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Lecture 8:

CULTURE IN INSECTS

Outline

- **Introduction**
  - A brief history of animal culture
  - Main empirical approaches
  - Patterns *versus* mechanisms
- **Insect social learning**
- **Evidence for insect culture**
- **Defining animal culture**

Part 1

- **Cultural transmission of sexual preferences in *D. melanogaster***
- **General conclusion**
- **Final remarks**
- **Challenges for the future**

Part 2

A brief history of animal culture

- **Until the end of the 1980s**: culture was mainly **human centered**
  - => Definitions adapted to humans (captured human specificities)
  - => Inappropriate to study animal culture
  - => Mainly theoretical. Few experiments
  - Historically human sciences started the study of culture

- **From the early 1990s**: **animals culture emerged**
  - From Animal Social Learning (see Lectures 2 & 3)
    - First in vertebrates,
    - After 2000 examples emerged in **insects**

- **Late 2000s became part of Behavioral Ecology**
  - Textbook: e.g. Chapter 20 in Danchin, Giraldeau and Cézilly 2008
  - + emergence of more experimental approaches

Main approaches

Three main approaches

- 1- Modelling: conditions of emergence and potential impacts
- 2- Animal social learning (see Lectures 2 & 3)
- 3- Reporting on persistent patterns of behavioral variation across populations (ie traditions)
- Produced the wealth of data presented in this module

Limitations

- Quasi no experiments
- Social learning: not sufficient to generate a cultural process
- Traditions: Hard to rule out other explanations for the observed patterns of variation among populations:
  - Ecological correlates/causes
  - Genetic correlates/causes
- **=> Other approaches necessary**

Patterns *versus* mechanisms

- The same pattern (traditions) can be produced by many different mechanisms
- Focus on the mechanism to show that the observed traditions are actually produced by the characteristics of social learning
- Implies rethinking the definition of animal culture

Insect social learning

Insect social learning

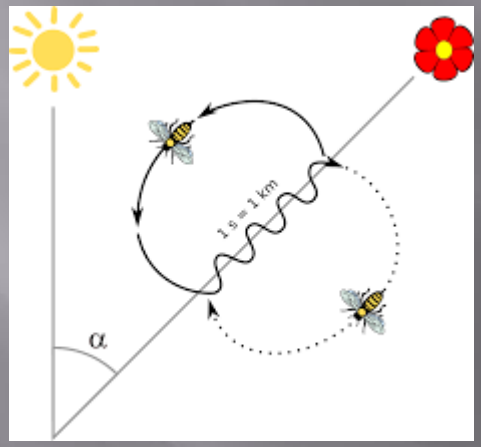
- Three contexts of insect social learning

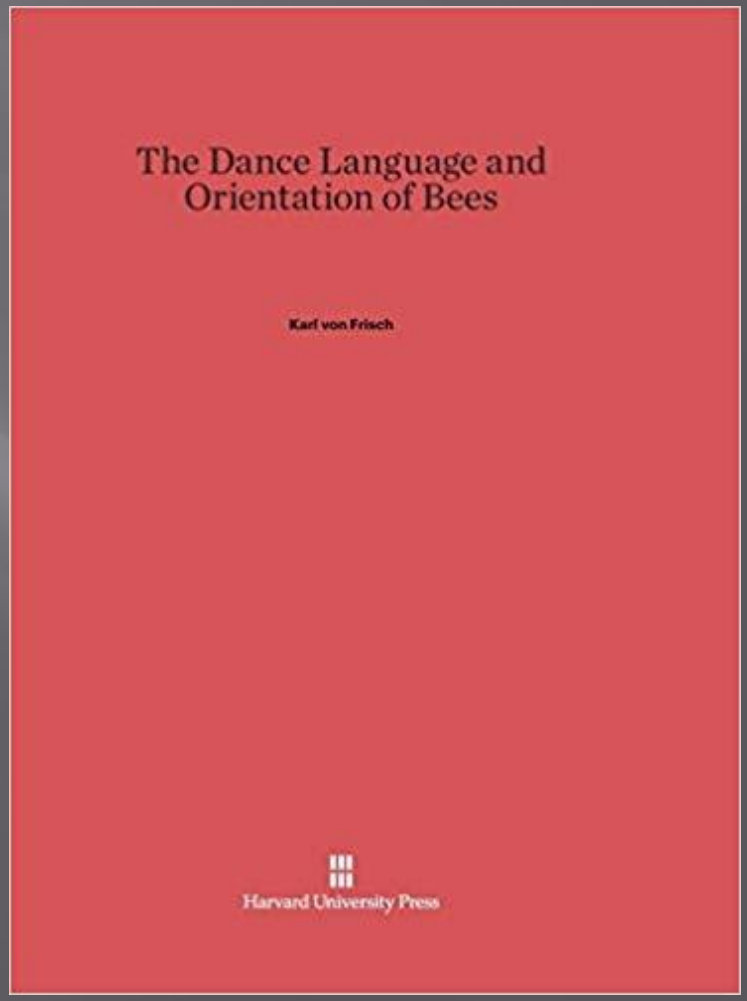
- **Foraging**:
  - Bee dance (Von Frisch & Chadwick. 1967)
  - Detecting cheating flowers (Baude *et al.* 2008. *Animal Behaviour*)

- **Danger**
  - Crickets: (Coolen *et al.* 2005. *Current Biology*)

- **Mate choice**:
  - Mate copying in Drosophila (Mery et al. 2009. *Current Biology*)

Foraging
The first and most famous example





Von Frisch & Chadwick. 1967
Nobel price in 1973

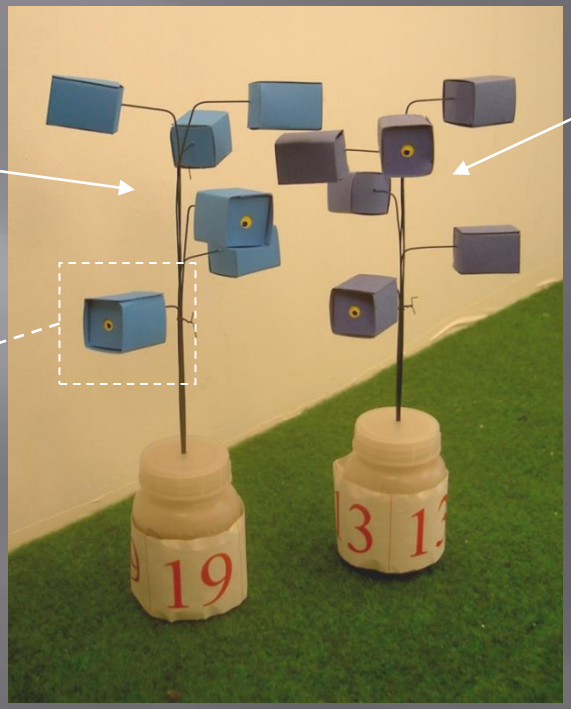
Social learning about foraging

- Bumble bees (*Bombus terrestris*)
- Cheating Plants don't provide nectar
- Detection and Learning by Bumble bees
- Experiment

Baude *et al.* 2008. *Animal Behaviour*

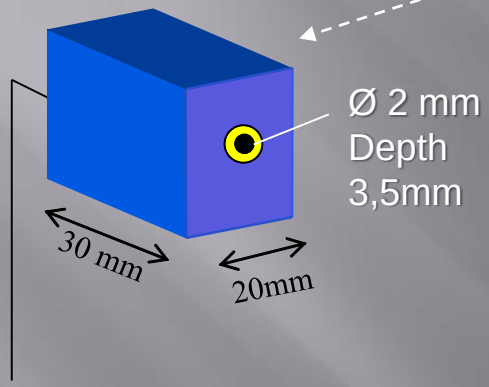
Cheating flowers

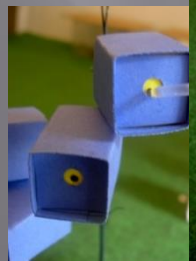
4 µL of water



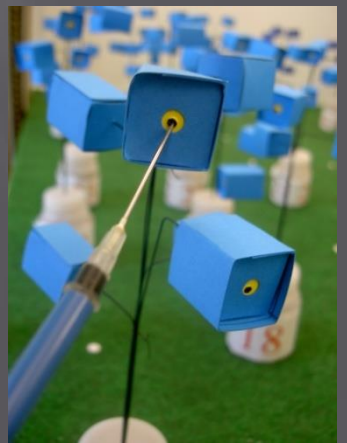
Flowers with nectar

4 µL of sugar 30% w/w without odour





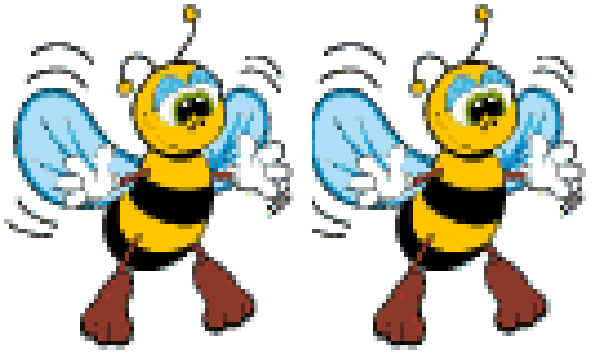
Filling and cleaning after every round



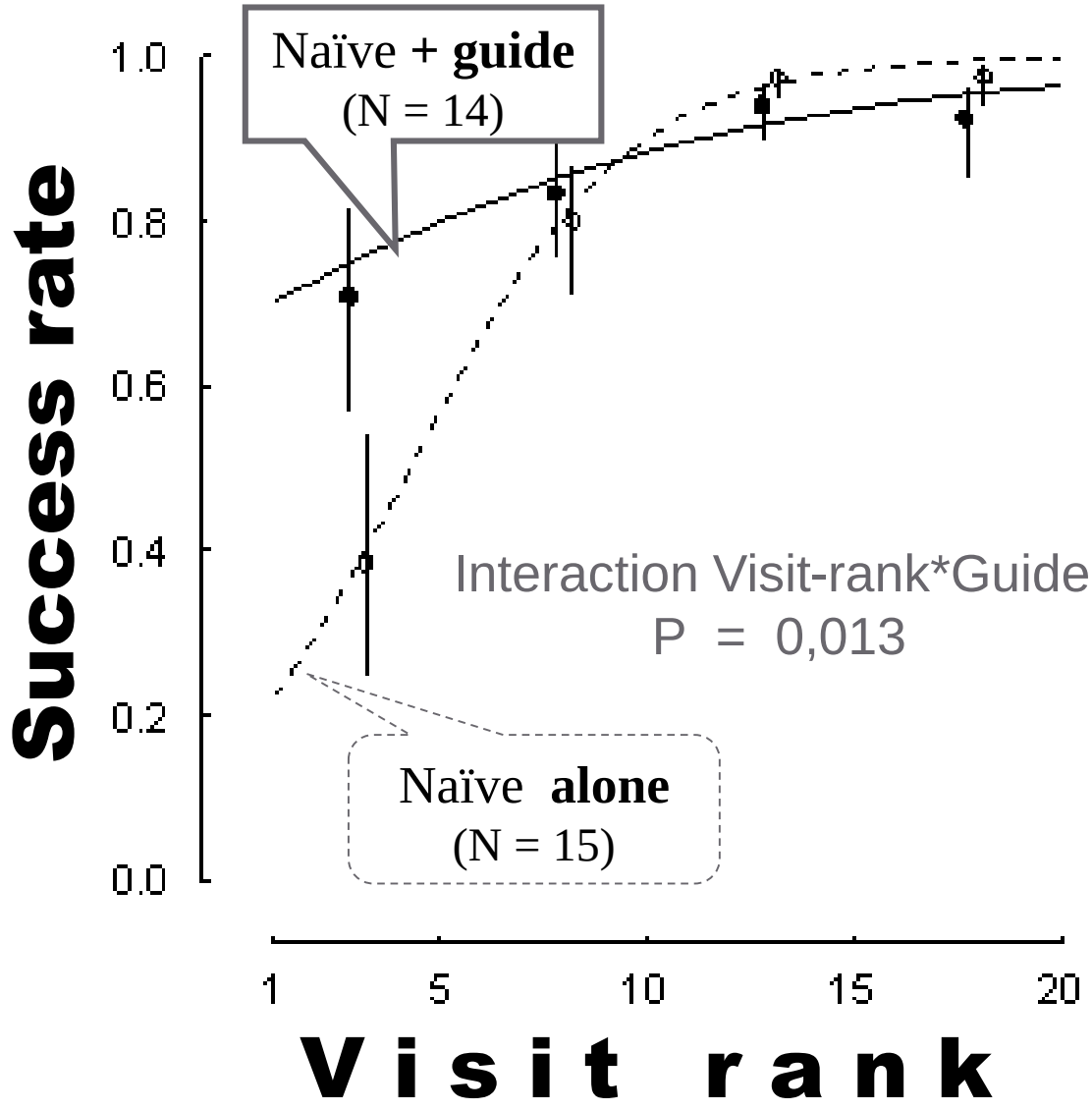
Cheating

?

Guide in the know



With nectar



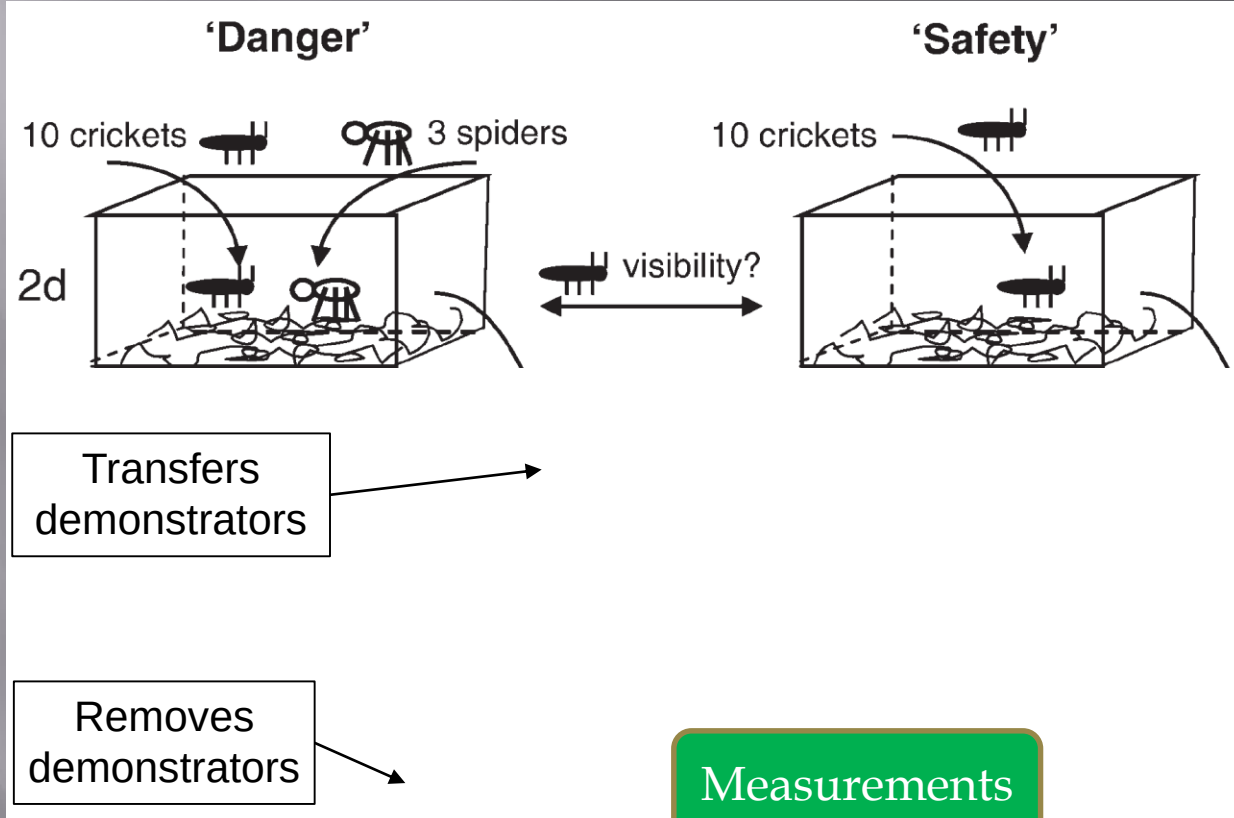
- Social learning in Bumble bees in a foraging context

Baude *et al.* 2008. *Animal Behaviour*

Social learning about danger (Crickets and Spiders)

Demonstrator crickets

Observer crickets



- Significant difference
- More hidden

Coolen et al. 2005. Current Biology

Social learning and mate-choice

Chosen green male

Copu
Demor

Observer Female:

I Love **Green!**

Observer Female:

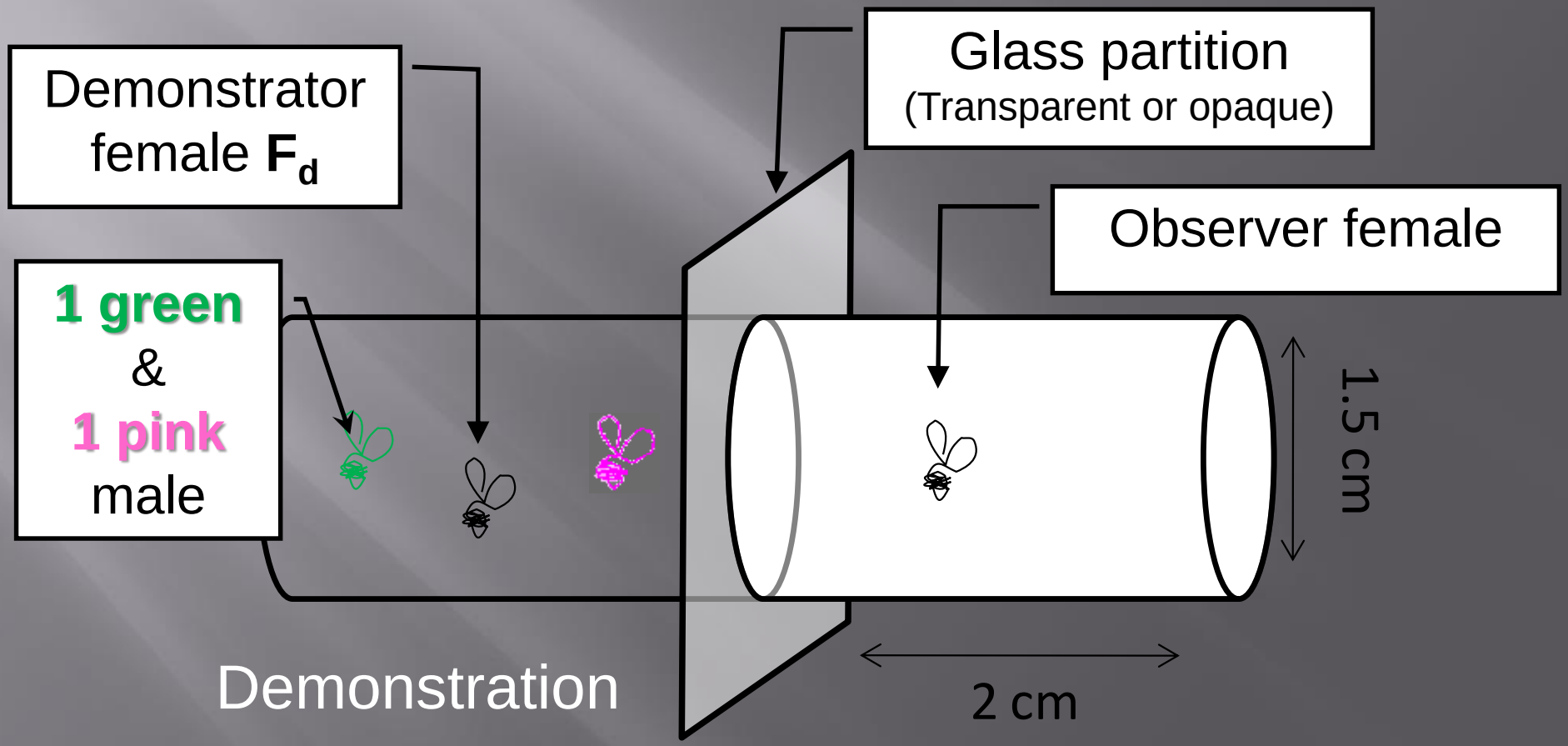
I Love **Green!**

Rejected pink male

© David Duneau

Criterion 1: social learning

- **One live Demonstration** of **one female** choosing between **1 green** and **1 pink** males

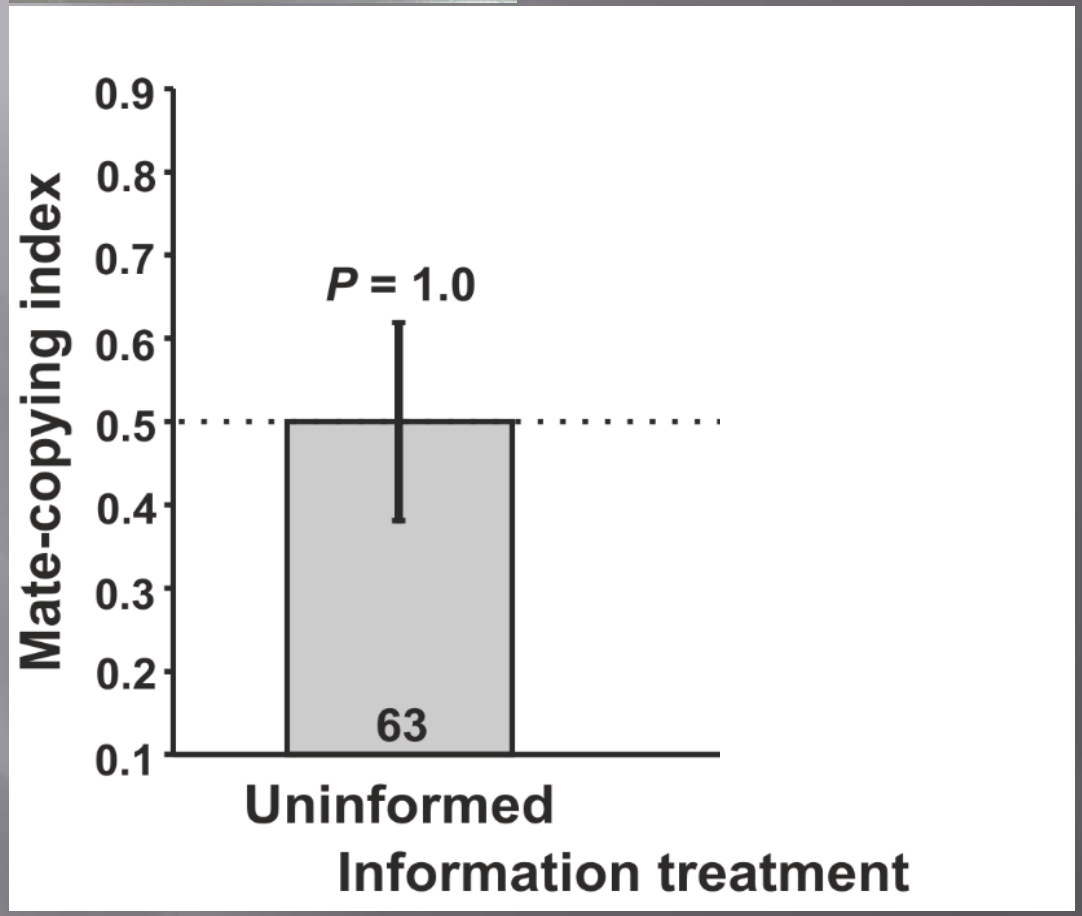


Mery *et al.* 2009 Current Biology; Dagaeff *et al.* 2016 Anim Behav

Criterion 1: social learning

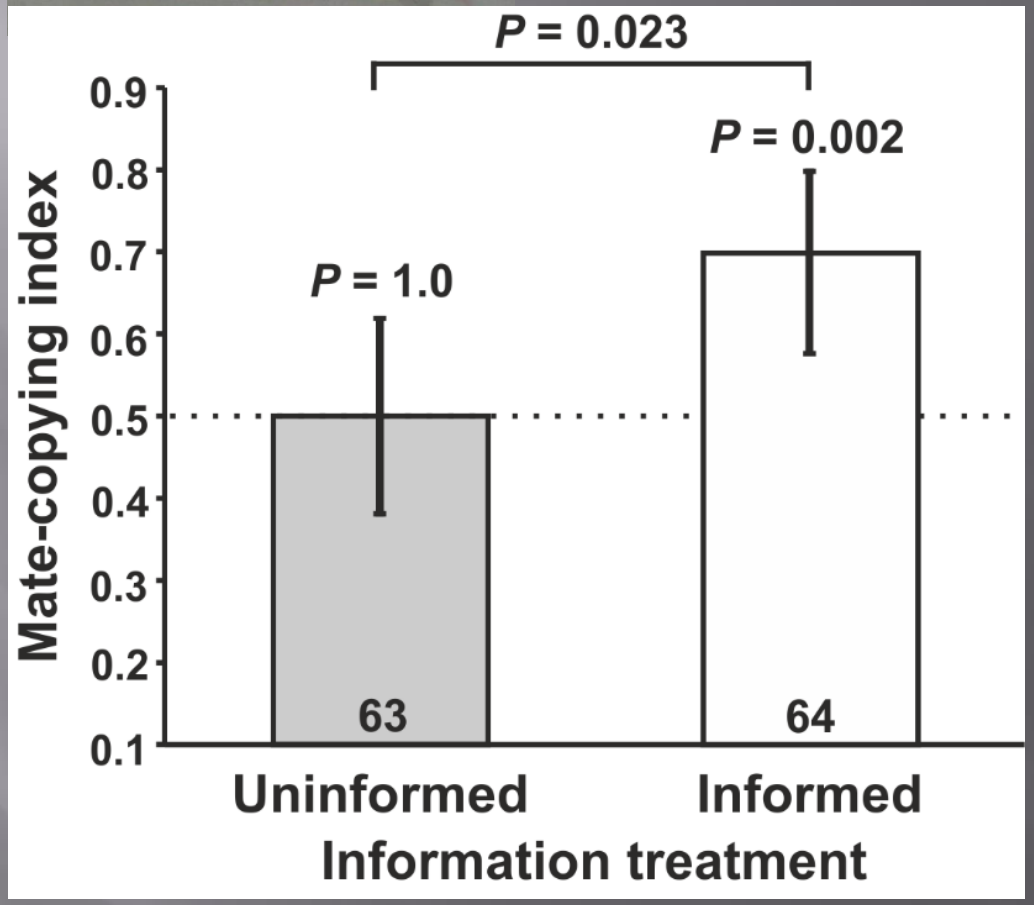
- **One live Demonstration** of **one female** choosing between **1 green** and **1 pink** males

Results



Mery *et al.* 2009 *Curr Biol*; Dagaeff *et al.* 2016 *Anim Behav*; Danchin *et al.* 2018 *Science*

Results



'Speed learning'

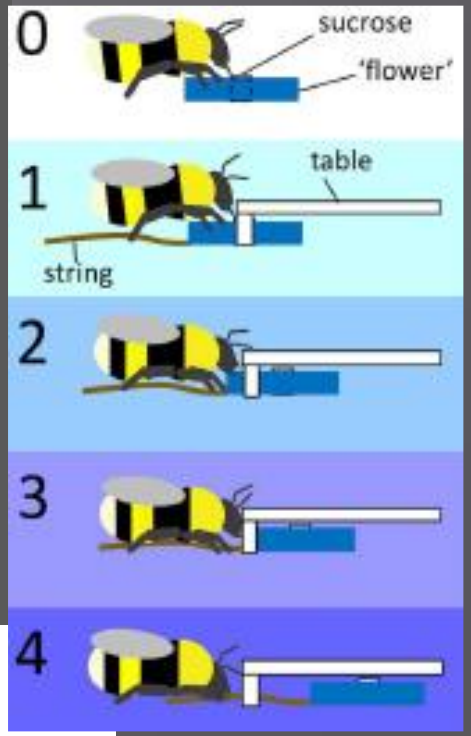
Females showed a bias for males of the accepted than the rejected phenotype during demonstrations

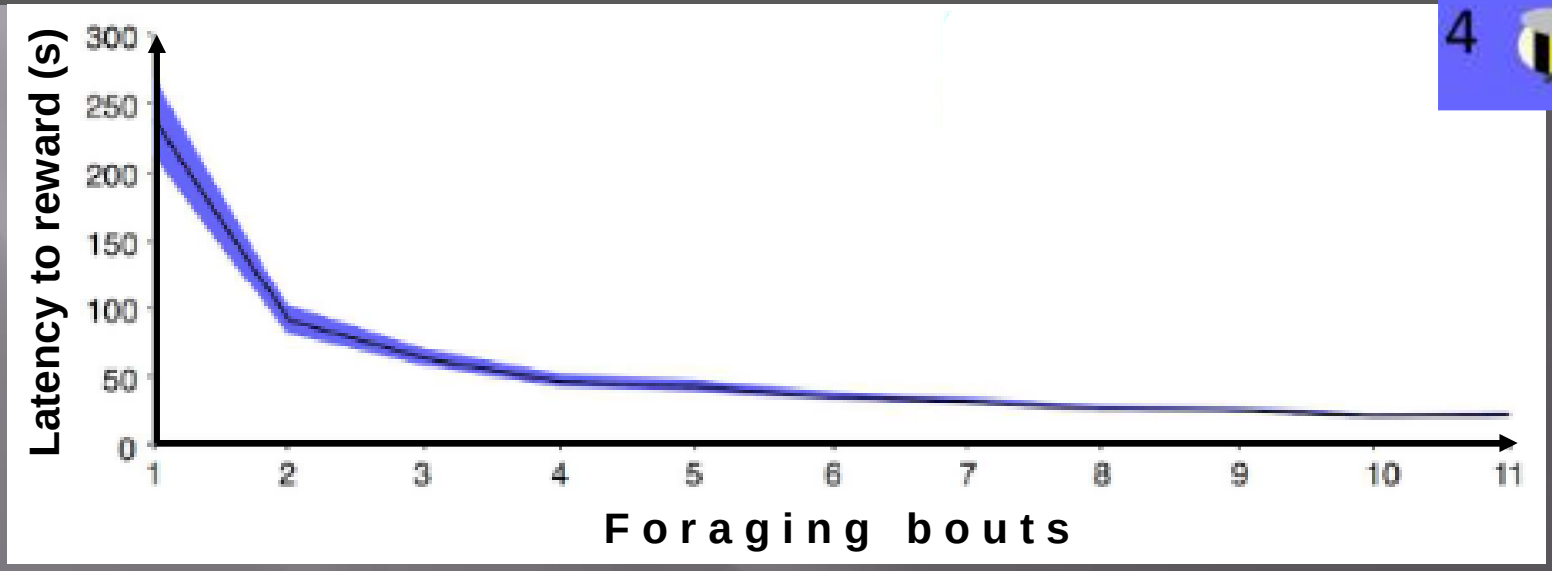
Mery *et al.* 2009 *Curr Biol*; Dagaeff *et al.* 2016 *Anim Behav*; Danchin *et al.* 2018 *Science*

Evidence for insect culture

Potential examples of insect culture

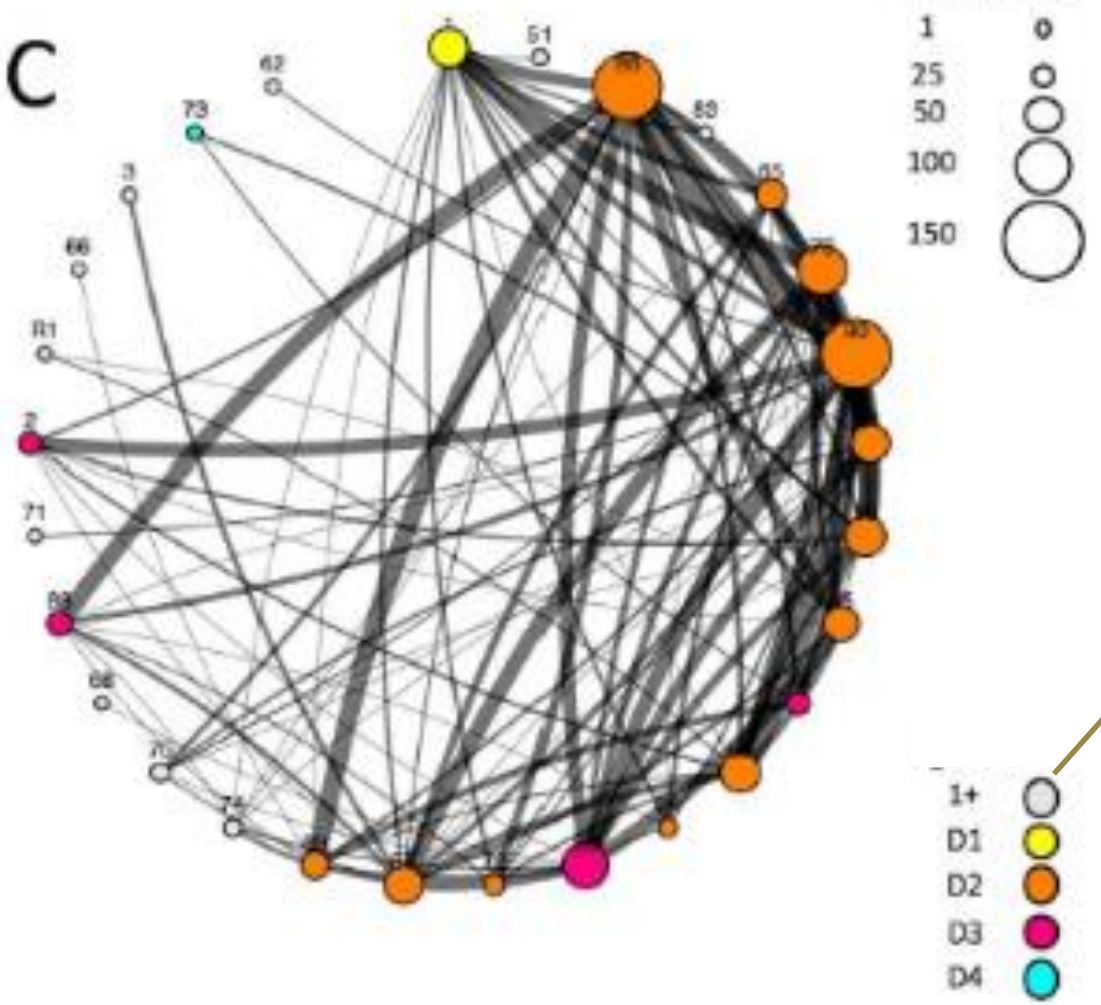
- String pulling in bumble bees
  - Training phase to pull a string to get reward
  - The introduce a trained individual in its colony
  - Observe the string pulling performance of colony members
  - Is there a diffusion of string pulling within the colony?





Alem *et al.* 2016. *PLoS Biology*; Loukola *et al.* 2017. *Science*

Diffusion of string pulling within a colony



Number of interactions

Before treatment

Learning ‘generations’

Alem *et al.* 2016. *PLoS Biology*; Loukola *et al.* 2017. *Science*

IS this an example of culture?

- Fascinating
- But,…
  - => it is only transmitted within colony
  - No transmission among colonies

- **What is animal culture exactly?**

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Part 2

What is animal culture?

In the light of what we now know about Social Learning and the history of the field

Is Social learning sufficient?

- 1990s authors underlined that social learning is not sufficient to generate culture. Social learning is just one criterion (**criterion 1**) of culture.
  The socially learned trait must **also** be
  - Transmitted from older to younger individuals in order to persist in time (across generations). (Avital & Jablonka 2000). **Criterion 2: transmission across age classes**
  - Memorized for sufficient time to allow other individuals to copy it (Brooks 1998). **Criterion 3: Durability**
  - Trait- rather than individual-based **Criterion 4: Trait-based**

- Four criteria integrated into a single definition of animal culture (Danchin & Wagner, *Oikos* 2010)

Definition of animal culture

1) "The part of phenotypic variation that is **transmitted across generations through social learning**"

Socially inherited variation among populations

= Patterns

Danchin & Wagner, 2010. *Oikos*
Danchin *et al.* 2011. *Nature Rev. Genet.*

2) Study the properties of social learning that can lead to patterns of cultural traditions

Most striking marker of Culture

=

Mechanisms

Danchin & Wagner, 2010. *Oikos*
Danchin *et al.* 2011. *Nature Rev. Genet.*

4 criteria of culture

- Be demanding: **the four criteria to be met simultaneously** to be able to claim that a trait is at least partly culturally transmitted

Danchin & Wagner, 2010. *Oikos*
Danchin *et al.* 2011. *Nature Rev. Genet.*

- Applying this mechanistic definition to a given animal model
- By testing the 4 **+ 1** criteria in that system