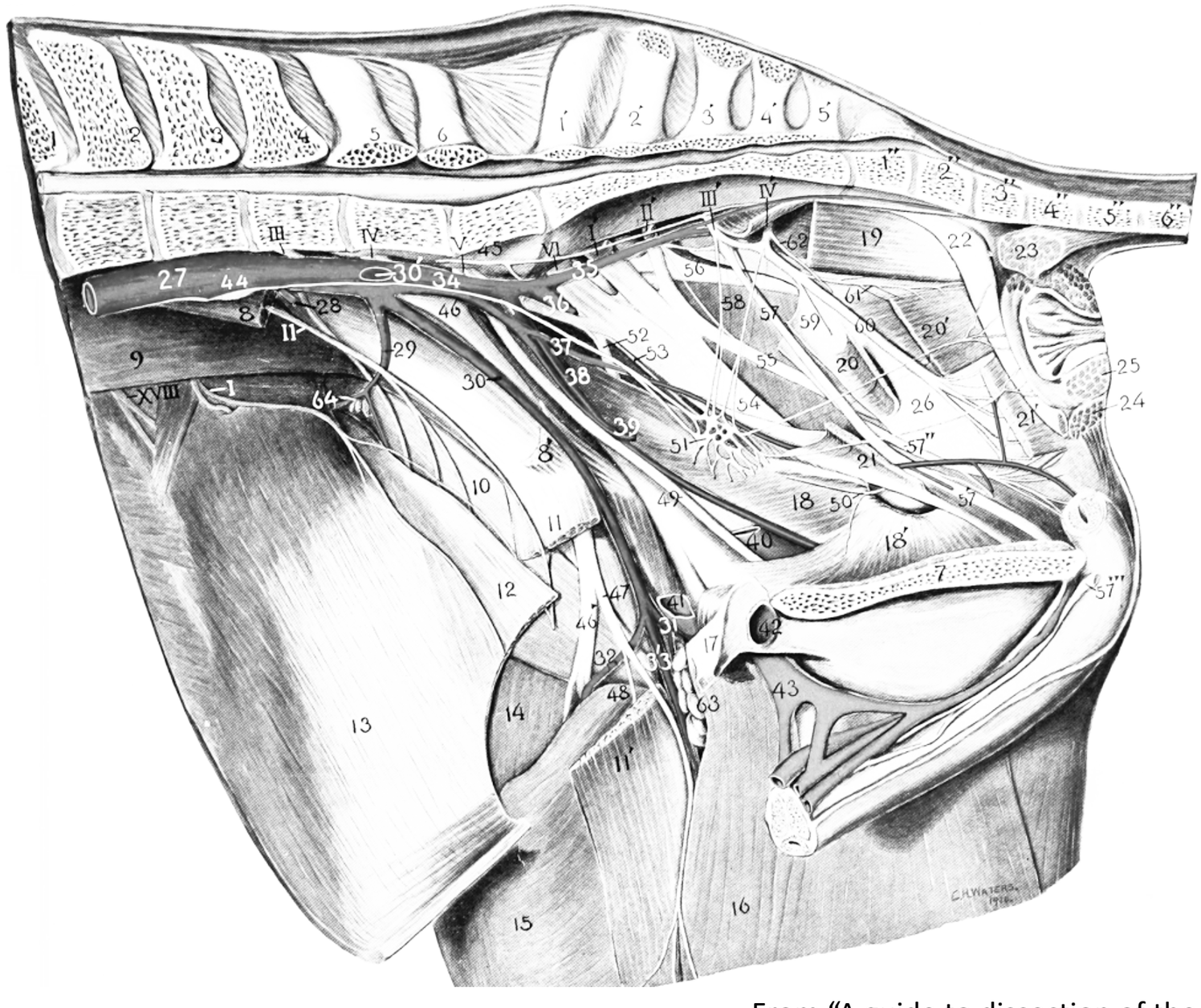
Early origins of behavioural science

- René Descartes, considered the “father of modern Western philosophy” had a bit to say about animals
- Considered animals to be “automata” (robots, basically) as they were not endowed with a “soul”
- His successful advocacy of the philosophy of empiricism though was helpful



Thanks a lot, René!

Contributions of Renaissance physiology and anatomy



From “A guide to dissection of the blood vessels and nerves of the pectoral and pelvic limbs of the horse” by GS Hopkins, 1914

Legacy of the anatomists

- Careful anatomy, histology neurobiology give a good understanding of physical basis for movement, coloration, display
- Anatomy and physiology still intimately tied to many subdisciplines of animal behaviour research
- E.g. detailed anatomical rendering, 3D scans, electrophysiology and brain imaging (etc.)

Comparative Psychologists

C. Lloyd Morgan, FRS (1852-1936)

Morgan's Canon:
"In no case is an animal activity to be interpreted in terms of higher psychological processes if it can be fairly interpreted in terms of processes which stand lower in the scale of psychological evolution and development."

An example of parsimony in explaining animal behaviour

EPIC BEARD ALERT!!!!!!

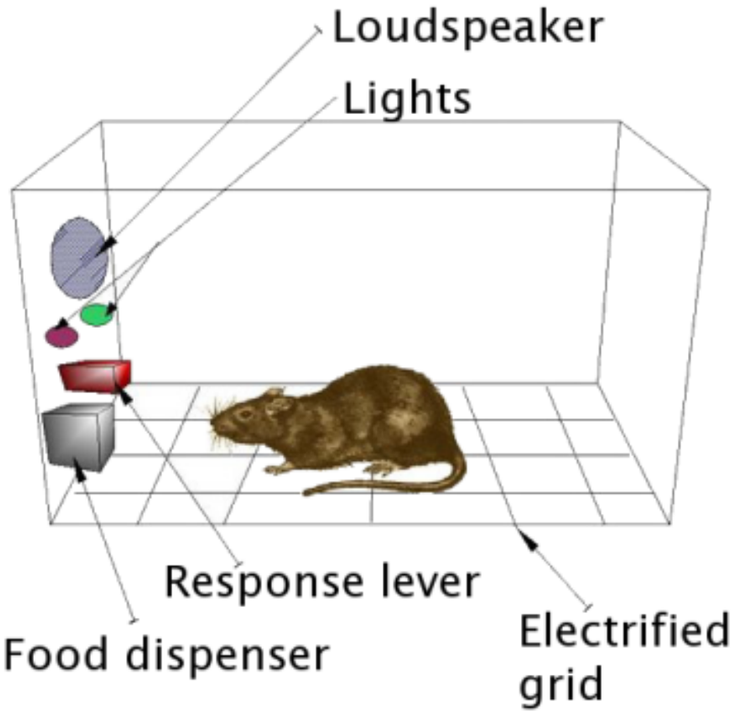
By Synnberg Photo-gravure Co., 1898 CC BY 4.0,

Ivan Pavlov

- Demonstration of classical conditioning, showing that instinctual behaviours could be induced by an unrelated stimulus (the conditioned stimulus)
- Also did seminal early work on reflex arcs (demonstrating that not all vertebrate behaviour needs a brain!)

Behaviourists

- B.F. Skinner was a behaviourist who studied and came up with “operant conditioning”
- A schedule of rewards and/or punishments can be used to modify behaviour



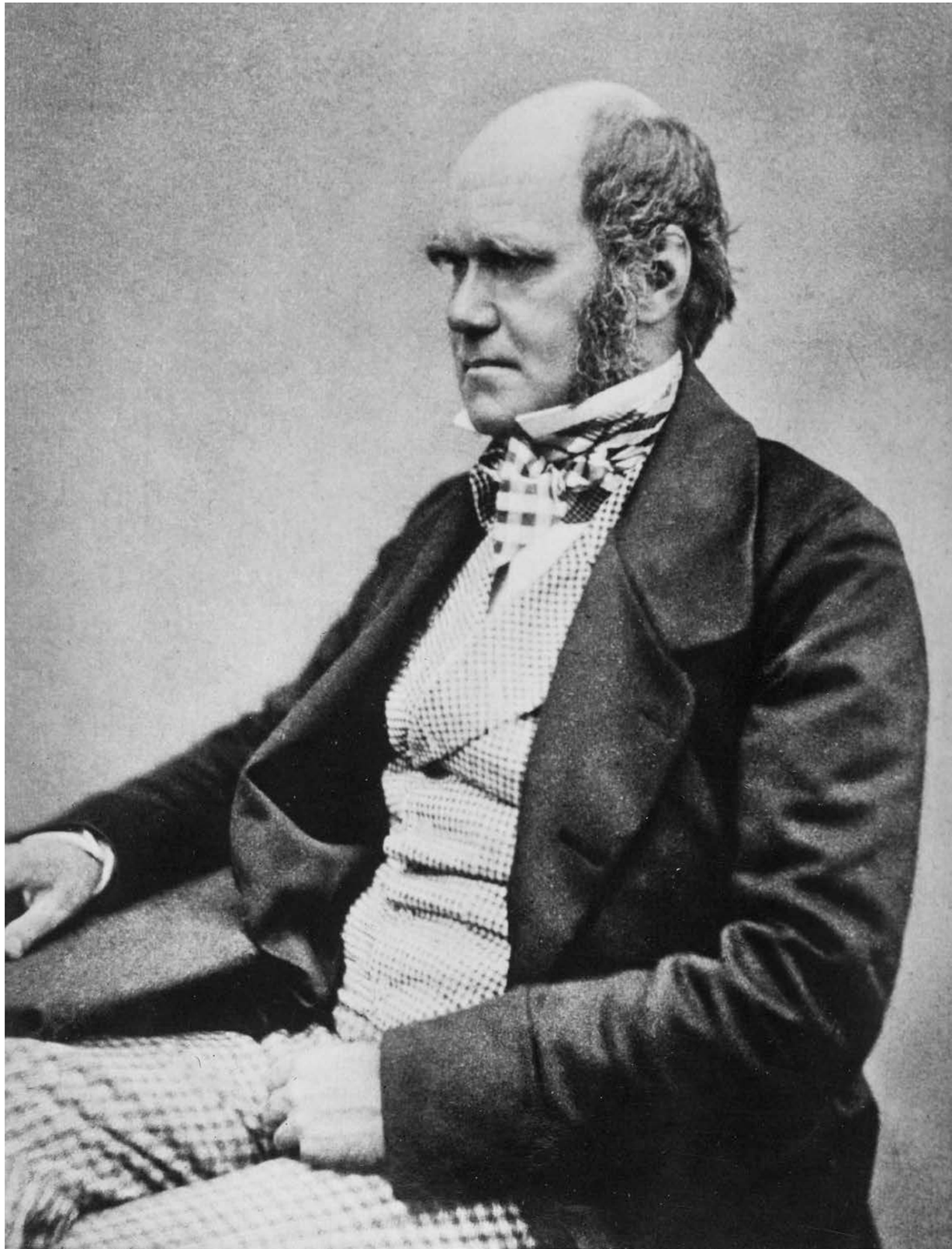
By Andreas1 - Adapted from Image:Boite skinner.jpg, CC BY-SA 3.0

Skinner’s Legacy

- The basis of much of modern advertising, video games, gambling, social media etc. rely on principles derived from Skinner and other prominent behaviourists (i.e. the field lives on!)
- Theories of learning derived from the behaviourist school are very useful in understanding how complex behaviour may be developed
- The experimental protocols of Skinner an other behaviourists can be used to answer a multitude of very relevant questions

Charles Darwin

- Victorian-era
- Exceptional naturalist
- Ground-breaking theoretician
- All round good guy
- We will come back to him



Darwin’s legacy

The ethologists: Niko Tinbergen, Karl von Frisch, Konrad Lorenz

By Max Planck Gesellschaft - CC BY-SA 3.0

Konrad Lorenz

- Seminal work on imprinting, showing that social environment during early development greatly influences later behaviour
- Developed a “psychohydraulic model” of motivation for behaviour

- From Tinbergen, we get
- 4 levels of analysis
- Elaboration of Lorenz’s psychohydraulic model for elicitation of instinctual behaviours

Karl von Frisch

- Demonstrated and elucidated the waggle dance of honeybees, showing that a complex symbolic language could be used by insects
- Together with Lorenz and Tinbergen, won the Nobel Prize in 1973

Tinbergen's 4 questions (AKA levels of analysis)

	Explanation
Function (adaptation)	What is the behaviour for WRT the individual?
Mechanism (causation)	How is the behaviour achieved? (physiology/anatomy)
Ontogeny (Development)	How does the behaviour develop? • Genes -> growth, maturation • Learning/culture
Phylogeny (Evolution)	Where has the behaviour come from? What pressures cause this to be favorable?

A video of *Maratus speciosus*, a salticid spider from Australia Credit: Jurgen Otto

If the video does not show up, link is here

Consider *Maratus*!

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A theory of mind

- All comparative psychologists, behaviourists and even ethologists were very concerned with how animals learn
- To account for what the animal was experiencing, they often invoked some kind of learning or reaction model
- These models are still very relevant to some fields in animal behaviour research

The mid 70's: time to shake things up

- E.O. Wilson published "Sociobiology: a new synthesis" in 1975
- In 1976 Richard Dawkins published "The Selfish Gene"
- Both of these publications led animal behaviour researchers to refocus their work on evolutionary mechanisms governing animal behaviour

W.D. Hamilton and inclusive fitness

- Prior to Hamilton (later Dawkins) most views of evolutionary fitness were organism or population-centric
- Hamilton's rule (an inequality) mathematically describes when altruism should flourish…

- Genes for altruism should increase in frequency when:

$$rB > C$$

Where *r* = the relatedness of the recipient to the actor

And B =the reproductive benefit gained by the recipient

And C= the cost to the actor of the altruistic act

Take-home message: inclusive fitness works for origin and stability of social behaviour!

Game theory

- Modelling conflict and cooperation between rational actors
- Has broad impact on the way that we understand evolutionary dynamics
- While an evolved taxon can't be considered to be a "rational actor", it can often behave as one
- Game theory is a major force for considering alternative or conflicting strategies in the life history of organisms

Contributions of game theoretical models

- Whereas some of the ethologists had had limited success reconciling Darwinian selection and altruism…
- Game theoretical models offered solid mathematical grounds for the emergence and persistence of altruistic strategies
- A strategy that can successfully compete in a world of alternatives is termed an Evolutionarily Stable Strategy (ESS)
- These correspond to attractors (stable fixed points) in the equations

Classical behavioural ecology

- Studies of cooperation and sociality
- Sperm competition and sexual conflict
- Sibling conflict

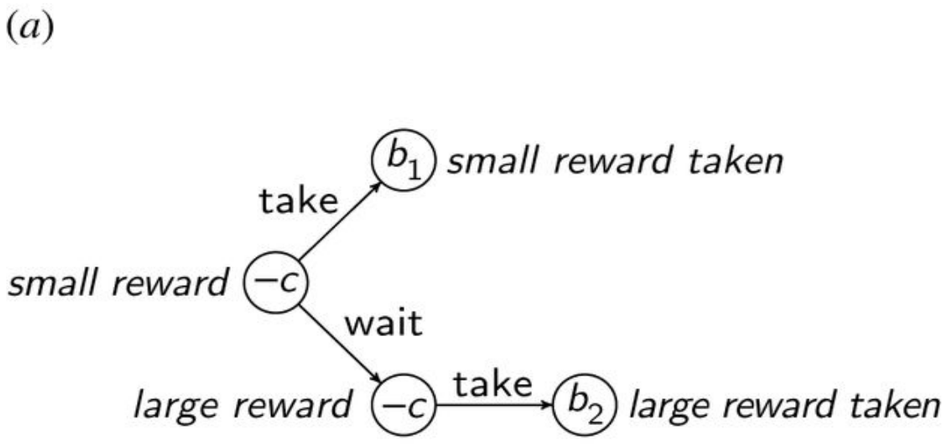
Current vogue in behavioural ecology

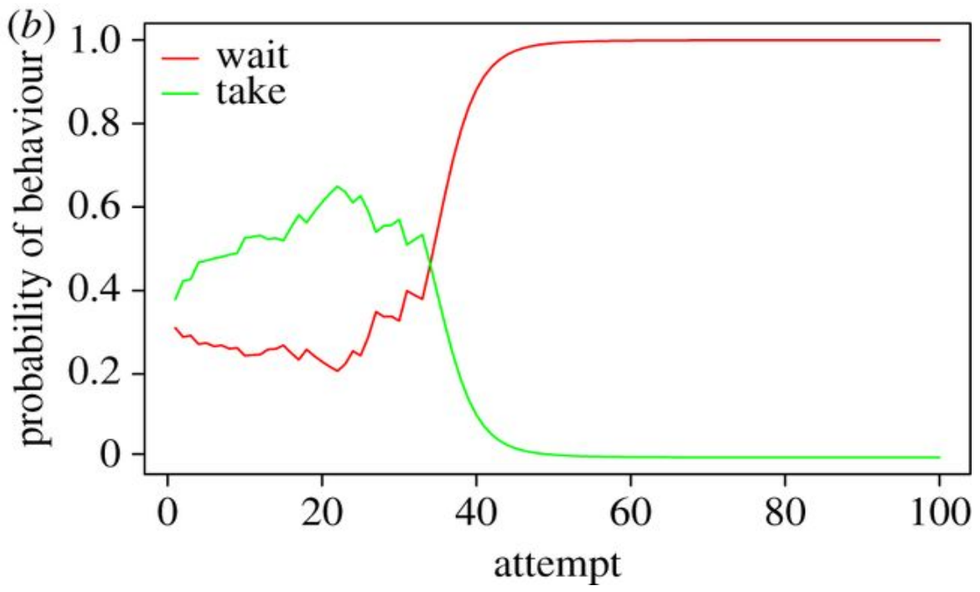
- Behavioural syndromes (i.e. “personality”)
- Tradeoffs and genetically plastic traits
- Meta analyses of many large behavioural studies
- Emergent behaviour of complex ecological systems (e.g. the “Landscape of Fear”)
- Cross-disciplinary integrative studies

But!!!

- Ethology and comparative psychology are NOT DEAD (despite what some behavioural ecologists might lead you to believe)
- In fact, models of cognition and learning are being integrated with modern behavioural ecology

Self-control through chaining.





Magnus Enquist et al. R. Soc. open sci. 2016;3:160734

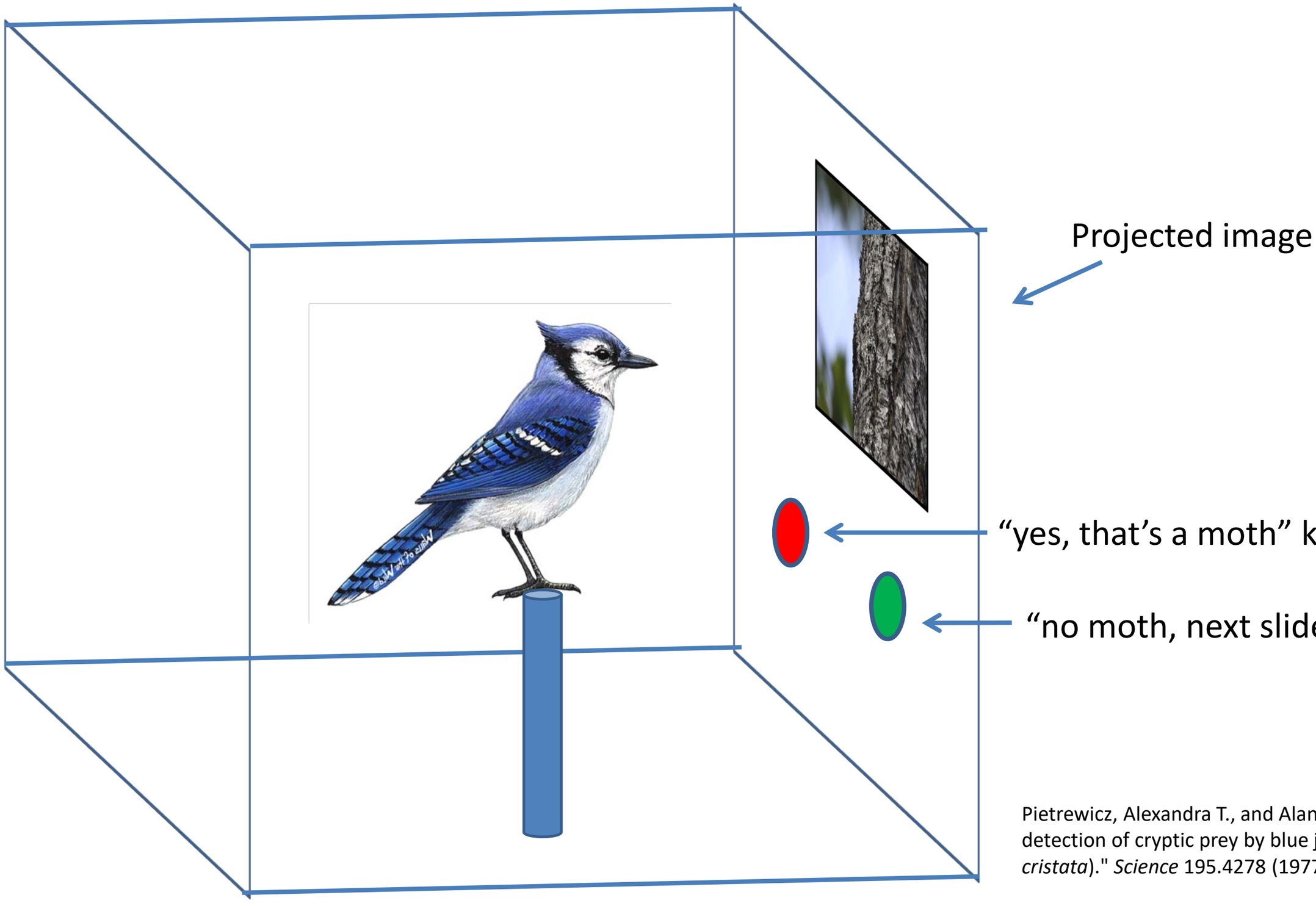
ROYAL SOCIETY OPEN SCIENCE

An example of a clever and useful Behavioural Ecology experiment

- Using operant conditioning to determine parameters by which predators can discriminate cryptic prey

Image: Eric Bégin CC-BY-NC

Image: Caleb Slemmons CC-BY-NC-2.0



Pietrewicz, Alexandra T., and Alan C. Kamil. "Visual detection of cryptic prey by blue jays (*Cyanocitta cristata*)." *Science* 195.4278 (1977): 580-582.

- The Pietrewicz and Kamil design has been replicated in a great many studies with many species
- Using well-known learning principles, we can probe the sensory capabilities of non-human animals

So what?

Good data!

- No matter what theoretical background of your research group, you need to:
- Recognize and learn from good research
- Recognize and avoid bad research
- Design good experiments
- Get good data

In summary

- Behavioural ecology emerged from a combination of comparative psychology, natural history, ethology and evolutionary theory
- It is spiced up with game theory and other mathematical disciplines
- In order to be good behavioural ecologists we must take a broad view


Don’t forget the
Assignment!

Assignment 1: Backgrounder!

- Due next week
- A short survey of your background and your plans for the future
- This can be somewhat difficult if you have none…
- Answer thoughtfully!

Next Class!

- We will meet in AC334 to learn about spiders (in general) and black widows (in particular)
- If we have time, we can go check out the lab and make some plans