IS SCIENCE SELF-DECEIVED?

Vivek Nityananda
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Introduction

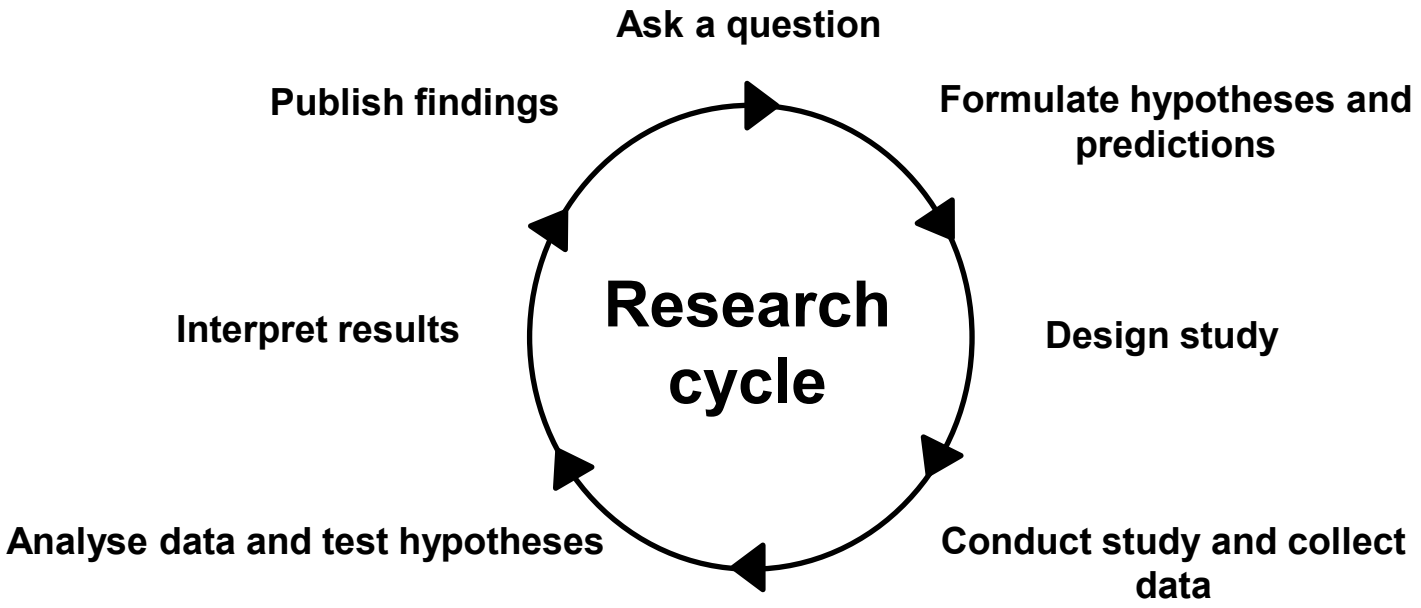
- Biosciences Institute, Faculty of Medical Sciences
- I research animal behaviour
- Comparative Cognition, Vision, Sensory Ecology, Decision Making
- I’ve researched bushcrickets (katydids), frogs, praying mantises, bees and humans

Information processing biases in self-deception

- Biased information search
  - Amount of searching
  - Selective searching
  - Selective attention
- Biased interpretation
  - Selective skepticism
- Misremembering

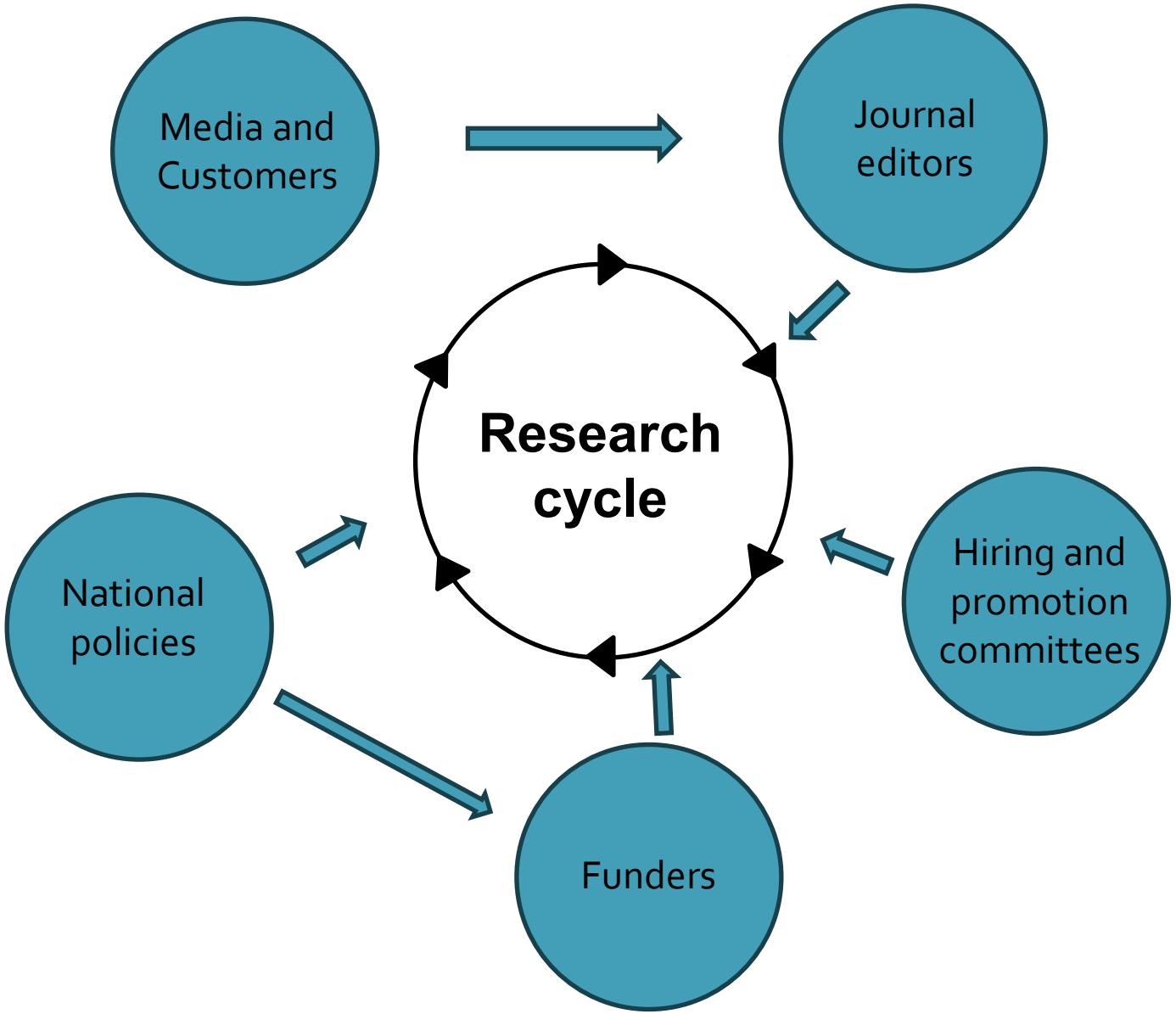
Trivers and von Hippel 2011

The idealised research cycle

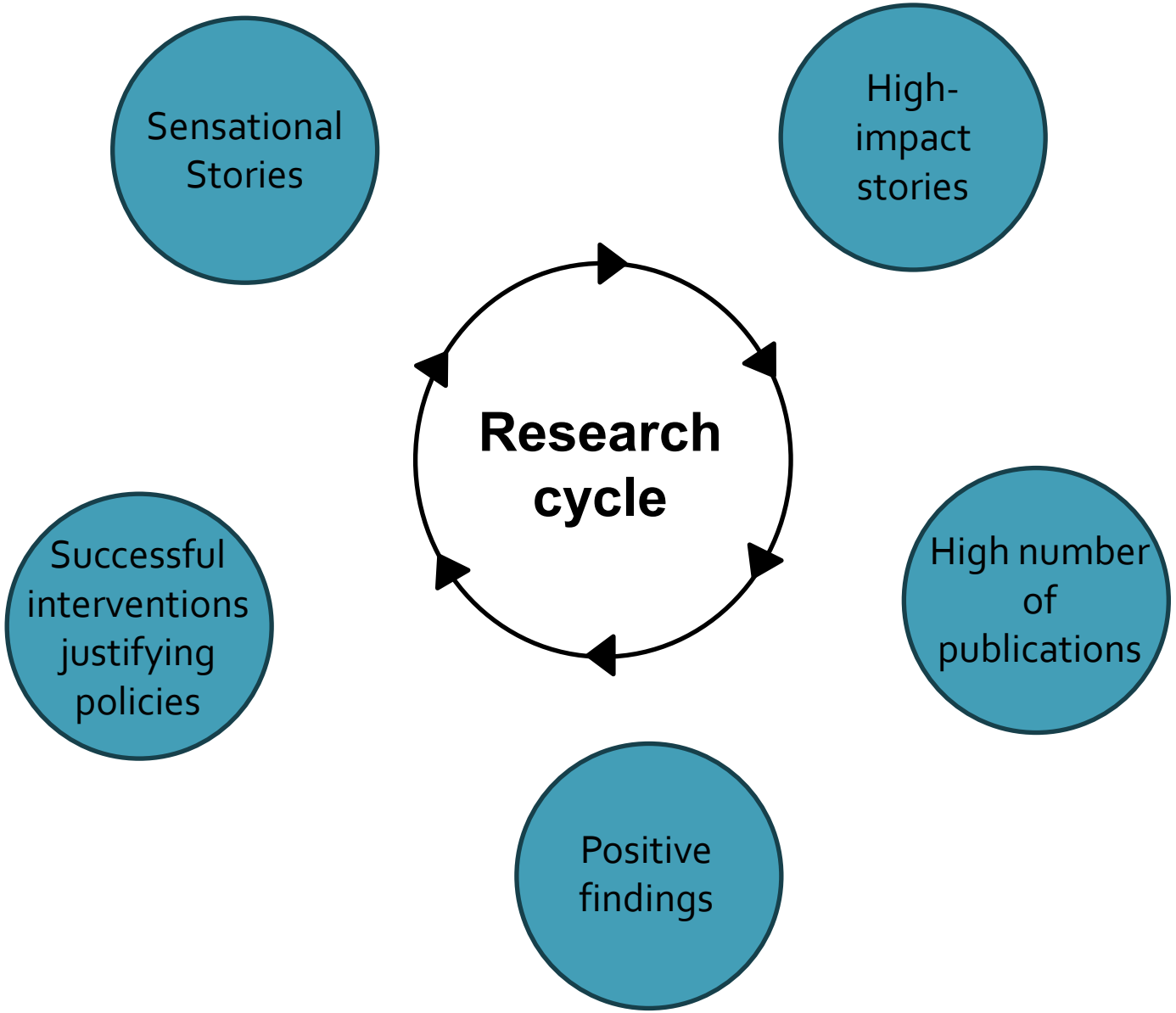


Graphic: Prof Melissa Bateson

Science does not operate in a vacuum

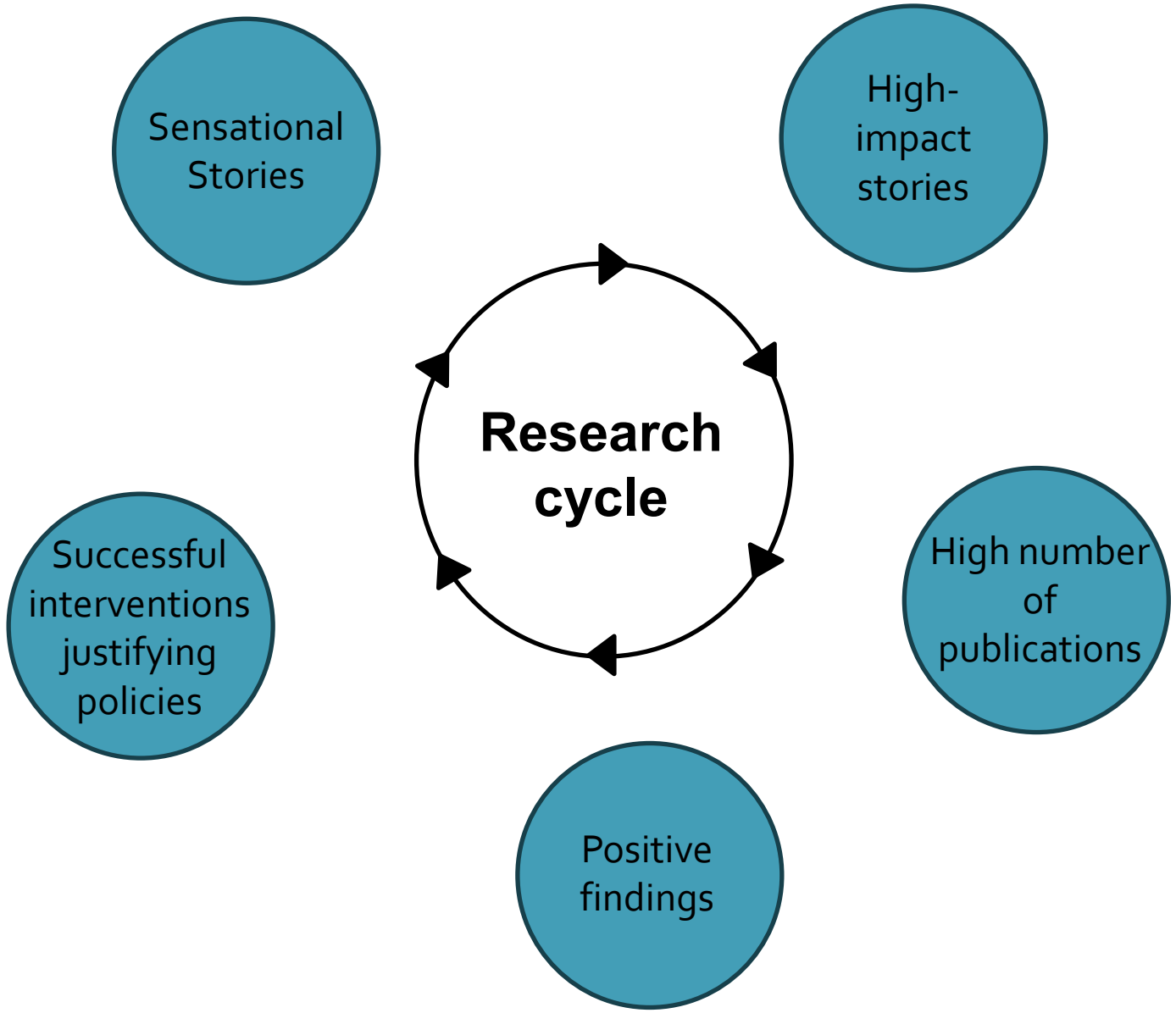


Incentives


Sensational Stories
High-impact stories
Research cycle
Successful interventions justifying policies
High number of publications
Positive findings

Incentives

- Biased information search
  - Amount of searching
  - Selective searching
  - Selective attention
- Biased interpretation
  - Selective skepticism
- Misremembering



Example 1

ON THE INTELLIGENCE OF BEES

‘Bees are really highly intelligent’: the insect IQ tests causing a buzz among scientists

We all know these busy insects are good for crops and biodiversity, but proof is emerging that they are also clever, sentient and unique beings



Bees can be trained to perform simple tasks. Photograph: Lars Chittka

“Our work and that of other labs has shown that bees are really highly intelligent individuals. That they can count, recognise images of human faces and learn simple tool use and abstract concepts.”

RESEARCH ARTICLE | PSYCHOLOGICAL AND COGNITIVE SCIENCES |

Simultaneous mastering of two abstract concepts by the miniature brain of bees

April 19, 2012 | 109 (19) 7481-7486 | https://doi.org/10.1073/pnas.1202576109

7,166 | 96

PDF

Vol. 109 | No. 19

Abstract
Results
Discussion
Materials and Methods
Acknowledgments
Supporting Information
References

Abstract

Sorting objects and events into categories and concepts is a fundamental cognitive capacity that reduces the cost of learning every particular situation encountered in our daily lives. Relational concepts such as “same,” “different,” “better than,” or “larger than”—among others—are essential in human cognition because they allow highly efficient classifying of events irrespective of physical similarity. Mastering a relational concept involves encoding a relationship by the brain independently of the physical objects linked by the relation and is, therefore, consistent with abstraction capacities. Processing several concepts at a time presupposes an even higher level of cognitive sophistication that is not expected in an invertebrate. We found that the miniature brains of honey bees rapidly learn to master two abstract concepts simultaneously, one based on spatial relationships (above/below and right/left) and another based on the perception of difference. Bees that

Published in



Frontiers in Psychology
Comparative Psychology

3.8 impact factor 7 citescore

Part of a Research Topic

Outline

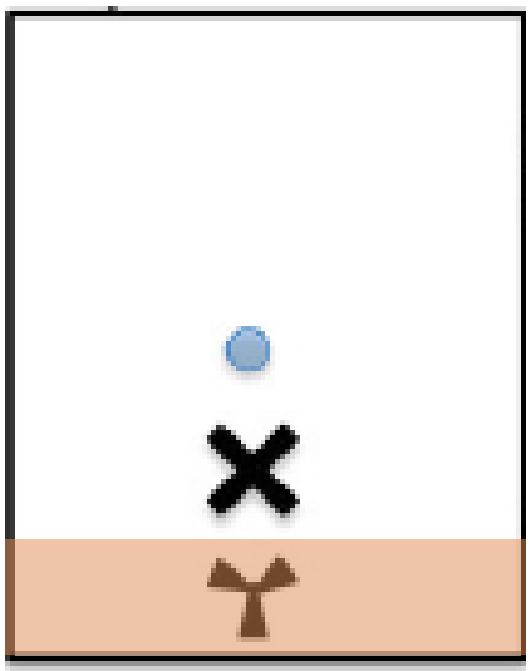
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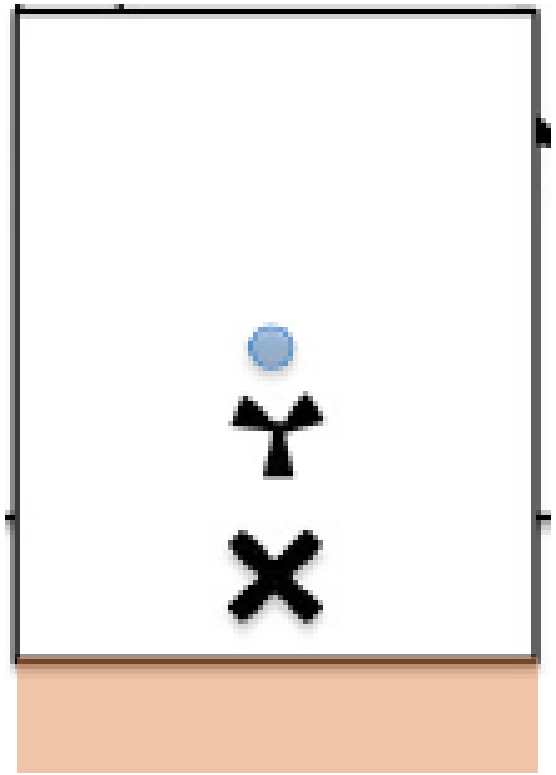
ORIGINAL RESEARCH article

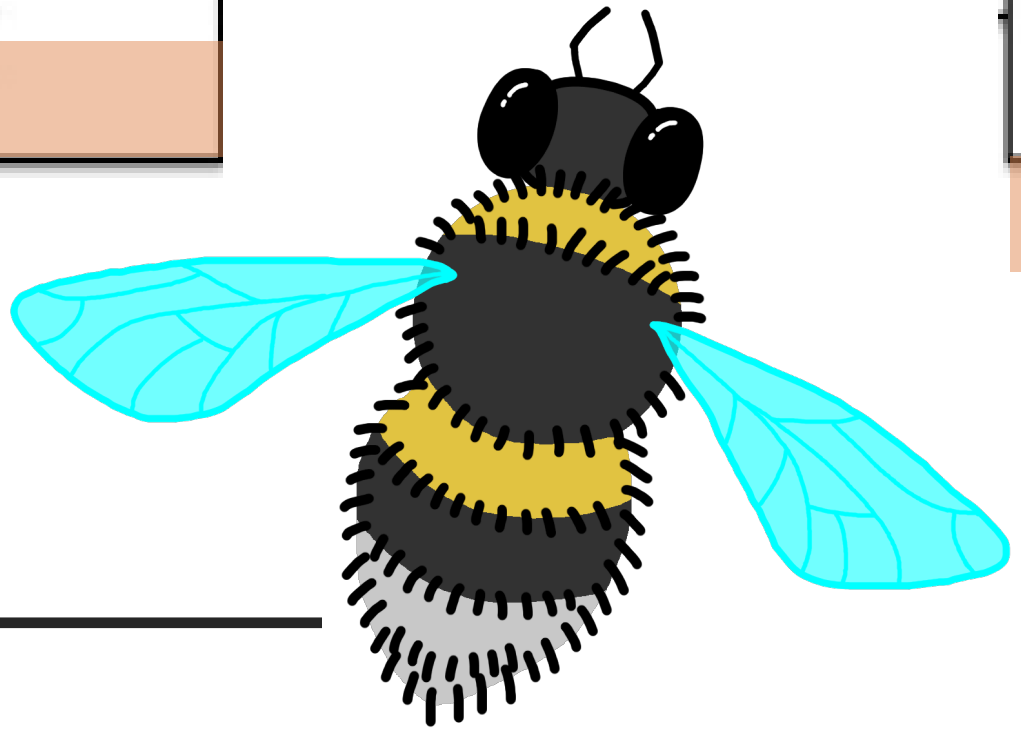
Front. Psychol., 03 August 2018
Sec. Comparative Psychology
Volume 9 - 2018 | https://doi.org/10.3389/fpsyg.2018.01347

High-Speed Videography Reveals How Honeybees Can Turn a Spatial Concept Learning Task Into a Simple Discrimination Task by Stereotyped Flight Movements and Sequential Inspection of Pattern Elements

Article metrics 34 Citations 12,3k Views 2,2k Downloads View details







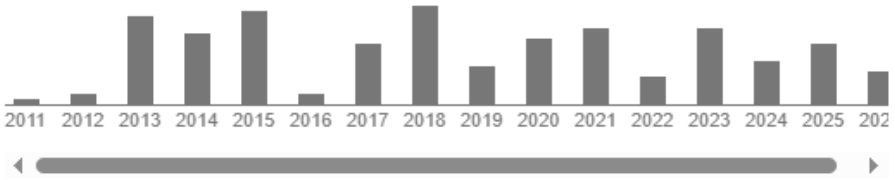
Simultaneous mastering of two abstract concepts by the miniature brain of bees

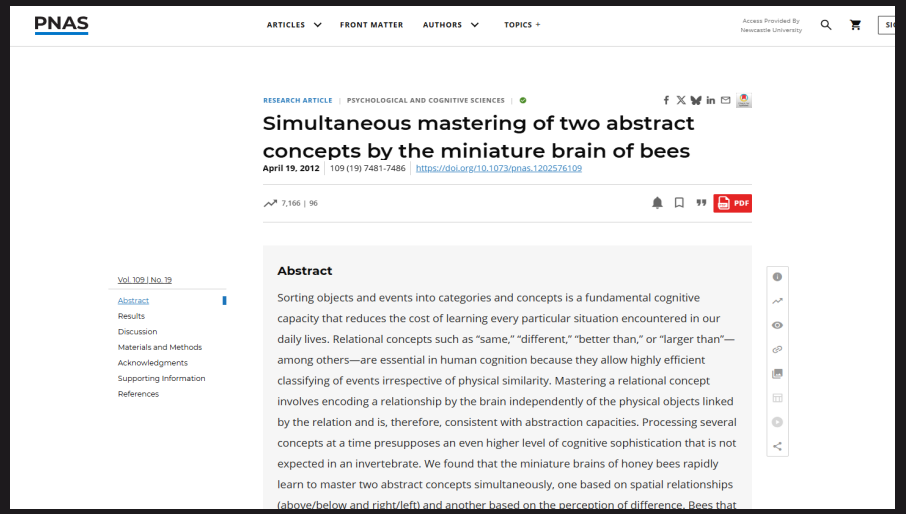
Description

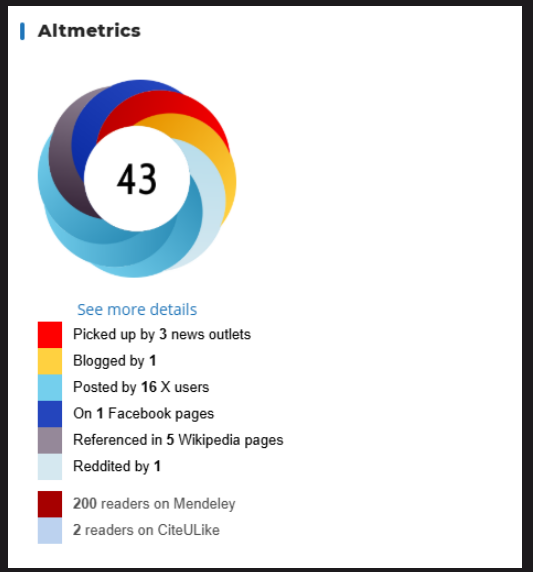
Sorting objects and events into categories and concepts is a fundamental cognitive capacity that reduces the cost of learning every particular situation encountered in our daily lives. Relational concepts such as “same,” “different,” “better than,” or “larger than”—among others—are essential in human cognition because they allow highly efficient classifying of events irrespective of physical similarity. Mastering a relational concept involves encoding a relationship by the brain independently of the physical objects linked by the relation and is, therefore, consistent with abstraction capacities. Processing several concepts at a time presupposes an even higher level of cognitive sophistication that is not expected in an invertebrate. We found that the miniature brains of honey bees rapidly learn to master two abstract concepts simultaneously, one based on spatial relationships (above/below and right/left) and another based …

Total citations

Cited by 160

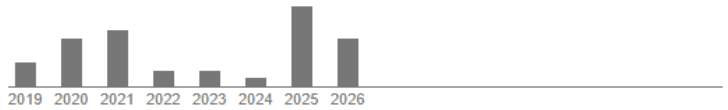






High-speed videography reveals how honeybees can turn a spatial concept learning task into a simple discrimination task by stereotyped flight movements and sequential …

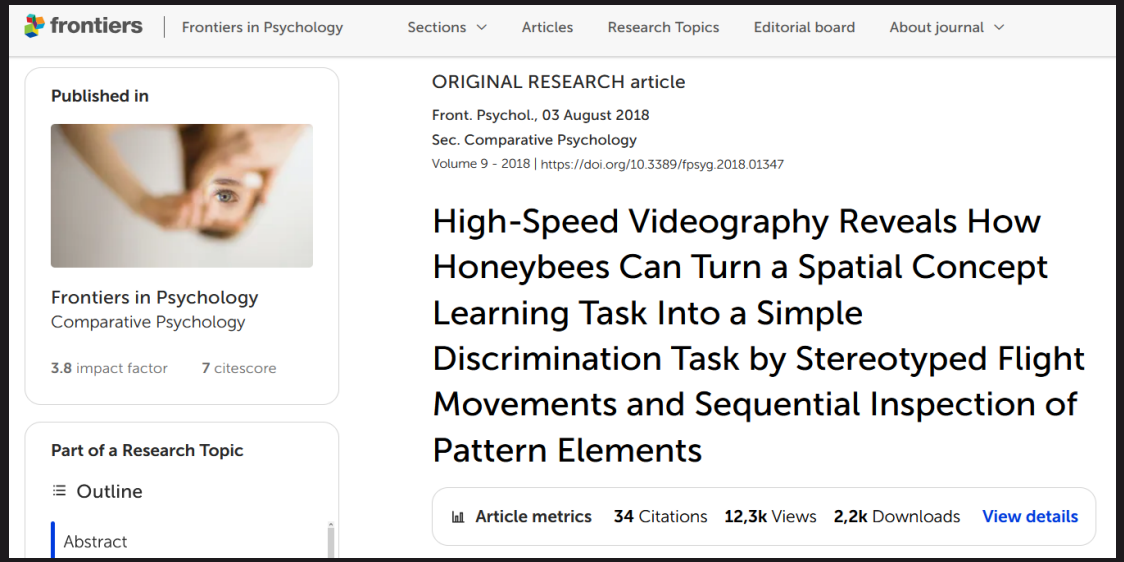
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Altmetric score



View altmetric score >



Article | Open access | Published: 06 March 2024

Bumblebees socially learn behaviour too complex to innovate alone

73k Accesses | 61 Citations | 1458 Altmetric | Metrics

Abstract

Culture refers to behaviours that are socially learned and persist within a population over time. Increasing evidence suggests that animal culture can, like human culture, be cumulative: characterized by sequential innovations that build on previous ones[1]. However, human cumulative culture involves behaviours so complex that they lie beyond the capacity of any individual to independently discover during their lifetime[1,2,3]. To our knowledge, no study has so far demonstrated this phenomenon in an invertebrate. Here we show that bumblebees can learn from trained demonstrator bees to open a novel two-step puzzle box to obtain food rewards, even though they fail to do so independently. Experimenters were unable to train demonstrator bees to perform the unrewarded first step without providing a temporary reward linked to this action, which was removed during later stages of training. However, a third of naive observer bees learned to open the two-step box from these demonstrators, without ever being rewarded after the first step. This suggests that social learning might permit the acquisition of behaviours too complex to 're-innovate' through individual learning. Furthermore, naive bees failed to open the box despite extended exposure for up to 24 days. This finding challenges a common opinion in the field: that the capacity to socially learn behaviours that cannot be innovated through individual trial and error is unique to humans.

where the reward was placed. Bees that learned this complex task then served as demonstrators for other observer bees who were finally tested to see if they could perform the task without their demonstrators. Five out of fifteen observer bees managed to do this on their own and two of them went on to consistently perform the task by themselves. In

The number of demonstrator bees that learnt the task in this study was also low. The fact that at least a couple of bees did efficiently learn the task demonstrates a proof of principle – that bees can learn the complex task. However, it also shows that social learning in this task did not typically lead to success and is therefore unlikely to be an important route to learning complex tasks. The role of social cues is clarified by another finding from the study. When examining how observer bees followed demonstrator bees, there was no difference in following behaviour between successful and unsuccessful observer bees. Thus, it does not seem likely that even the successful bees learnt specifically because they were imitating what the demonstrator bees were doing. Finally, it is perhaps unsurprising

Social learning and culture in bees: Simple mechanisms, complex outcomes

Perspectives | Published: 23 July 2024
Volume 49, article number 75 (2024) Cite this article

Access provided by University of Newcastle



Vivek Nityananda

768 Accesses 2 Citations 8 Altmetric Explore all metrics →

Abstract

Bees have been excellent model systems to study social learning – the ability of animals to change their behaviour based on observations of other individuals. Researchers have investigated several aspects of social learning in bees, including how it can lead to cultural traditions. A recent study also argues that bees have the capacity to socially learn behaviours that they could not innovate on their own. To understand these findings better, I review what we know about the mechanisms underlying social learning in bees and use these findings to compare social learning and culture in bees and humans. The findings suggest that the seemingly complex social behaviours of bees could arise from simple mechanisms underlying learning in general. I highlight the importance of investigating cognitive mechanisms and how they might differ across animals.

Sections
Abstract
References
Acknowledgements
Author information
Additional information
Rights and permissions
About this article

Online attention



754 tweeters
163 news outlets
139 Mendeley
8 blogs
11 Redditors
5 Facebook pages
6 Video uploaders

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View more on Altmetric

Mentions in news and blogs

Bumblebees Are as Clever as Humans, New Study Finds
Revyuh

장애물 만난 벌, 동료에게 해결책 배운다
Biz Chosun

La inteligencia cultural no es solo humana: chimpancés y abejorros también la desarrollan
La Vanguardia

Experimentos con chimpancés y abejorros cuestionan que la transmisión cultural sea exclusiva de los humanos
elDiario.es

Bumblebees surprise scientists with advanced social learning skills
Phys.org

Bee-2-Bee influencing: Bees master complex tasks through social interaction
EurekAlert!

Social Interaction Enables Bees to Master Complex Tasks
Mirage News

Hummeln vermitteln sich Experten-Wissen
wissenschaft.de

Шмели решили головоломку благодаря социальному научению
N+1: научные статьи, новости, открытия

Bumblebees Can Learn Complex Tasks through Social Interaction, New Study Says
Sci-News.com

Article | Open access | Published: 06 March 2024

Bumblebees socially learn behaviour too complex to innovate alone

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  - Amount of searching
  - Selective searching
  - Selective attention
- Biased interpretation
  - Selective skepticism
- Misremembering = biased citation count

Trivers and von Hippel 2011

Quick detour

BIRD INTELLIGENCE



Volume: Volume 226

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Anthropocentric bias may explain research disparities between animal tool use and nest building

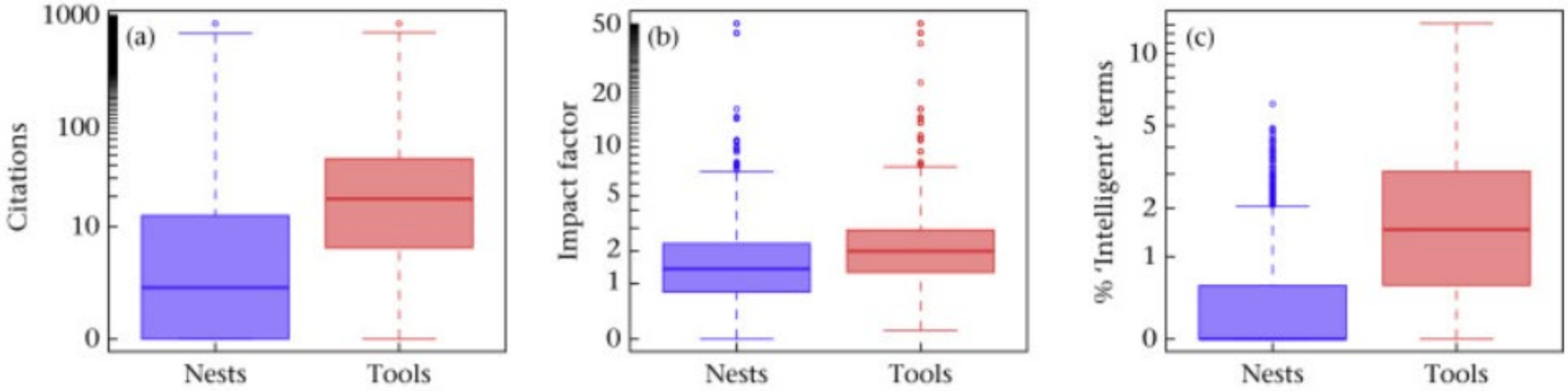
Highlights

- Animal tool use attracts widespread interest among academic and broader audiences.
- Nest building, an arguably similar behaviour, rarely attracts the same attention.
- We show that tool use attracts more research attention than nest building.
- Researchers also describe tool use with more 'intelligent' language than nest building.
- We conclude that the appeal of tool use is partly due to anthropocentric bias.

Scientists are not immune from bias. Studying nonhuman species objectively is inherently

Outline

Highlights
Keywords
Methods
Results
Discussion
Author Contributions
Data Availability
Declaration of Interest
Acknowledgments
Supplementary Material


(a)
Citations
1000
100
10
0
Nests
Tools
(b)
Impact factor
50
20
10
5
2
1
0
Nests
Tools
(c)
% 'Intelligent' terms
10
5
2
1
0
Nests
Tools

Example 2

ON BEE SENTIENCE

Definitions of sentience

- "Capacity to have feelings- mental states that are consciously experienced as good or bad."
- "Sentience is the capacity to feel. Understood broadly, sentience encompasses all felt experiences, including sensory experiences (e.g. visual, auditory, tactile, olfactory) as well as (for example) feelings of warmth, comfort, fatigue, hunger, thirst, boredom, excitement, distress, anxiety, pain, pleasure and joy"
- "A sentient being might not be able to reflect on its feelings or to understand others' feelings."
- "Sentience is the ability to experience feelings and sensations."
- Animal Welfare (Sentience) Act

Birch et al 2021, Gibbons et al 2022, Crump et al 2022

A framework for assessing if insects feel pain

- 8 Criteria
  - Criterion 1: Nociception
  - Criterion 2: Sensory integration
  - Criterion 3: Integrated nociception
  - Criterion 4: Analgesia
  - Criterion 5: Motivational trade-offs
  - Criterion 6: Flexible self-protection
  - Criterion 7: Associative learning
  - Criterion 8: Analgesia preference

Birch et al 2021, Gibbons et al 2022, Crump et al 2022

Table 11 Confidence level for each criterion for adults of each focal insect order.

Adults	Criterion 1: Nociception	Criterion 2: Sensory integration	Criterion 3: Integrated nociception	Criterion 4: Analgesia	Criterion 5: Motivational trade-offs	Criterion 6: Flexible self-protection	Criterion 7: Associative learning	Criterion 8: Analgesia preference
Blattodea	H	VH	VH	H	VL (no research found)	H	VH	VL (no research found)
Coleoptera	VH	VH	VL (no research found)	VL (no research found)	VL (no research found)	VL (no research found)	VL (no research found)	VL (no research found)
Diptera	VH	VH	VH	VH	H	VL (no research found)	VH	VL (no research found)
Hymenoptera	VH	VH	VL (no research found)	M	H	VL (no research found)	VH	VL
Lepidoptera	VH	VH	VL (no research found)	VL (no research found)	VL (no research found)	VL (no research found)	VH	VL (no research found)
Orthoptera	H	VH	VL (no research found)	L	VL (no research found)	VL (no research found)	VH	VL (no research found)

VH = Very high; H = High; M = Medium; L = Low; VL = Very low; VL (no research found) = Very low (no research found).

Gibbons et al 2022

‘Bees are sentient’: inside the stunning brains of nature’s hardest workers



Bees are in a class by themselves as pollinators, a role that requires a sophisticated mind, says one expert. Photograph: Alamy

‘Fringe’ research suggests the insects that are essential to agriculture have emotions, dreams and even PTSD, raising complex ethical questions

Most viewed

A framework for assessing if insects feel pain

- 8 Criteria
- Criterion 1: Nociception
- Criterion 2: Sensory integration
- Criterion 3: Integrated nociception
- Criterion 4: Analgesia
- Criterion 5: Motivational trade-offs
- Criterion 6: Flexible self-protection
- Criterion 7: Associative learning
- Criterion 8: Analgesia preference

Gibbons et al 2022

BRIEF REPORT | PSYCHOLOGICAL AND COGNITIVE SCIENCES

Motivational trade-offs and modulation of nociception in bumblebees

THIS ARTICLE HAS BEEN UPDATED

THIS ARTICLE HAS BEEN CORRECTED +

THIS ARTICLE IS DISCUSSED ON A PODCAST +

12,265 | 46

PDF EPUB

Abstract

Insects are traditionally thought to respond to noxious stimuli in an inflexible manner, without the ability to modulate their behavior according to context. We investigated whether bumblebees' attraction to high sucrose solution concentrations reduces their avoidance of noxious heat. Bees were given the choice between either unheated or noxiously heated (55 °C) feeders with different sucrose concentrations and marked by different colors. Bees avoided noxious feeders when the unheated feeders contained high sucrose concentrations, but progressively increased feeding from noxious feeders when the sucrose concentration at unheated feeders decreased. This shows a motivational trade-off of nociceptive responses. Bees used learned color cues for their decisions, and thus the trade-off was based on processing in the brain, rather than just

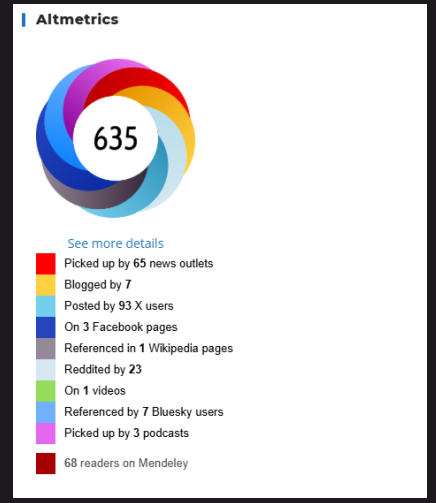
Motivational trade-offs and modulation of nociception in bumblebees

Description Insects are traditionally thought to respond to noxious stimuli in an inflexible manner, without the ability to modulate their behavior according to context. We investigated whether bumblebees' attraction to high sucrose solution concentrations reduces their avoidance of noxious heat. Bees were given the choice between either unheated or noxiously heated (55 °C) feeders with different sucrose concentrations and marked by different colors. Bees avoided noxious feeders when the unheated feeders contained high sucrose concentrations, but progressively increased feeding from noxious feeders when the sucrose concentration at unheated feeders decreased. This shows a motivational trade-off of nociceptive responses. Bees used learned color cues for their decisions, and thus the trade-off was based on processing in the brain, rather than just peripheral processing. Therefore, bees can use contextual information …

Total citations Cited by 104







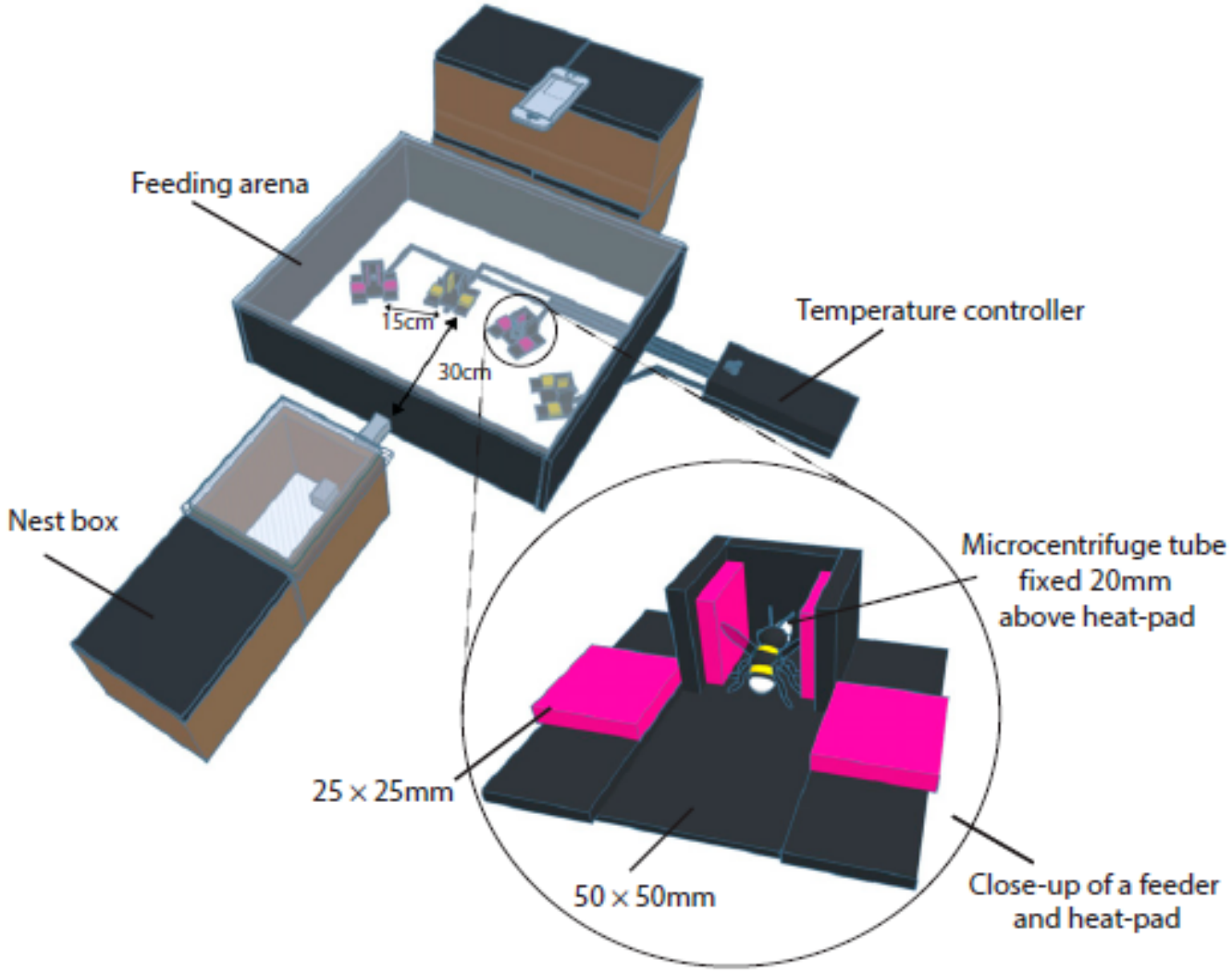


Fig. 2. Testing arena set-up (not to scale). Four feeders on the floor of the arena, 30 cm from the entrance, 15-cm apart. The arena could be accessed from nest box via a Perspex corridor. A temperature controller was outside the arena and controlled the temperature of each feeder. The iPhone was placed above. Black circle shows one feeder close up, with the black heat-pad (50 cm × 50 cm), colored Perspex squares (25 cm × 25 cm), and a 1.5-mL microcentrifuge tube (with the end cut off) 20 mm above the heat-pad. Bee is shown in a feeding position.

Gibbons et al 2022

Trading off heat and sugar rewards

- Motivational trade-offs and nociception
- 'Enough flexibility must be shown to indicate centralized, integrative processing of information involving a common measure of value'

A

Unheated temperature condition

	High-quality feeders (unheated)	Alternative feeders (unheated)
Concentration (%)	40	10
	40	20
	40	30
	40	40

45-minute break

Heated temperature condition

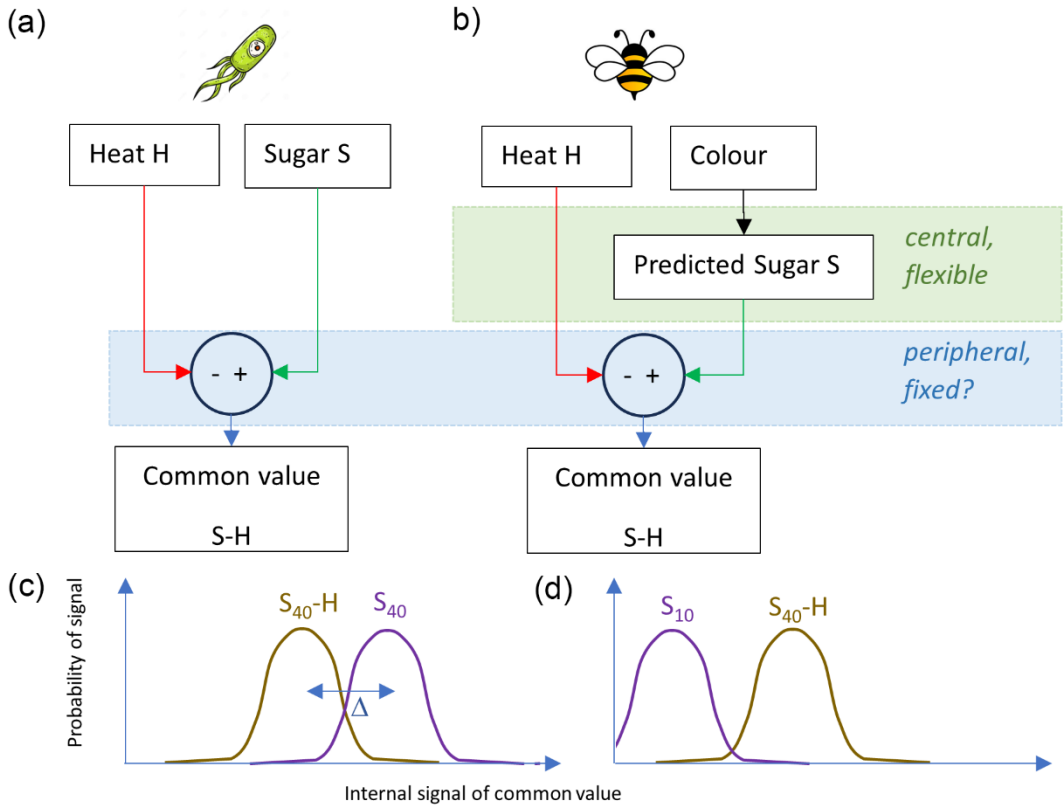
	High-quality feeders (heated)	Alternative feeders (unheated)
Concentration (%)	40	10
	40	20
	40	30
	40	40

Gibbons et al 2022; Gibbons and Chittka 2022

Motivational vs Behavioural trade-offs

Jenny Read

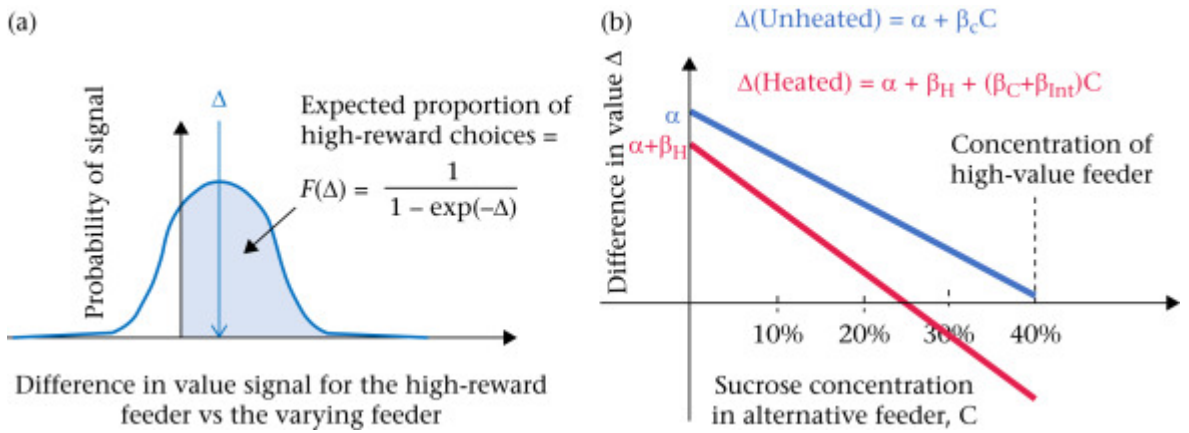




Read and Nityananda, 2025

Motivational vs Behavioural trade-offs

- The effect of heat needs to be different for different concentrations – an "interaction effect".



Jenny Read



Insects and Pain

- Motivational trade-offs and nociception

A

Unheated temperature condition

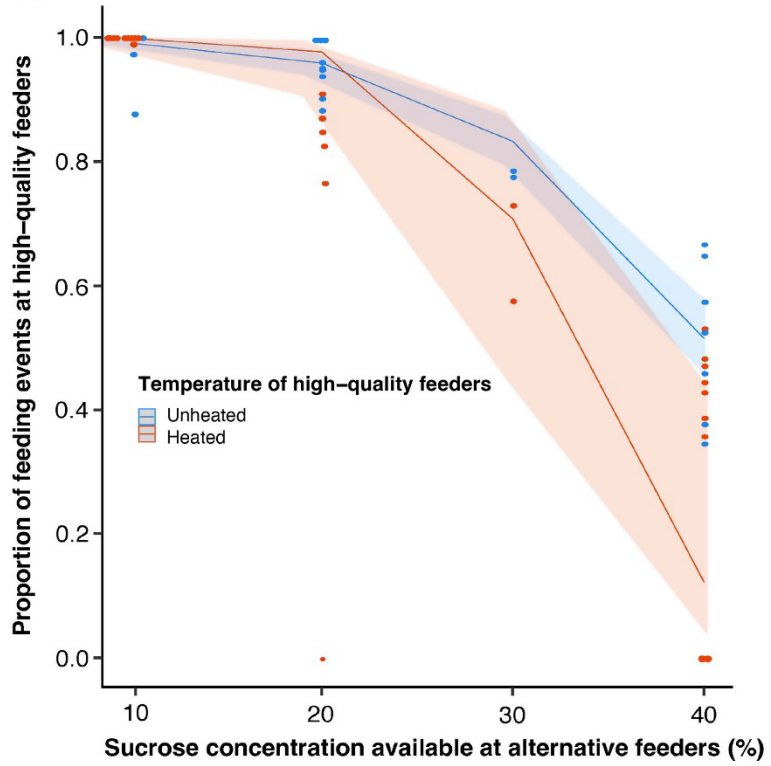
Concentration (%)	High-quality feeders (unheated)	Alternative feeders (unheated)
	40	10
	40	20
	40	30
	40	40

45-minute break

Heated temperature condition

Concentration (%)	High-quality feeders (heated)	Alternative feeders (unheated)
	40	10
	40	20
	40	30
	40	40

B



Gibbons et al 2022

Our Criticisms

- Excluding data points in a manner that could bias the results.

- Statistical models were “overfit” (singular models). Simpler models do not show the key effect.

- Very low sample size for some crucial points

- Heat was not reliably aversive

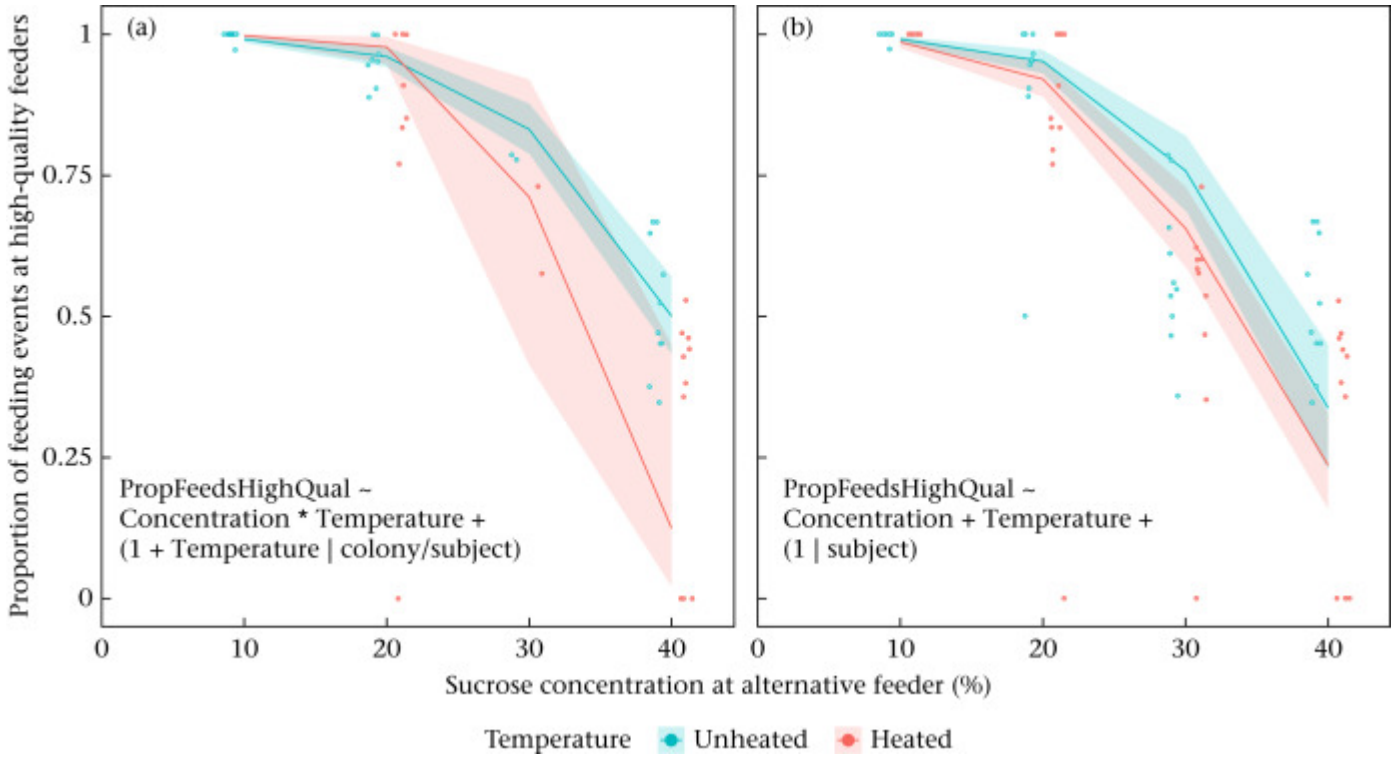
Read and Nityananda 2026a, 2026b

Reanalysis of the data

- Simpler models show no effect

Gibbons et al 2022

Read and Nityananda 2026a



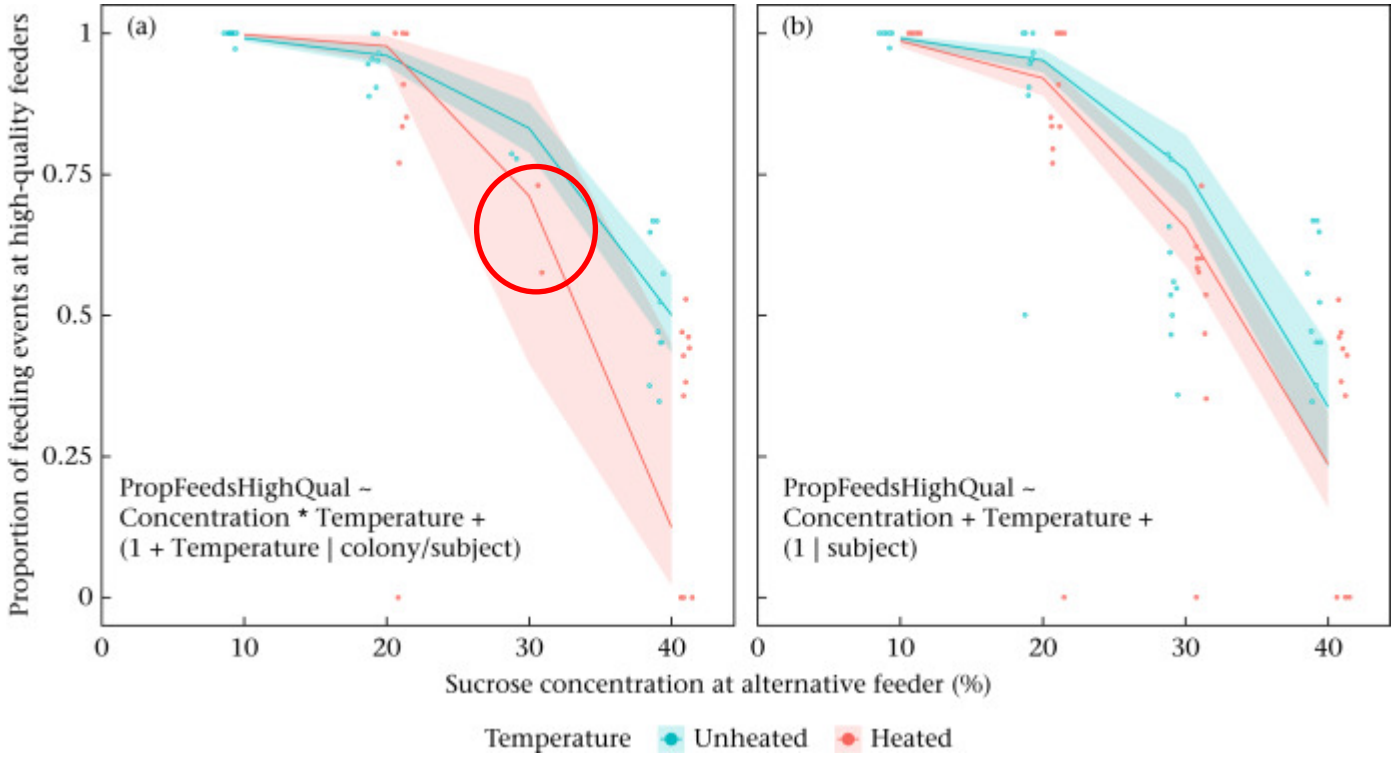
Read and Nityananda, 2026

Reanalysis of the data

- Excluding data leads to low sample size

Gibbons et al 2022

Read and Nityananda 2026a



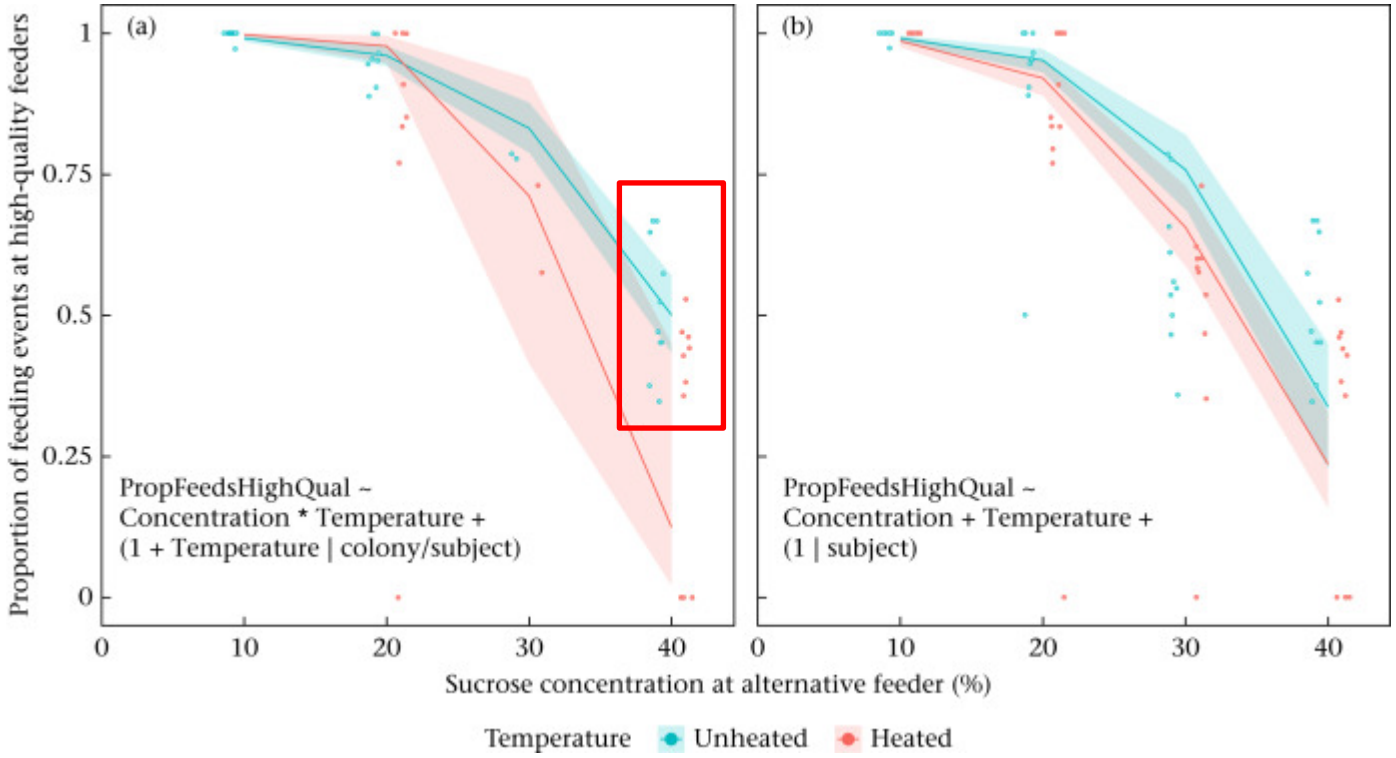
Read and Nityananda, 2026

Reanalysis of the data

- Heat is not reliably aversive

Gibbons et al 2022

Read and Nityananda 2026a



Read and Nityananda, 2026

Information processing biases in self-deception

- Biased information search
  - Amount of searching
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- Biased interpretation
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Trivers and von Hippel 2011

How can we create a better environment?



Junior group members



Group leaders



Departments & Universities



Publishers, Editors and Peer Reviewers



Funders

Junior group members



Flag up resources to the lab



Teach the PI



Build in replications into projects

Group leaders

01

Publish null results

02

Create an environment accepting of errors

03

Emphasize collaboration over competition

04

Hire with open research as a criterion

05

Build in replications into projects

Departments and Universities



CVs without journal names



Hire with open research as a criterion, or even the more weighted criterion



Include in promotion criteria



Build open research work into the workload model

Publishers, Editors, Peer Reviewers

- Open data and code compulsory
- Publish replications- include failed ones
- Publish null results
- Registered reports
- A ratings system for reproduced research (Multi lab, multiple times)
- Ensure they really are shared
- Do not peer review without shared code and data

Funders

1

Fund large scale replication efforts

2

Require open data and open access (e.g. Plan S)

3

Require every project to include a replication

4

Allow for “slow science”