The poverty of the stimulus in the animal kingdom (humans included)

Tyler Knowlton

University of Pennsylvania

WoSSP 19 – Nantes Université

Poverty of the Stimulus (PoS) poster child

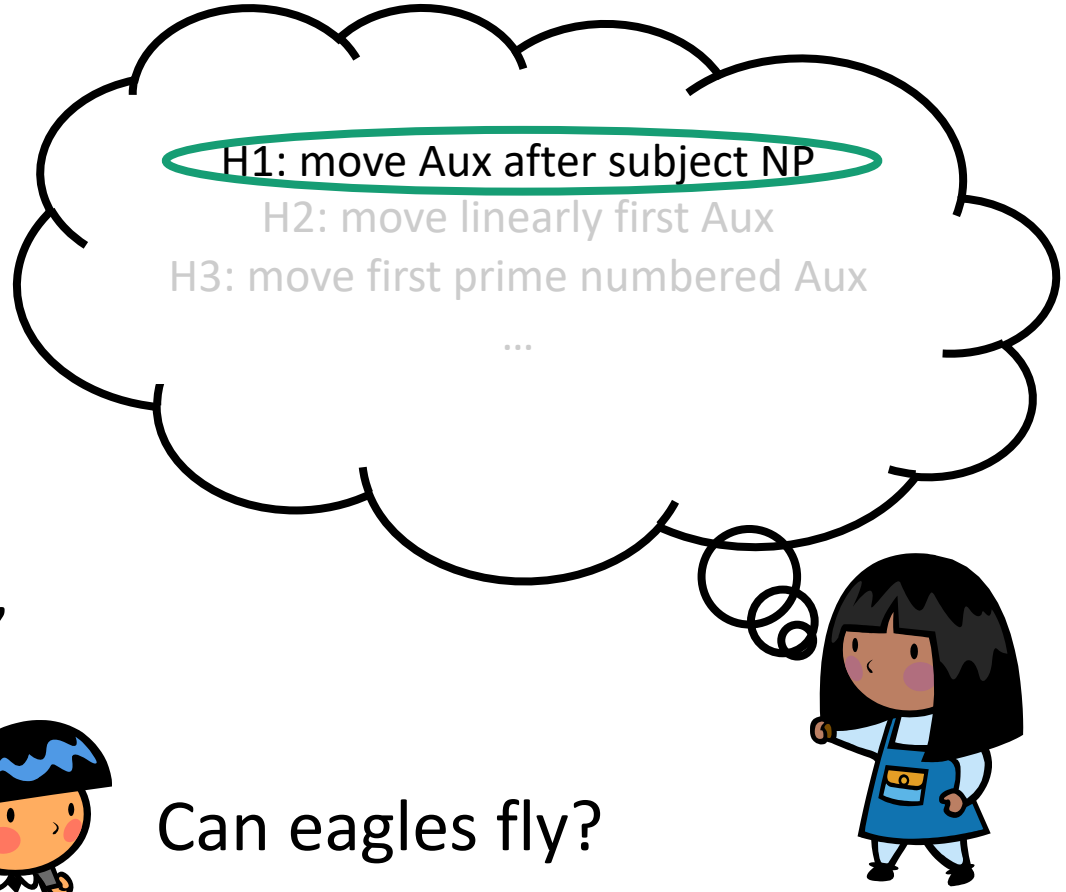
(1) Can eagles that fly eat?

(2) a. Eagles that fly can eat

b. Eagles that can fly eat

Speakers know something like

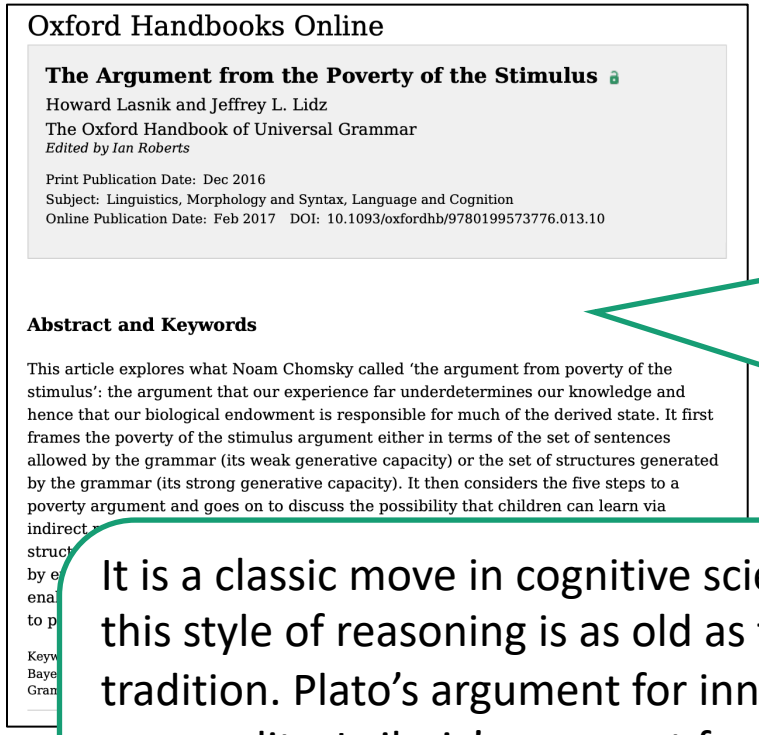
“move the Aux after the subject NP”



Can eagles fly?

Chomsky 1968; 1971; 1975; 1978; Legate & Yang 2002; Berwick et al. 2011; Lasnik & Lidz 2016; etc.

PoS arguments are old…



Oxford Handbooks Online

The Argument from the Poverty of the Stimulus

Howard Lasnik and Jeffrey L. Lidz

The Oxford Handbook of Universal Grammar

Edited by Ian Roberts

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Abstract and Keywords

This article explores what Noam Chomsky called 'the argument from poverty of the stimulus': the argument that our experience far underdetermines our knowledge and hence that our biological endowment is responsible for much of the derived state. It first frames the poverty of the stimulus argument either in terms of the set of sentences allowed by the grammar (its weak generative capacity) or the set of structures generated by the grammar (its strong generative capacity). It then considers the five steps to a poverty argument and goes on to discuss the possibility that children can learn via indirect
struct
by e
ena
to p

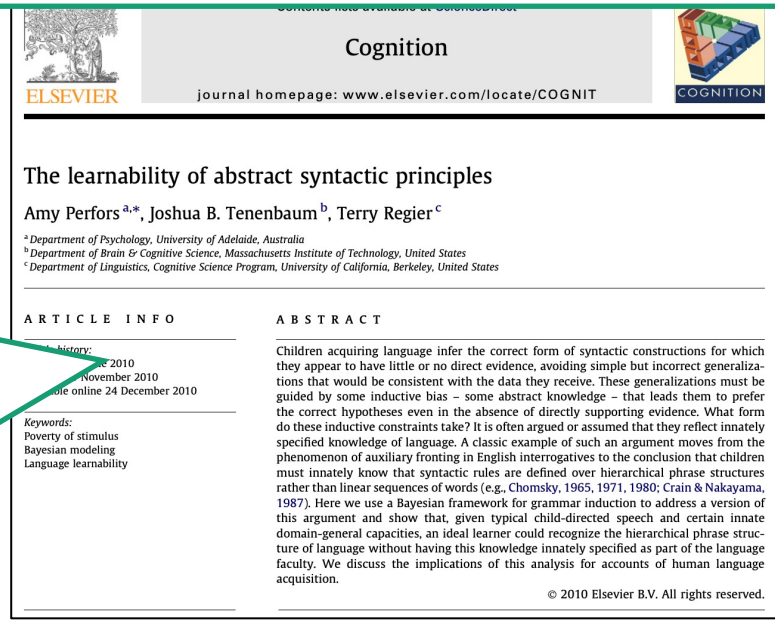
Keyw
Baye
Gran

The argument from the poverty of the stimulus, the argument that our experience far underdetermines our knowledge and hence that our biological endowment is responsible for much of the derived state… is essentially equivalent to the problem of induction. As Hume (1739) stated, … experience simply does not provide the basis for generalizing to the future.

Lasnik & Lidz (2016) *The Oxford Handbook of Universal Grammar*

It is a classic move in cognitive science, but in some version this style of reasoning is as old as the Western philosophical tradition. Plato's argument for innate principles of geometry or morality, Leibniz' argument for an innate ability to understand necessary truths, and Kant's argument for an innate spatiotemporal ordering of experience…

Perfors, Tenenbaum & Regier (2011) *Cognition*



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COGNITION

The learnability of abstract syntactic principles

Amy Perfors [a,*], Joshua B. Tenenbaum [b], Terry Regier [c]

[a] Department of Psychology, University of Adelaide, Australia
[b] Department of Brain & Cognitive Science, Massachusetts Institute of Technology, United States
[c] Department of Linguistics, Cognitive Science Program, University of California, Berkeley, United States

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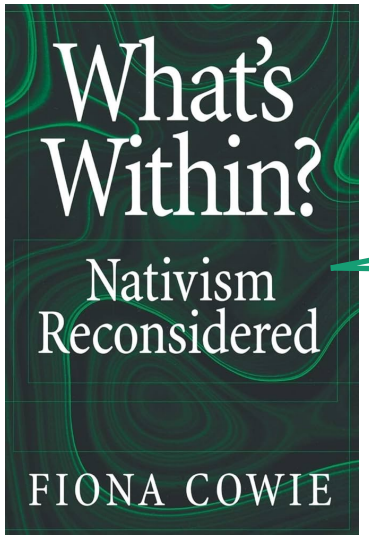
ABSTRACT

Children acquiring language infer the correct form of syntactic constructions for which they appear to have little or no direct evidence, avoiding simple but incorrect generalizations that would be consistent with the data they receive. These generalizations must be guided by some inductive bias – some abstract knowledge – that leads them to prefer the correct hypotheses even in the absence of directly supporting evidence. What form do these inductive constraints take? It is often argued or assumed that they reflect innately specified knowledge of language. A classic example of such an argument moves from the phenomenon of auxiliary fronting in English interrogatives to the conclusion that children must innately know that syntactic rules are defined over hierarchical phrase structures rather than linear sequences of words (e.g., Chomsky, 1965, 1971, 1980; Crain & Nakayama, 1987). Here we use a Bayesian framework for grammar induction to address a version of this argument and show that, given typical child-directed speech and certain innate domain-general capacities, an ideal learner could recognize the hierarchical phrase structure of language without having this knowledge innately specified as part of the language faculty. We discuss the implications of this analysis for accounts of human language acquisition.

PoS arguments are contentious…

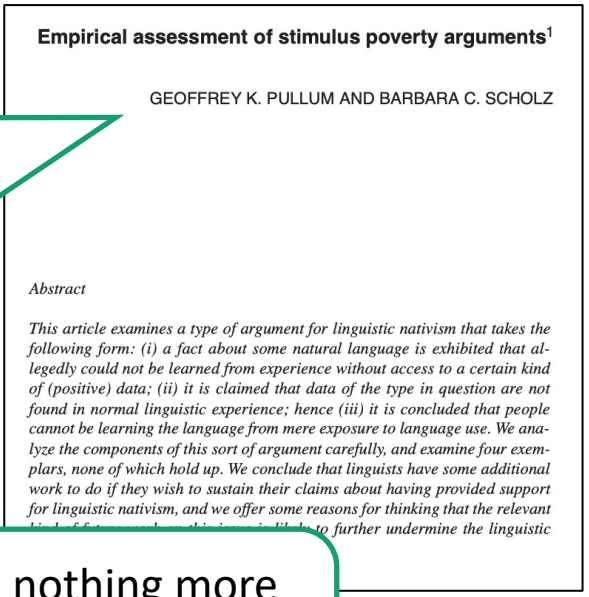


[PoS Arguments are] based on empirical assumptions that are at worst outright false, and at best highly dubious… obsession with such arguments has therefore been a mistake.

Cowie (1999) *What's Within?*

The putative argument has become a mainstream topic in cognitive science. Yet no one attempts to *state* the argument… The one thing that is clear about the argument from poverty of the stimulus is what its conclusion is supposed to be… What is not clear at all is the structure of the reasoning that is supposed to get us to this conclusion.

Pullum & Scholz (2002) *The Linguistic Review*

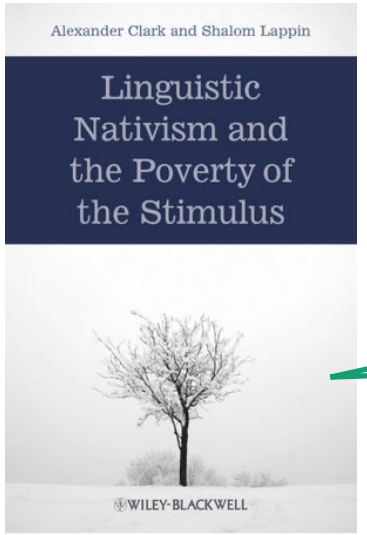


Empirical assessment of stimulus poverty arguments[1]

GEOFFREY K. PULLUM AND BARBARA C. SCHOLZ

Abstract

This article examines a type of argument for linguistic nativism that takes the following form: (i) a fact about some natural language is exhibited that allegedly could not be learned from experience without access to a certain kind of (positive) data; (ii) it is claimed that data of the type in question are not found in normal linguistic experience; hence (iii) it is concluded that people cannot be learning the language from mere exposure to language use. We analyze the components of this sort of argument carefully, and examine four exemplars, none of which hold up. We conclude that linguists have some additional work to do if they wish to sustain their claims about having provided support for linguistic nativism, and we offer some reasons for thinking that the relevant



…the "poverty of the stimulus" argument stems from nothing more than poverty of the imagination.

Sag (2010) back cover of *Linguistic Nativism and the PoS*

Roadmap

The structure of a PoS argument

Non-human examples

- ➥ Rats learning what can make them sick
- ➥ Bees learning about food and landmarks
- ➥ Bees learning the solar ephemeris

Humans learning what *one* can be anaphoric to

Why are PoS arguments so contentious when it comes to humans?

The form of a PoS argument

i. The data are compatible with (at least) two hypotheses

ii. It's possible to define other data that would distinguish these hypotheses

iii. Learners don't have access to the data in (ii)

iv. But they all come to the correct hypothesis

v. Conclusion: they never considered the incorrect hypothesis

➥ innate knowledge/special learning mechanism, general computational principles

Roadmap

✓ **The structure of a PoS argument**

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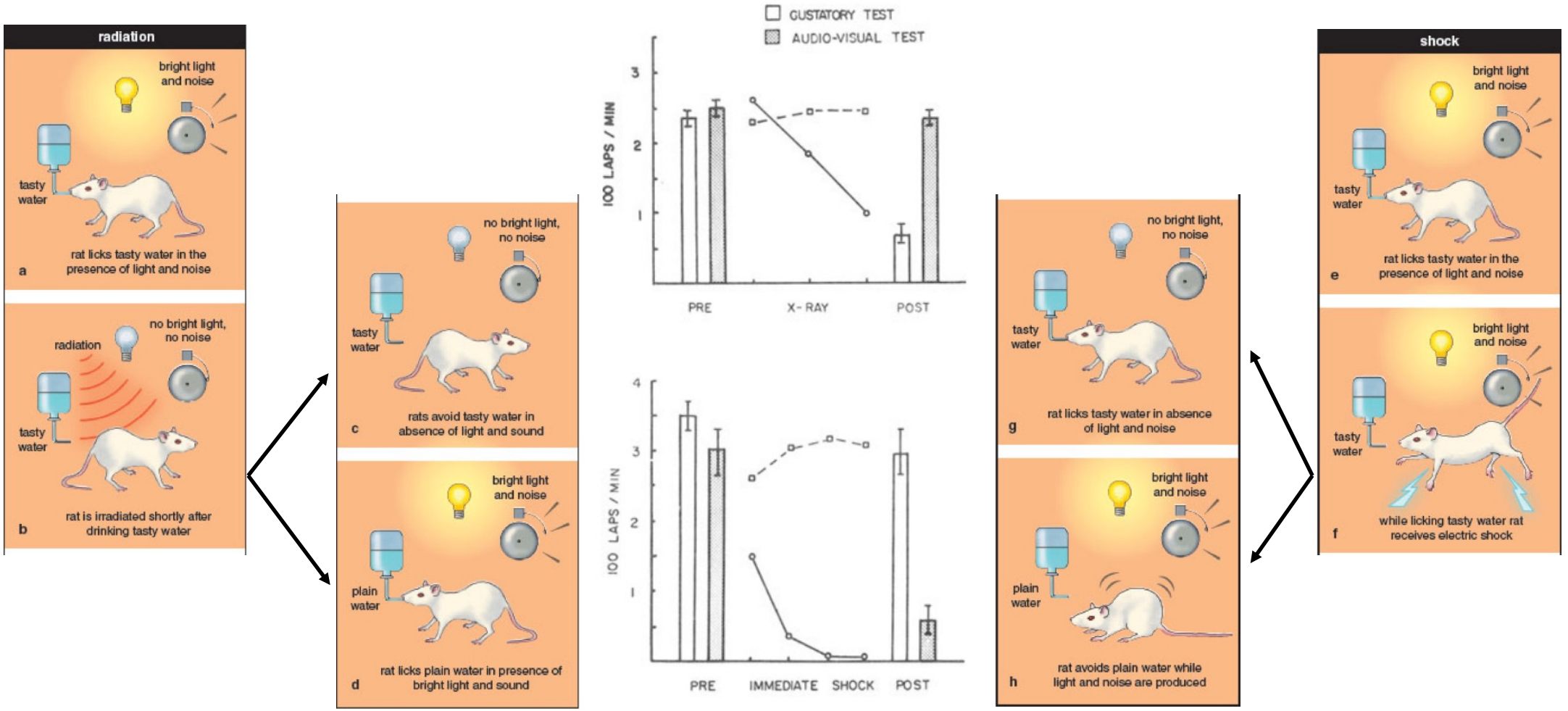
The limits of associative learning



Garcia & Koelling 1966 *Psychonomic science*

PoS argument for rats learning about sources of sickness

i. The data are compatible with (at least) two hypotheses

➥ H1[tasty water = sickness]; H2[lights & noise = sickness]

ii. It's possible to define other data that would distinguish H1 & H2

➥ Tasty water by itself; Lights & noise by itself

iii. Learners don't have access to the data in (ii)

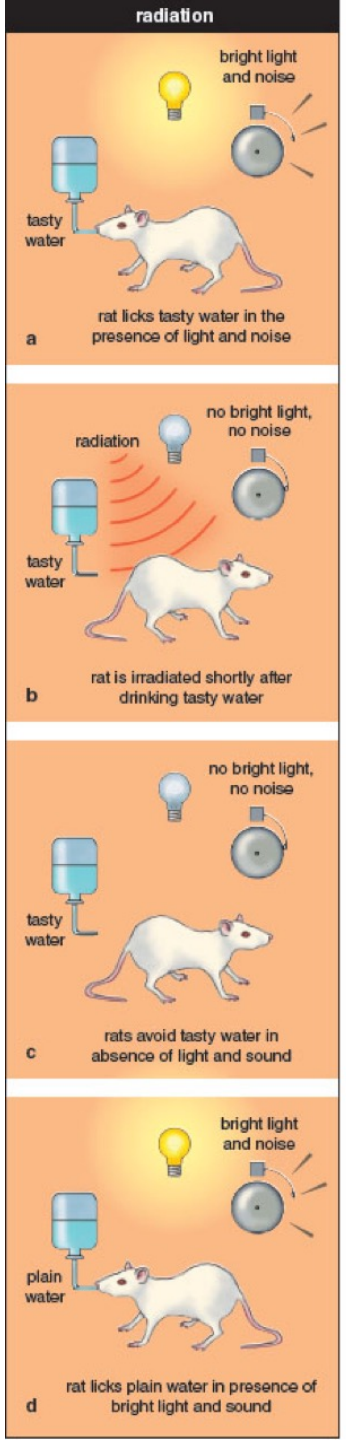
➥ Both potential culprits are presented at once

iv. But they all come to the same hypothesis

➥ Strange food can make you sick!

v. Conclusion: they never considered the alternative hypothesis

Garcia & Koelling 1966 *Psychonomic science*



PoS argument for rats learning about sources of sickness

i. The data are compatible with (at least) two hypotheses

➥ H1[tasty water = sickness]; H2[lights & noise = sickness]

ii. It's possible to c… H2

➥ Tasty water by …

iii. Learners don't …

➥ Both potential …

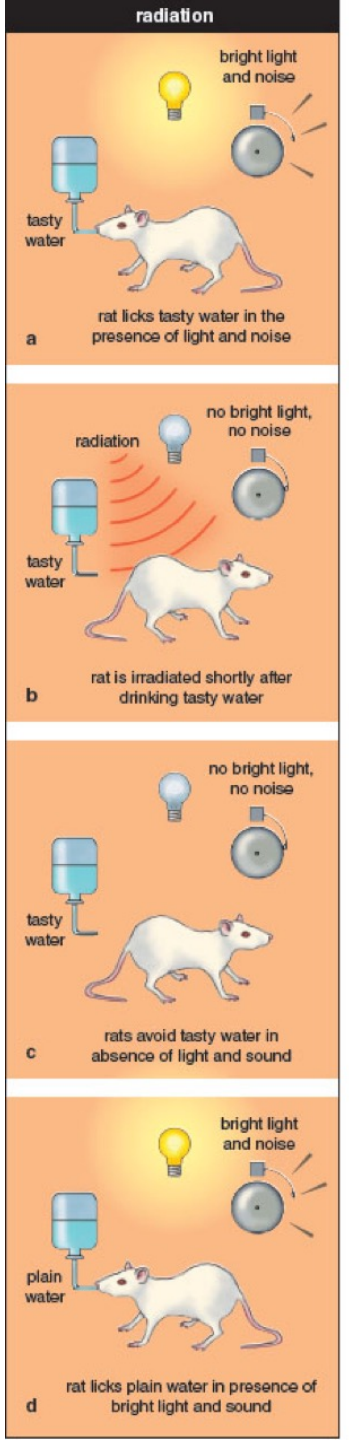
iv. But they all cor…

➥ Strange food can make you sick!

> …natural selection may have favored mechanisms which associate gustatory and olfactory cues with internal discomfort since the chemical receptors sample the materials soon to be incorporated into the internal environment. Krechevsky (1933) postulated such a genetically coded hypothesis to account for the predispositions of rats to respond systematically to specific cues in an insoluble maze. The hypothesis of the sick rat, as for many of us under similar circumstances, would be, "It must have been something I ate."
>
> –Garcia & Koelling 1966

v. Conclusion: they never considered the alternative hypothesis

Garcia & Koelling 1966 *Psychonomic science*



PoS argument for rats learning about sources of pain

i. The data are compatible with (at least) two hypotheses

➥ H1[tasty water = pain]; H2[lights & noise = pain]

ii. It's possible to define other data that would distinguish H1 & H2

➥ Tasty water by itself; Lights & noise by itself

iii. Learners don't have access to the data in (ii)

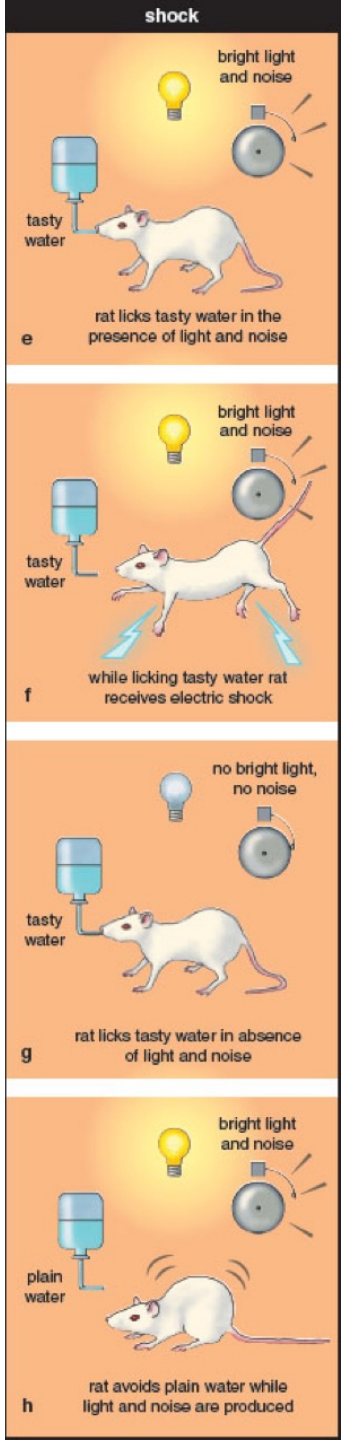
➥ Both potential culprits are presented at once

iv. But they all come to the same hypothesis

➥ Loud flashy stuff can shock you!

v. Conclusion: they never considered the alternative hypothesis

Garcia & Koelling 1966 *Psychonomic science*



Roadmap

✓ **The structure of a PoS argument**

Non-human examples

✓ Rats learning what can make them sick

➥ Bees learning about food and landmarks

➥ Bees learning the solar ephemeris

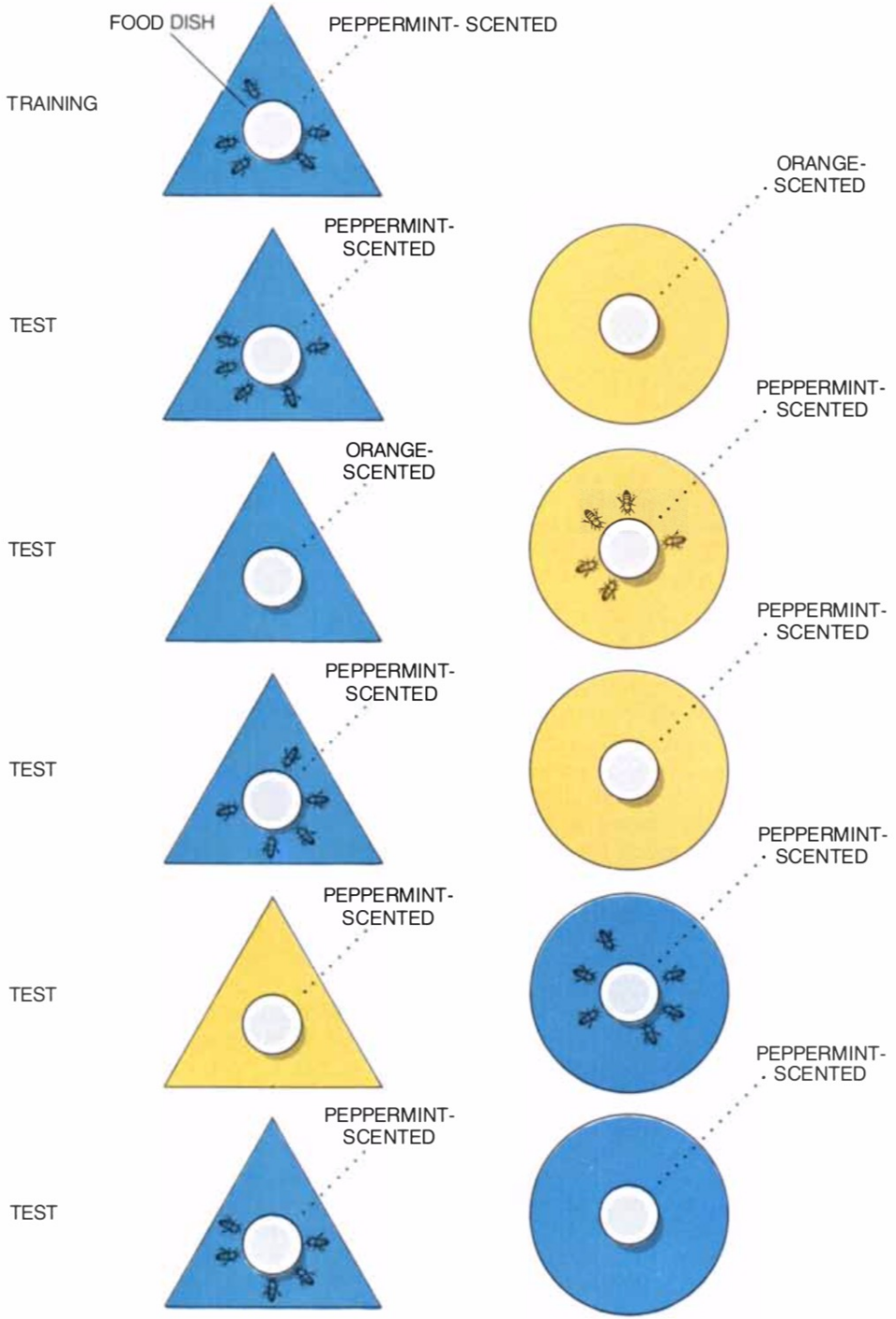
Humans learning what *one* can be anaphoric to

Why are PoS arguments so contentious when it comes to humans?

Asymmetries in inference

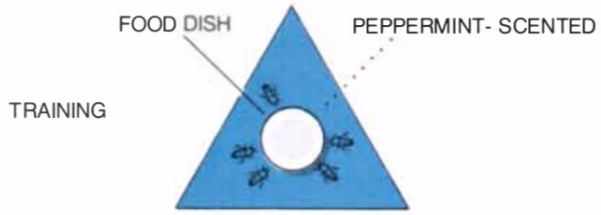
For food:
Odor > Color > Shape

For landmarks:
Color > **Odor** > Shape



Gould 1984

PoS argument for bees learning about sources of food



i. The data are compatible with (at least) two hypotheses

➥ H1[peppermint scented = good food]; H2[blue flower = good food]

ii. It's possible to define other data that would distinguish H1 & H2

➥ Like what they did at test

iii. Learners don't have access to the data in (ii)

➥ Both features present during initial exposure

iv. But they all come to the same hypothesis

➥ It's the scent that signals food!

v. Conclusion: they never considered the alternative hypothesis

Roadmap

✓ **The structure of a PoS argument**

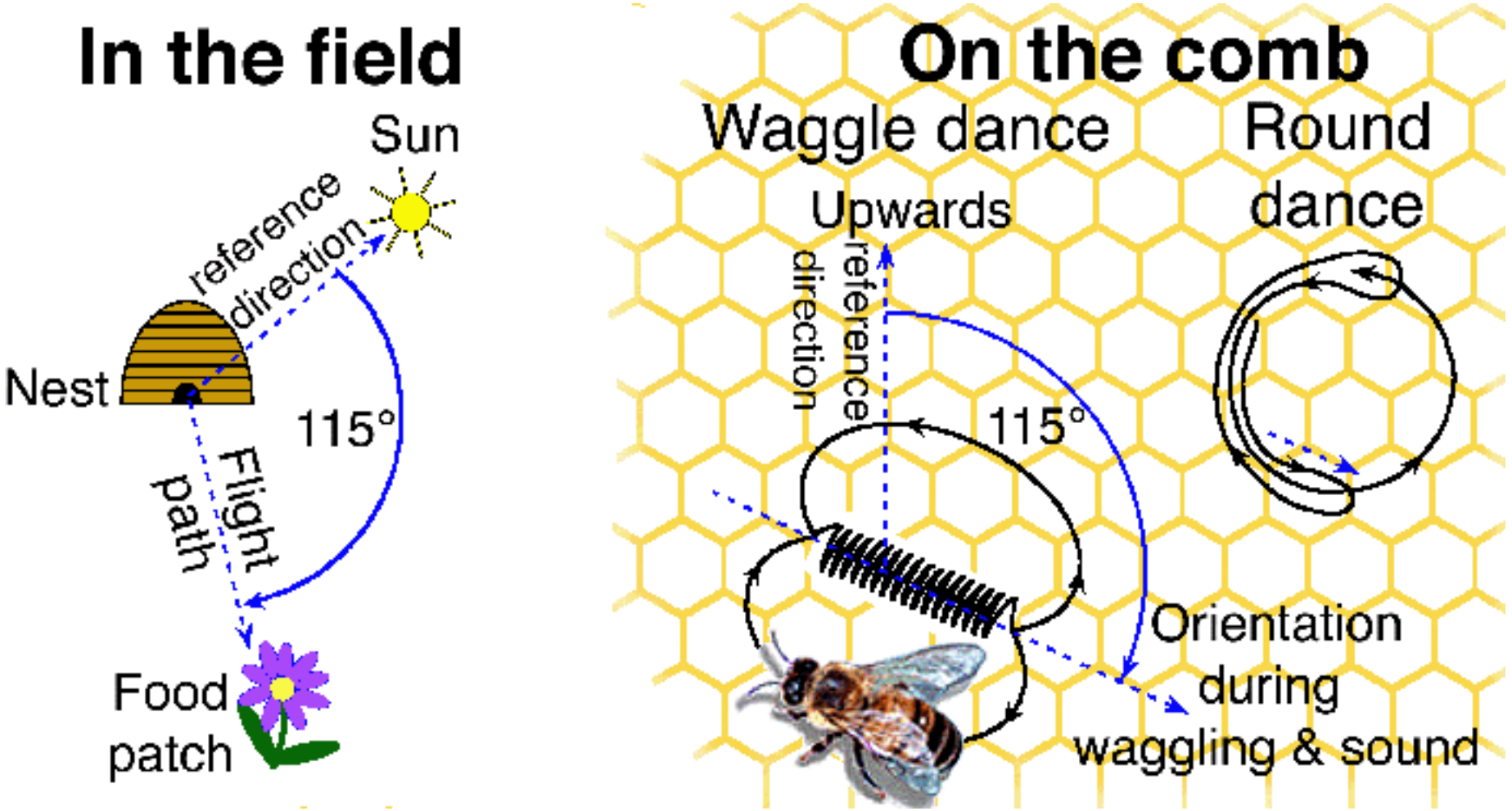
Non-human examples

- ✓ Rats learning what can make them sick
- ✓ Bees learning about food and landmarks
- ➥ Bees learning the solar ephemeris

Humans learning what *one* can be anaphoric to

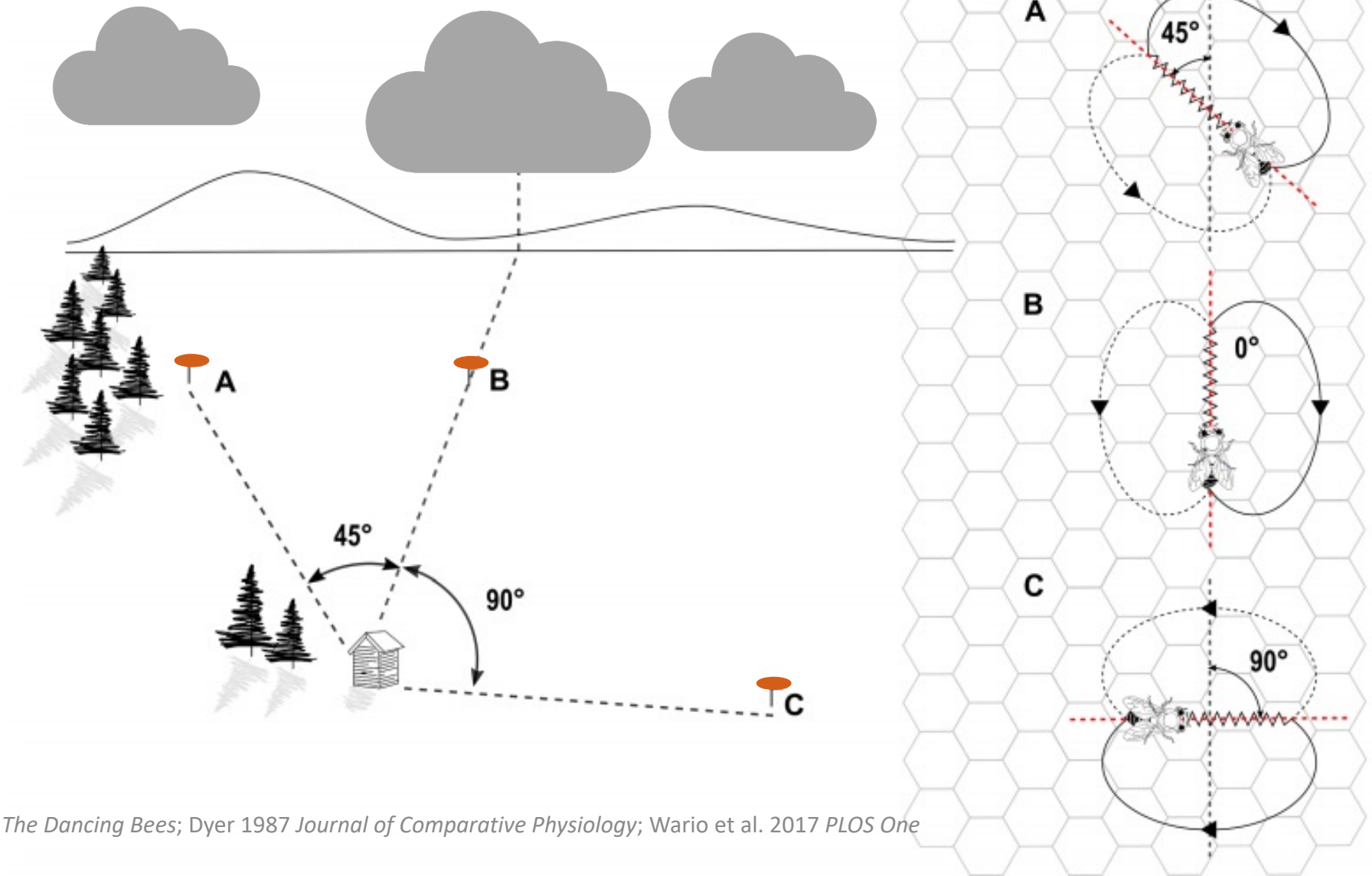
Why are PoS arguments so contentious when it comes to humans?

Bees communicate food locations through dance



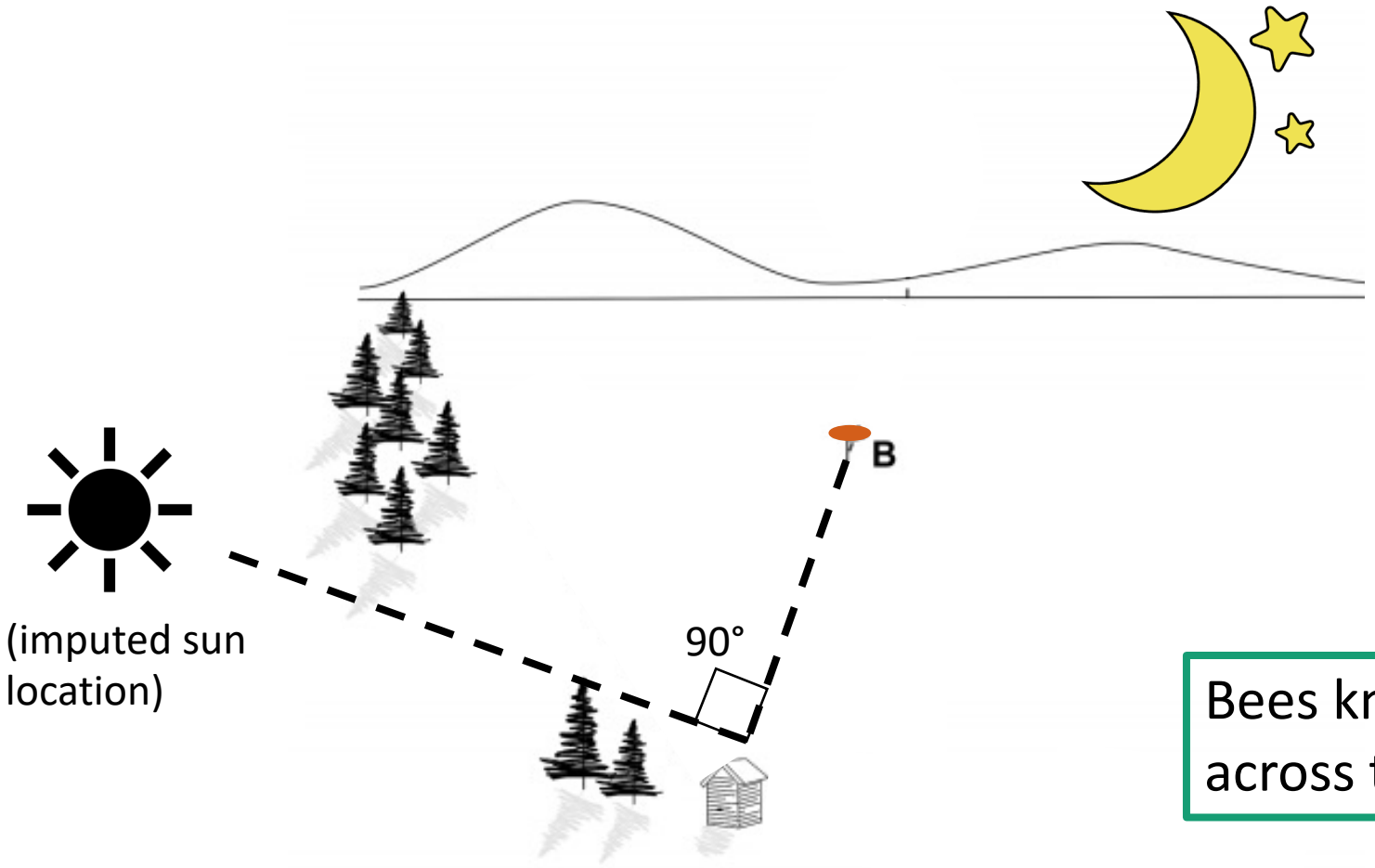
von Frisch 1954 *The Dancing Bees*; Visscher 2003 *Encyclopedia of Insects*

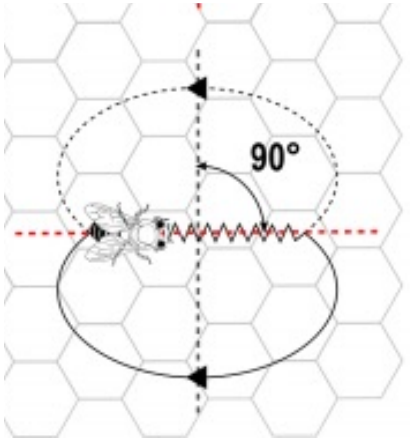
Dance direction is relative to sun's current position



von Frisch 1954 *The Dancing Bees*; Dyer 1987 *Journal of Comparative Physiology*; Wario et al. 2017 *PLOS One*

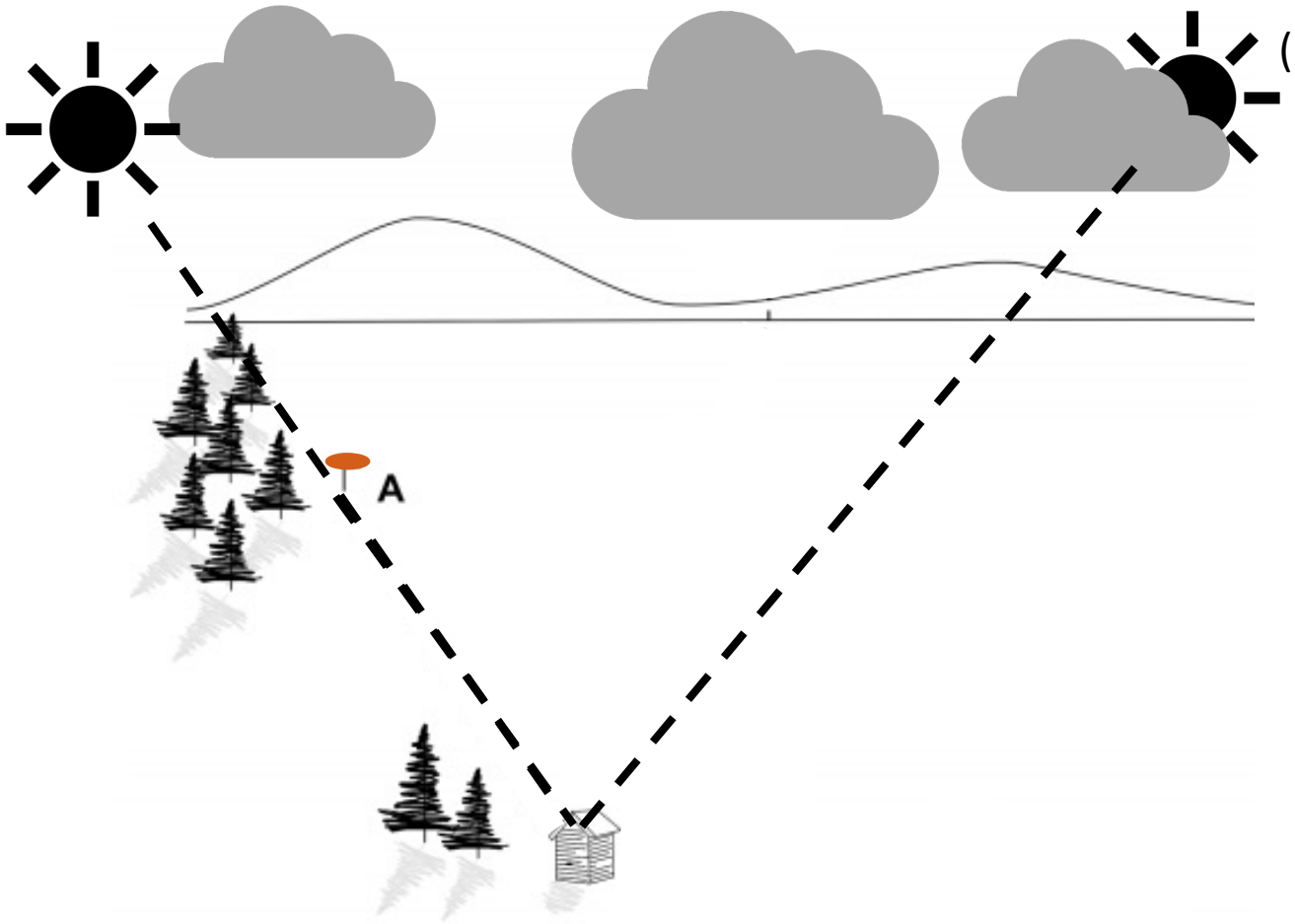
Dance direction is relative to sun's current position



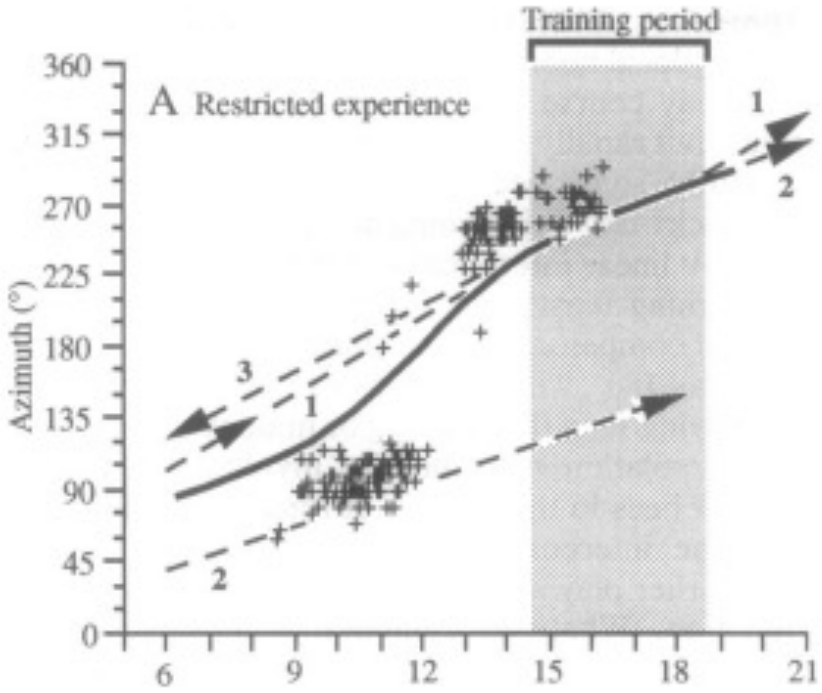


Bees know that the sun moves across the sky east to west!

How do bees learn the solar ephemeris?



(bees can't see sun)



Lindauer 1957 *Nature*; 1959 *Zeitschrift für vergleichende Physiologie*; Dyer & Dickinson 1994 *PNAS*

PoS argument for the solar ephemeris

i. The data are compatible with (at least) two hypotheses

➥ H1[the sun is always in the west]; H2[the sun moves east to we

ii. It's possible to define other data that would distinguish

➥ Where the sun is at earlier times of the day

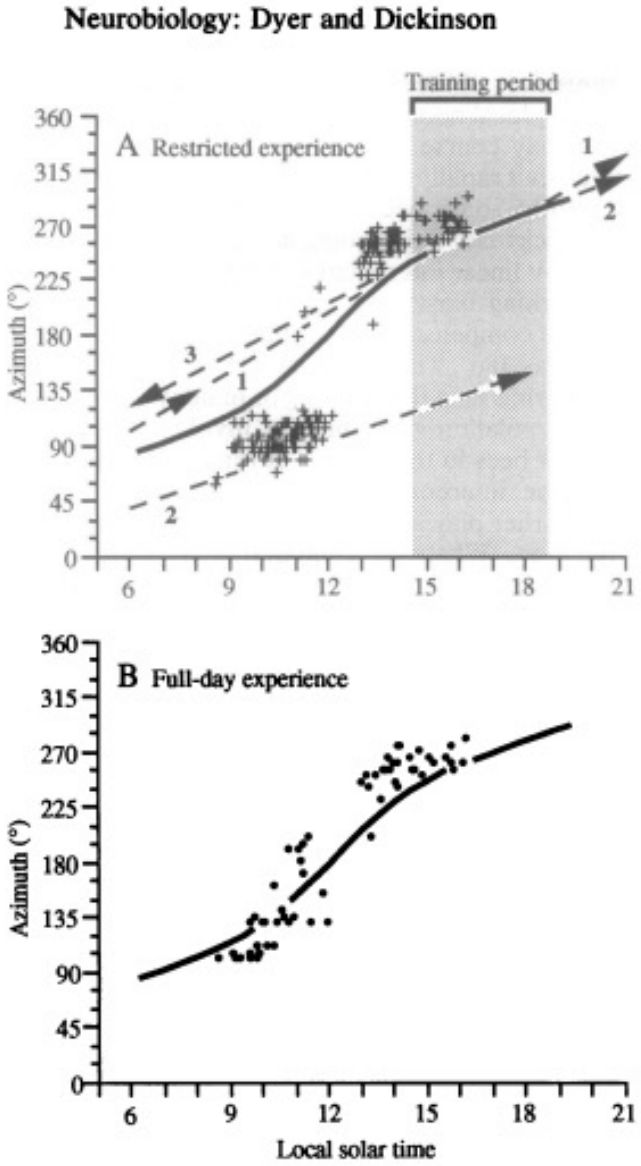
iii. Learners don't have access to the data in (ii)

➥ Only allowed out between 14:30 and 18:40 (23% of the sun's d

iv. But they all come to the correct hypothesis

➥ They expect the sun to be in the east in the morning!

v. Conclusion: they never considered the incorrect hypothesis



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iii. Learne

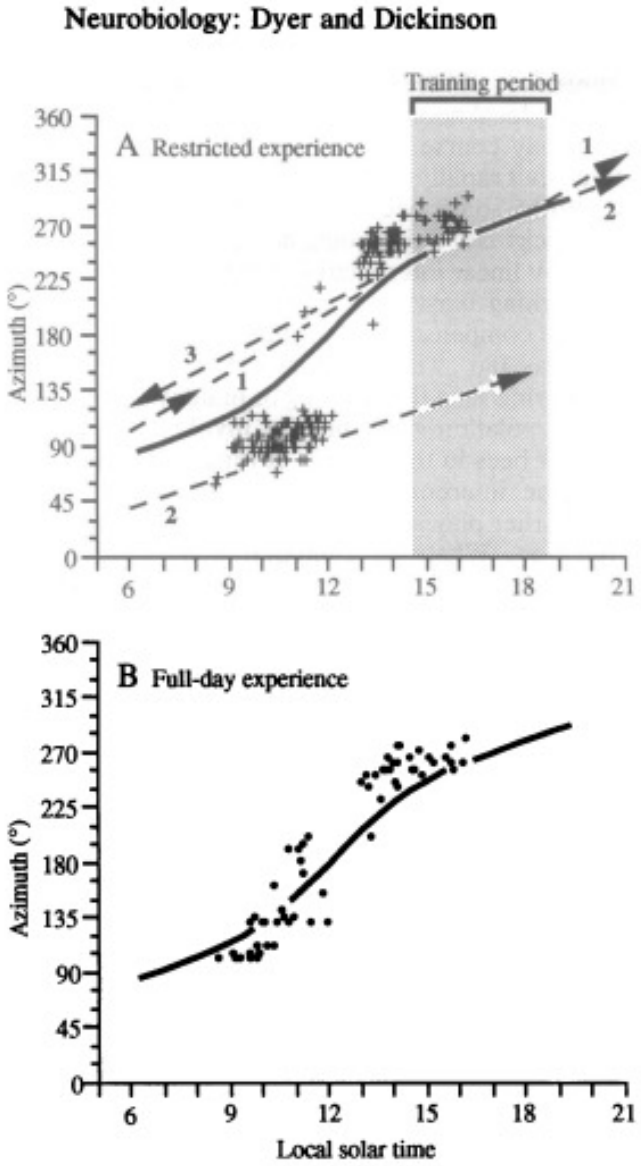
➥ Only

iv. But the

➥ They expect the sun to be in the east in the morning!

These observations reinforce the conclusion that bees can estimate the global properties of solar movement that they have never seen, as if they have an innate "template" guiding the learning process.

Dyer & Dickenson 1994



v. Conclusion: they never considered the incorrect hypothesis

Roadmap

✓ **The structure of a PoS argument**

✓ **Non-human examples**

✓ Rats learning what can make them sick

✓ Bees learning about food and landmarks

✓ Bees learning the solar ephemeris

Humans learning what *one* can be anaphoric to

Why are PoS arguments so contentious when it comes to humans?

Anaphoric *one* is anaphoric to N′, not N

(1) I like this blue mug and you like that **one**

$[_{NP}$ this $[_{N'}$ blue $[_{N'}$ $[_{N}$ mug]]]]

=blue mug

=mug

(2) I drank this mug of coffee and you drank that **one**

$[_{NP}$ this $[_{N'}$ $[_{N}$ mug] of coffee]]

=mug of coffee

*=mug

(3) *I drank this mug of coffee and you drank that **one** of tea

Baker 1978; Hornstein & Lightfoot 1981; Lightfoot 1982; Hamburger & Crain 1984

Hypotheses a learner might consider

(1) I like this blue mug and you like that **one**

$[_{NP}$ this $[_{N'}$ blue $[_{N'}$ $[_{N}$ mug]]]]

=blue mug

=mug

^this situation wouldn't help

H1: *one* can be anaphoric to N'

H2: *one* can be anaphoric to N

H3: *one* can be anaphoric to either N' or N

What data could help the learner?

(4) I have a blue mug but you don't have **one**

$[_{NP}$ a $[_{N'}$ blue $[_{N'}$ $[_{N}$ mug]]]]

=~~mug~~

=blue mug

H1: *one* can be anaphoric to N'

H2: *one* can be anaphoric to N

H3: *one* can be anaphoric to either N' or N

Do learners ever encounter those situations?

1,129 parental uses of ***one*** (out of 54,800 parental utterances considered)

792 pronominal uses

antecedent	Det N	Det Adj N	Det N PP
number ***percent***	750 95%	32 3.5%	5 0.5%

of 37 cases w/phrasal antecedent: 2 unambig. (0.2%)

# of ungrammatical uses of one ***= 4 (0.5%)***

PoS argument for anaphoric *one* (so far)

i. The data are compatible with (at least) two hypotheses

➥ H1[*one*=N']; H2[*one*=N]; H3[*one*=N' or N]

ii. It's possible to define other data that would distinguish these hypotheses

➥ *I have a blue mug, but you don't have one* [modified N w/negation & helpful context]

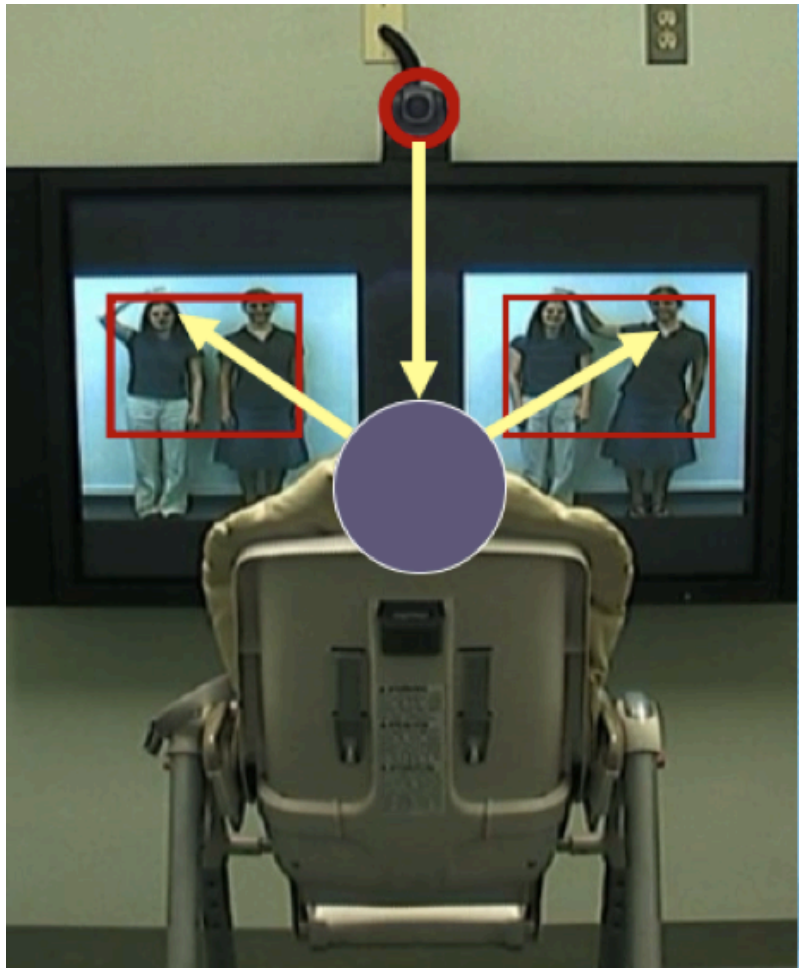
iii. Learners don't have access to the data in (ii)

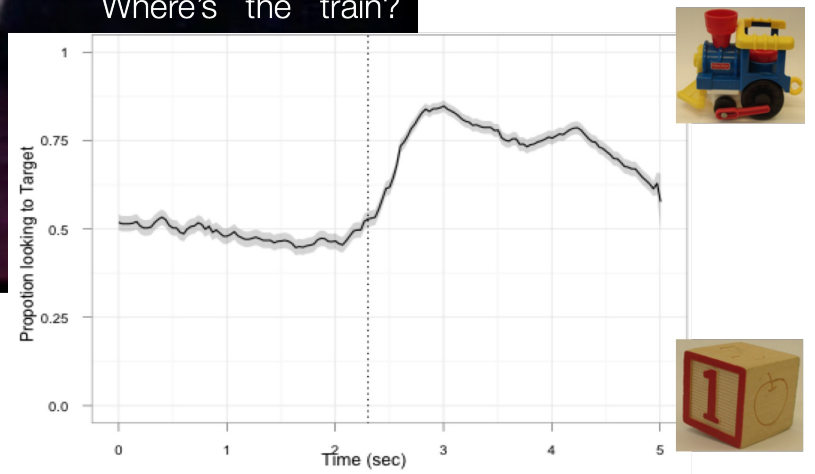
➥ Rate of unambiguous uses = ½*Rate of ungrammatical uses

iv. But they all come to the correct hypothesis

v. Conclusion: they never considered the incorrect hypothesis

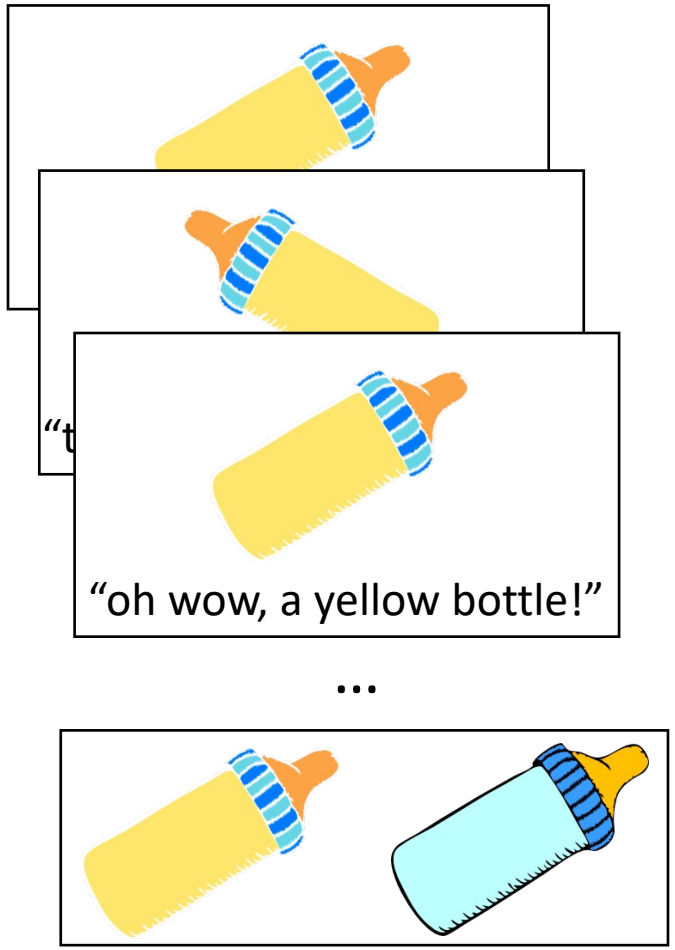
Preferential looking with 18-month-olds

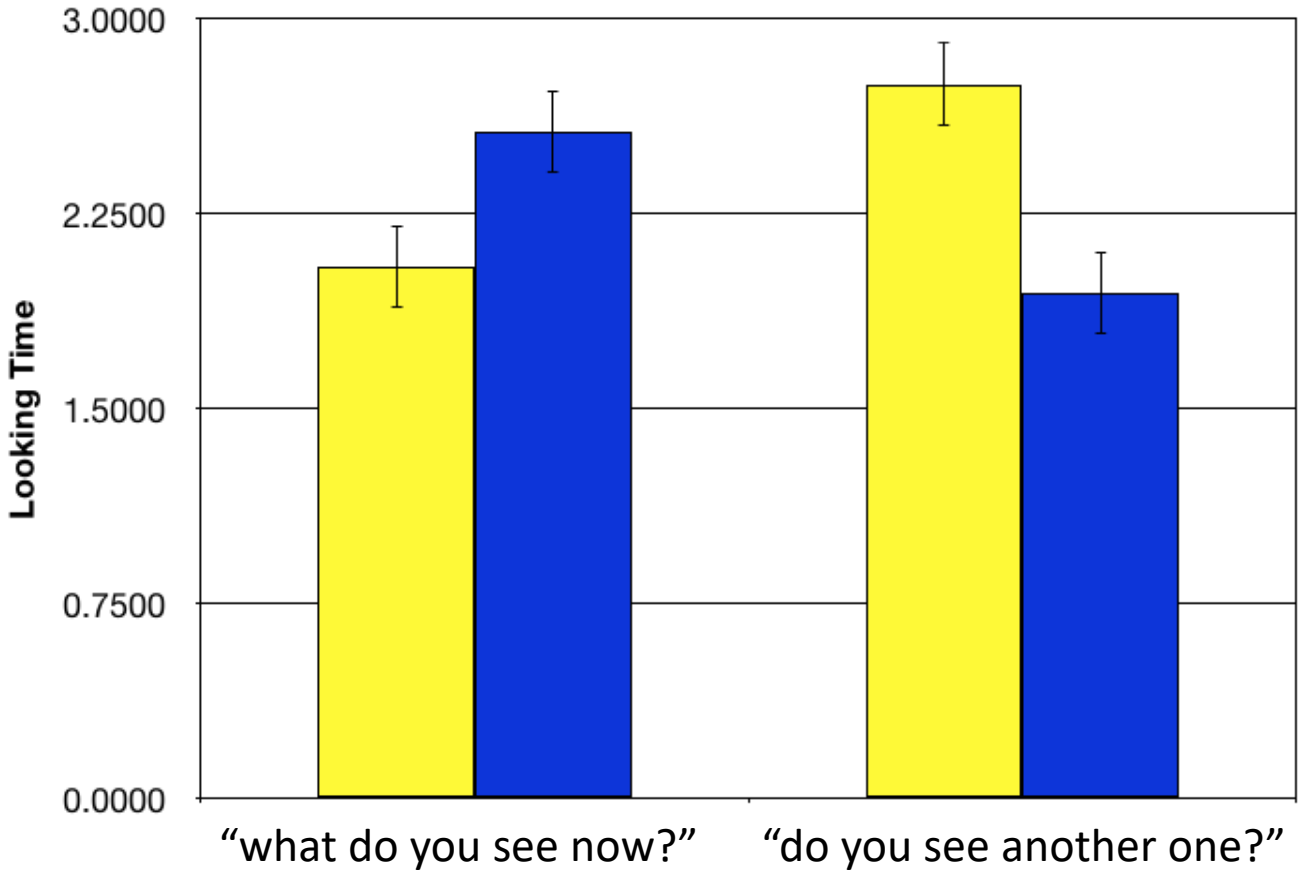




Spelke 1979

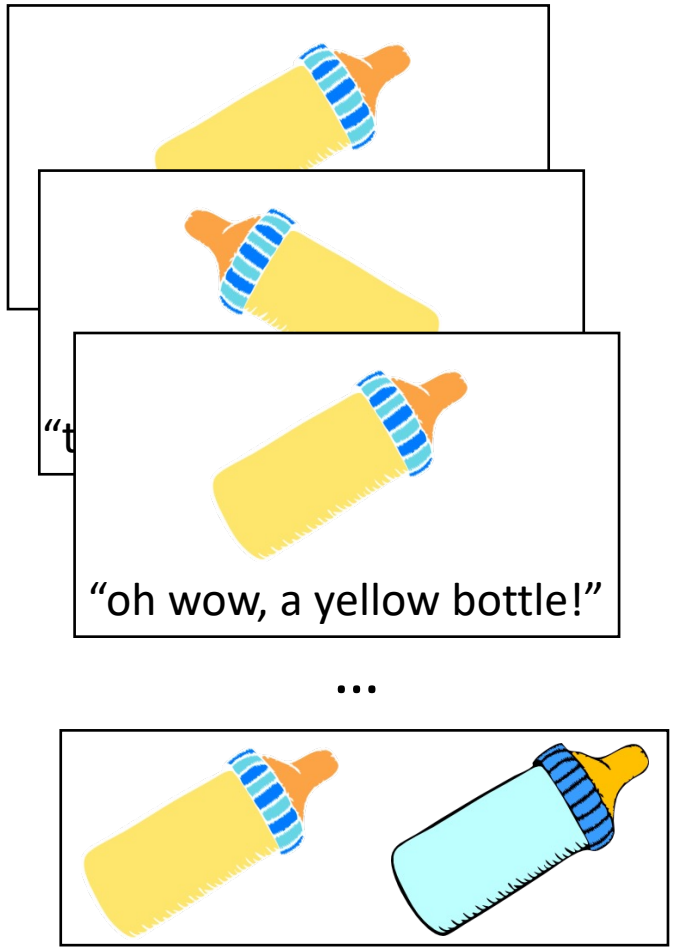
Preferential looking with 18-month-olds

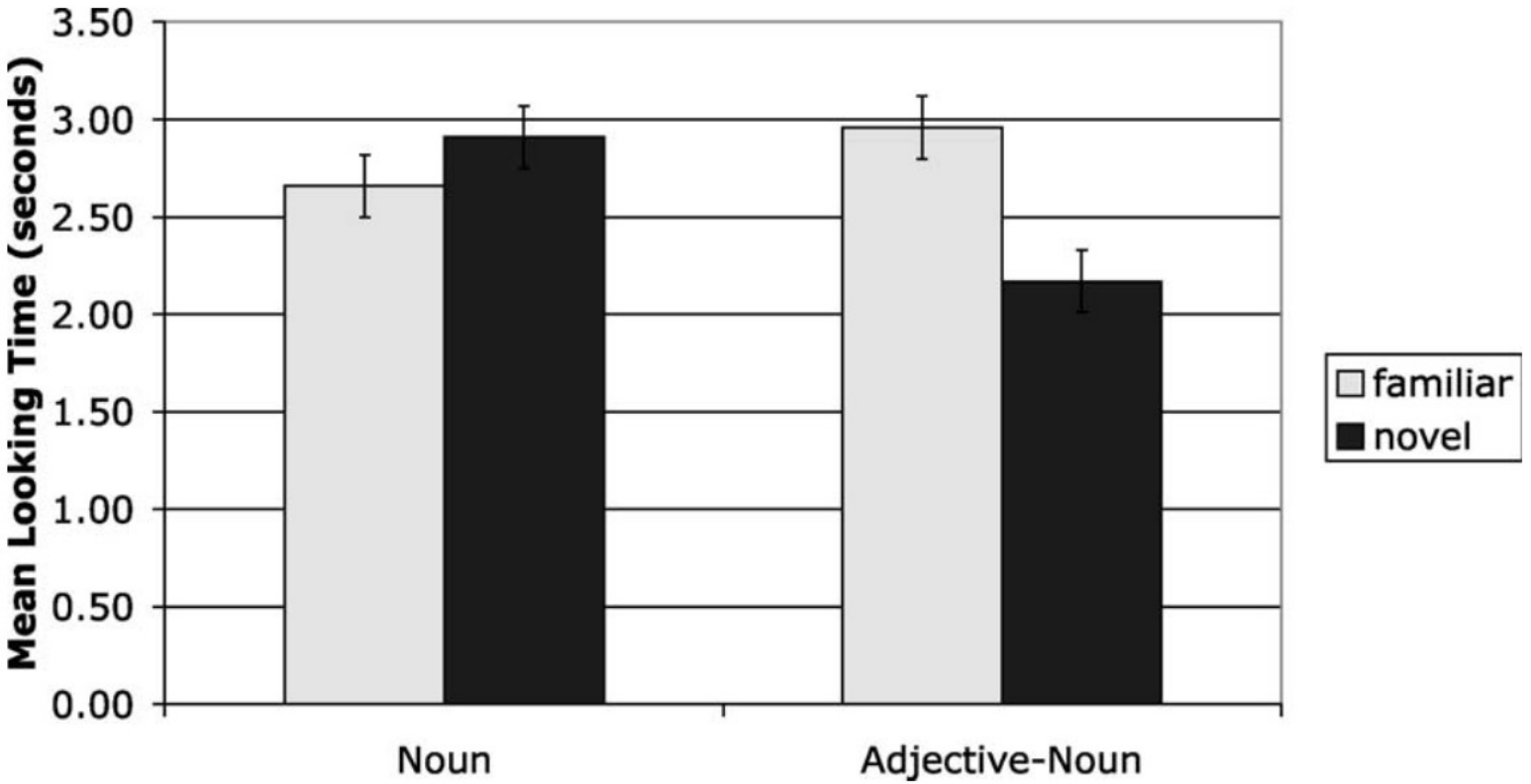




Lidz, Waxman & Freedman 2003 *Cognition*

Could it just be about *another*?





"Do you see another bottle?"

"do you see another yellow bottle?"

PoS argument for anaphoric *one*

i. The data are compatible with (at least) two hypotheses

➥ H1[*one*=N']; H2[*one*=N]; H3[*one*=N' or N]

ii. It's possible to define other data that would distinguish these hypotheses

➥ *I have a blue mug, but you don't have one* [modified N w/negation & helpful context]

iii. Learners don't have access to the data in (ii)

➥ Rate of unambiguous uses = ½*Rate of ungrammatical

iv. But they all come to the correct hypothesis

➥ At least by the time they're 18 months old!

v. Conclusion: they never considered the incorrect hypothesis

Why not?
Babies' minds are structured s.t. they expect anaphors to be anaphoric to phrasal categories, not heads

PoS argument for anaphoric *one*

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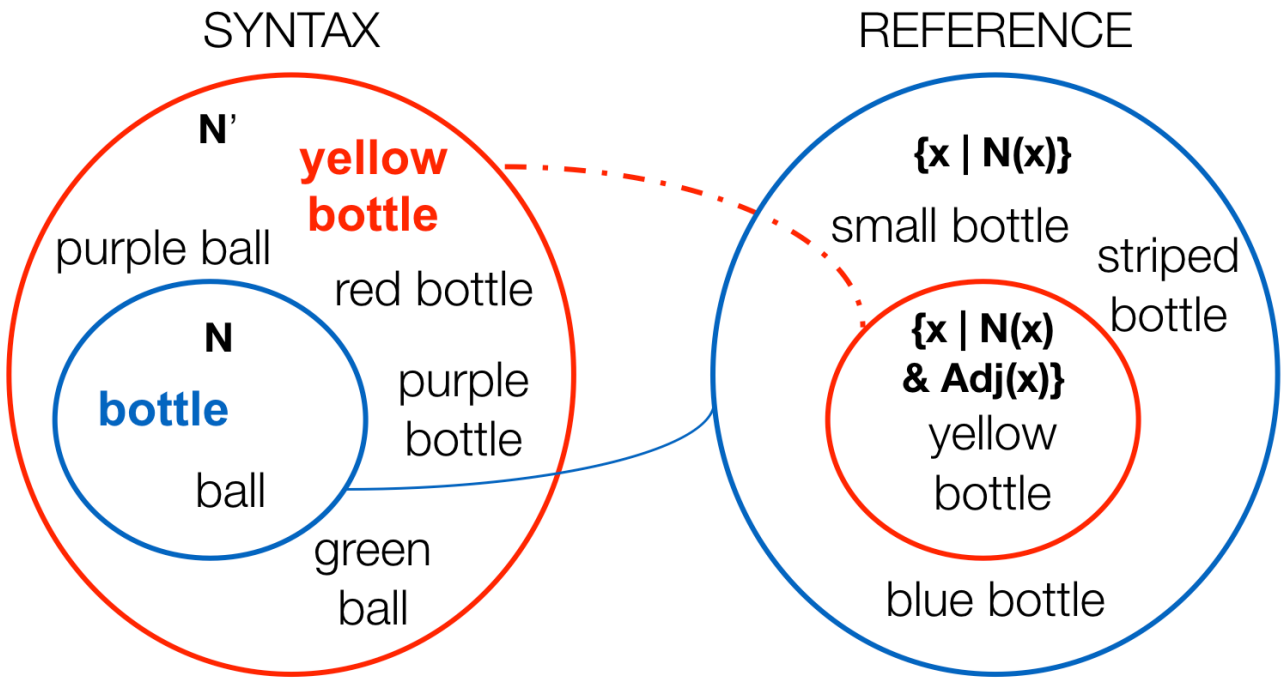
Would the size principle help?

(1) I like this yellow bottle and you like that **one**

$[_{NP}$ this $[_{N'}$ yellow $[_{N'}$ $[_{N}$ bottle $]]]]$

=bottle

=yellow bottle



Roadmap

✓ **The structure of a PoS argument**

✓ **Non-human examples**

✓ Rats learning what can make them sick

✓ Bees learning about food and landmarks

✓ Bees learning the solar ephemeris

✓ **Humans learning what *one* can be anaphoric to**

Why are PoS arguments so contentious when it comes to humans?

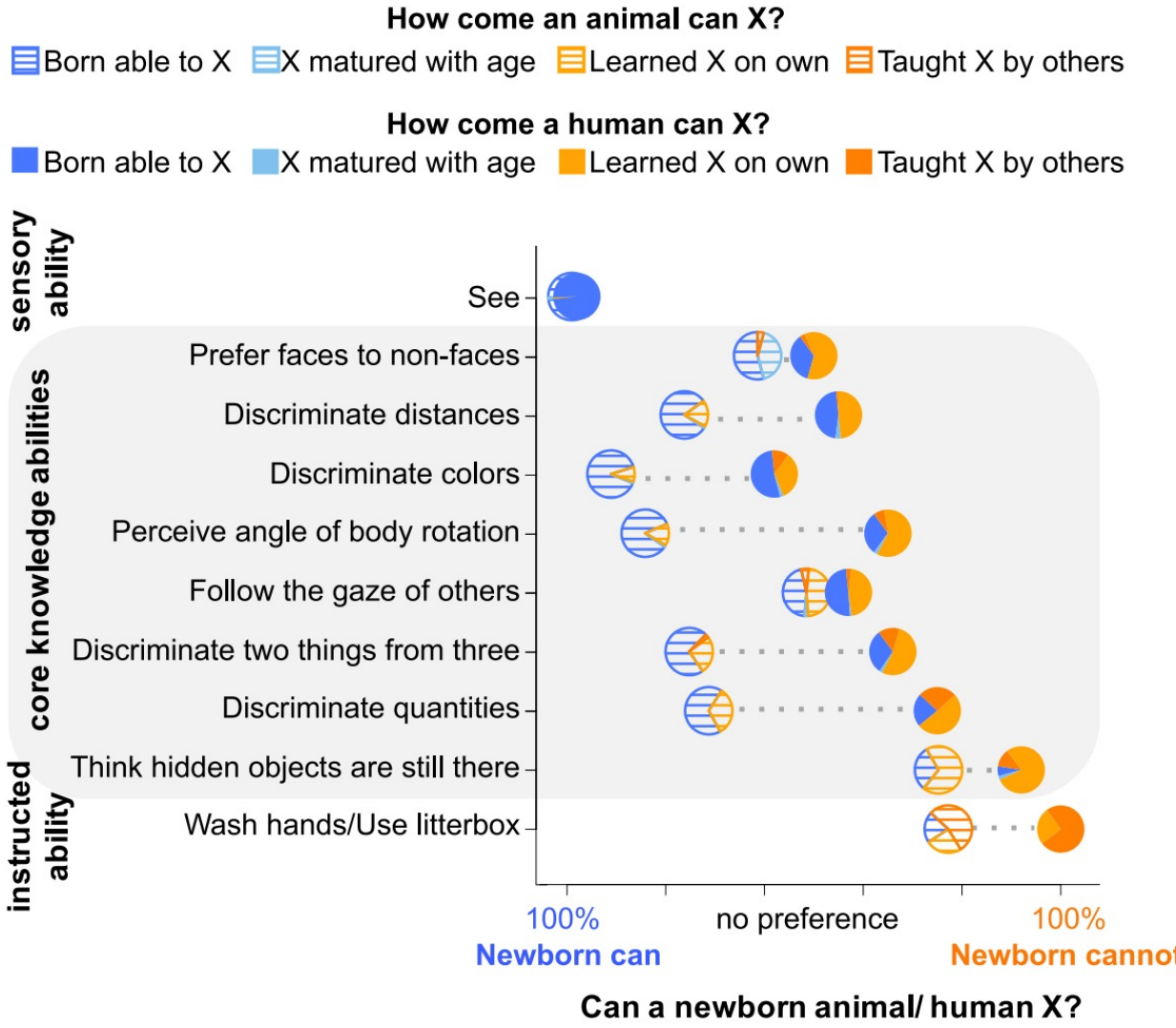
Why is PoS reasoning so contentious when applied to humans?

In the animal cases the stimulus is artificially impoverished?

Conclusion vs. invitation?

Something deeper…

Why is PoS reasoning so contentious when applied to humans?

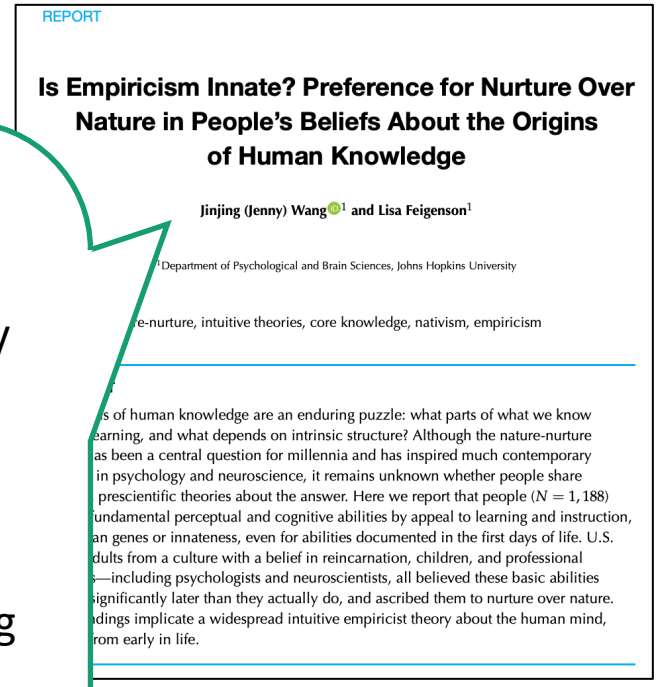


Why is PoS reasoning so contentious when applied to humans?

"Empiricism is innate!"
Lila Gleitman

…a bias to focus on learning as the source of knowing could conceivably be a product of evolution, selected for because it increases pedagogy and encourages information transmission… Alternatively, intuitive empiricism might be learned—perhaps by noticing the enormous effort and resources humans spend on teaching, by seeing that infants are behaviorally limited, or observing that many human abilities (like reading) do require experience and practice… Finally, it is possible that people's preference for empiricist explanations is promoted by the feeling that focusing on learning is more optimistic… A belief that knowledge is acquired could lead people to conclude that with relevant experience anything can be learned...

Wang & Feigenson (2019) *Open Mind*



REPORT

Is Empiricism Innate? Preference for Nurture Over Nature in People's Beliefs About the Origins of Human Knowledge

Jinjing (Jenny) Wang[1] and Lisa Feigenson[1]

[1]Department of Psychological and Brain Sciences, Johns Hopkins University

e-nurture, intuitive theories, core knowledge, nativism, empiricism

s of human knowledge are an enduring puzzle: what parts of what we know earning, and what depends on intrinsic structure? Although the nature-nurture as been a central question for millennia and has inspired much contemporary in psychology and neuroscience, it remains unknown whether people share prescientific theories about the answer. Here we report that people ($N = 1,188$) undamental perceptual and cognitive abilities by appeal to learning and instruction, an genes or innateness, even for abilities documented in the first days of life. U.S. dults from a culture with a belief in reincarnation, children, and professional —including psychologists and neuroscientists, all believed these basic abilities ignificantly later than they actually do, and ascribed them to nurture over nature. dings implicate a widespread intuitive empiricist theory about the human mind, rom early in life.