Individuality, cooperation, and cognitive evolution in paper wasps

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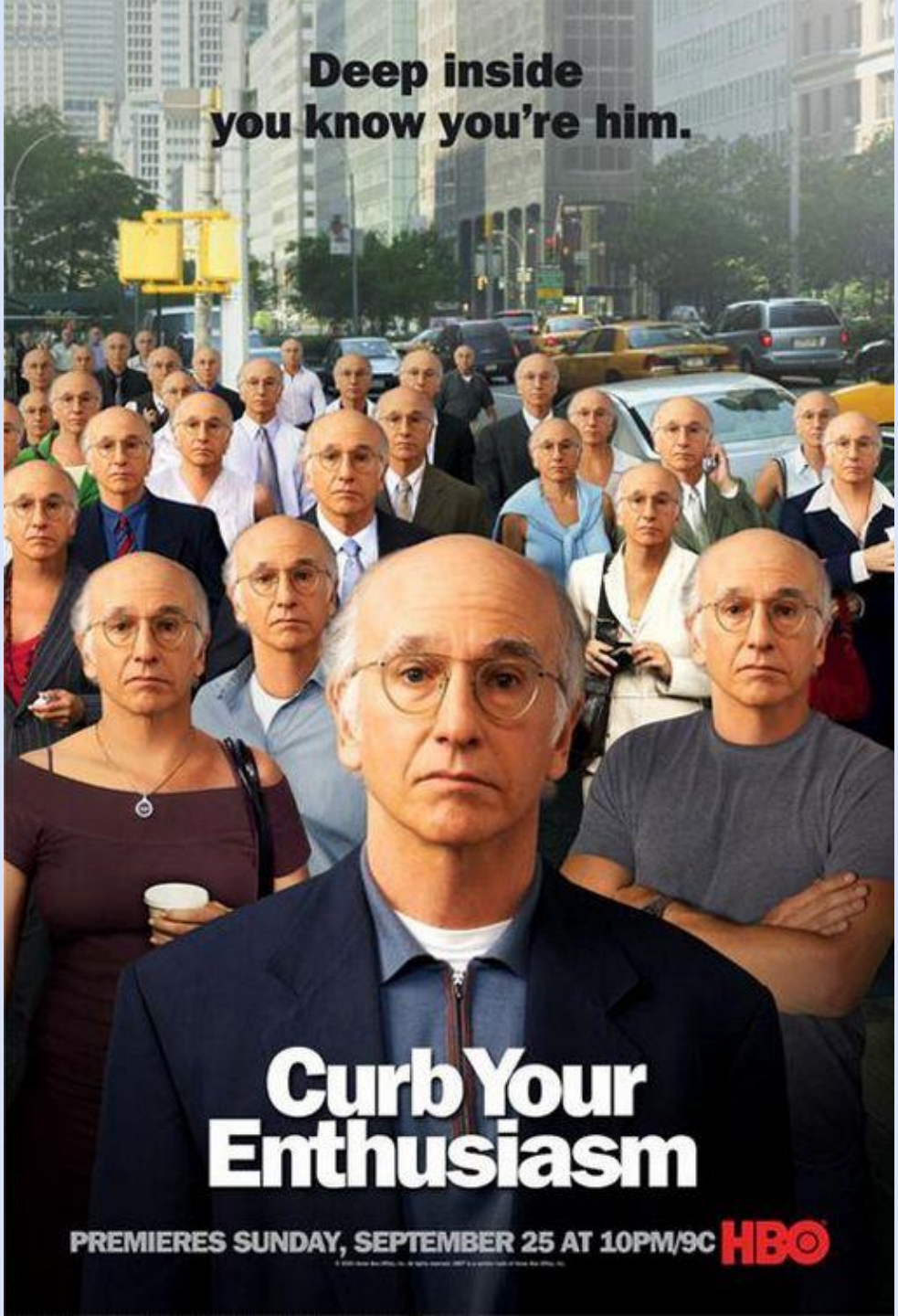
Ecology & Evolutionary Biology
University of Michigan


Deep inside
you know you're him.
Curb Your
Enthusiasm
PREMIERES SUNDAY, SEPTEMBER 25 AT 10PM/9C
HBO

Diapause

Founding phase

Worker phase

Mating

Diapause

Founding phase

‘Workers’ enter early diapause

Mating

Worker phase

***Polistes fuscatus* learn each other's facial markings and use the markings for individual recognition.**

Tibbetts, 2002 Proc R Soc B

How do wasps use individual recognition?

Identify all nestmates

How do wasps use individual recognition?

Interactions with competitors off nests

How do wasps use individual recognition?

Do wasps learn about individuals by observing contests?

Photo: Marlin

Transitive inference

John stronger than Sally

Sally stronger than Pete

Is John stronger or weaker than Pete?

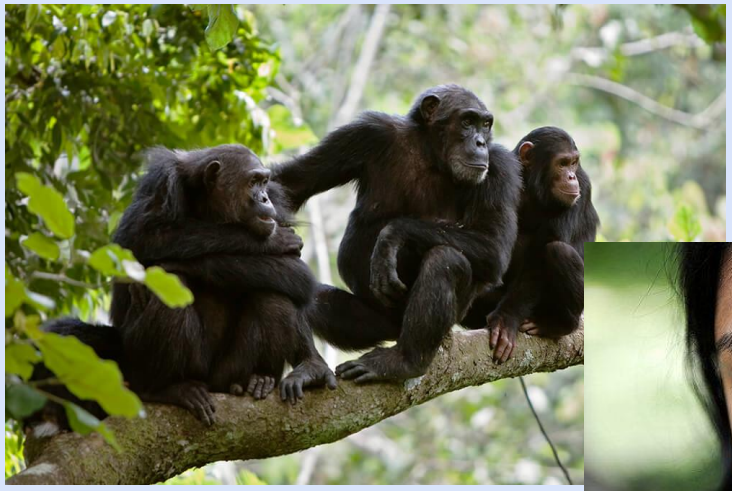
Transitive inference

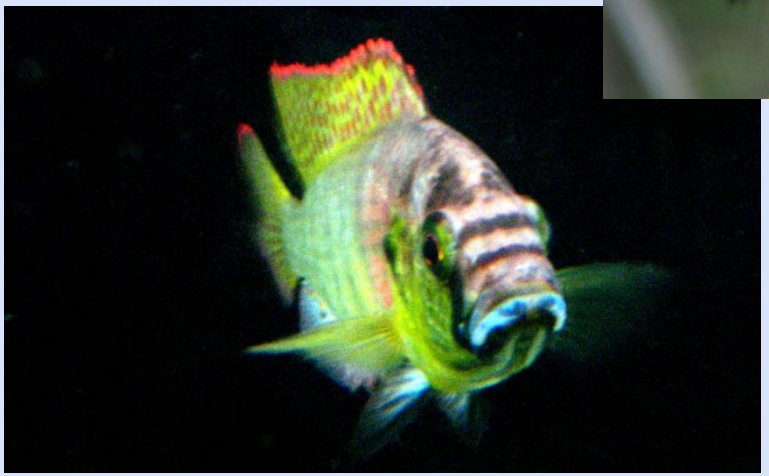
John stronger than Sally

Sally stronger than Pete

John stronger than Pete.

Transitive inference





Bond et al 2004 Nature; Grosnick et al. 2007 Nature; Gazes et. al 2012 J Exp Phys

Bees fail transitive inference tests

Bernard & Guirfa, 2004

Testing transitive inference

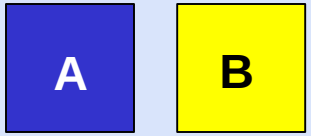
A > B, B > C, C > D, D > E

B vs D

Testing transitive inference

A > B, B > C, C > D, D > E

B vs D



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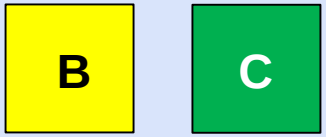

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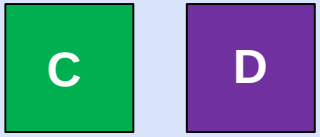

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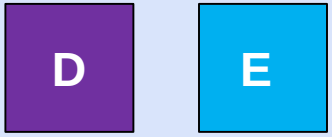

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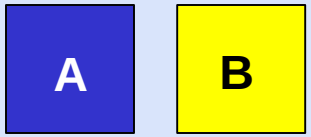
Testing transitive inference

A > B, B > C, C > D, D > E

B vs D



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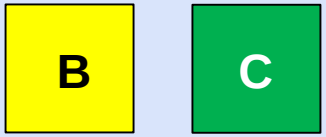

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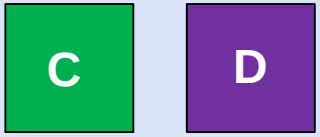

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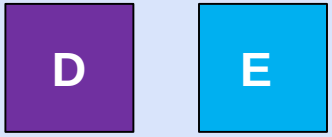

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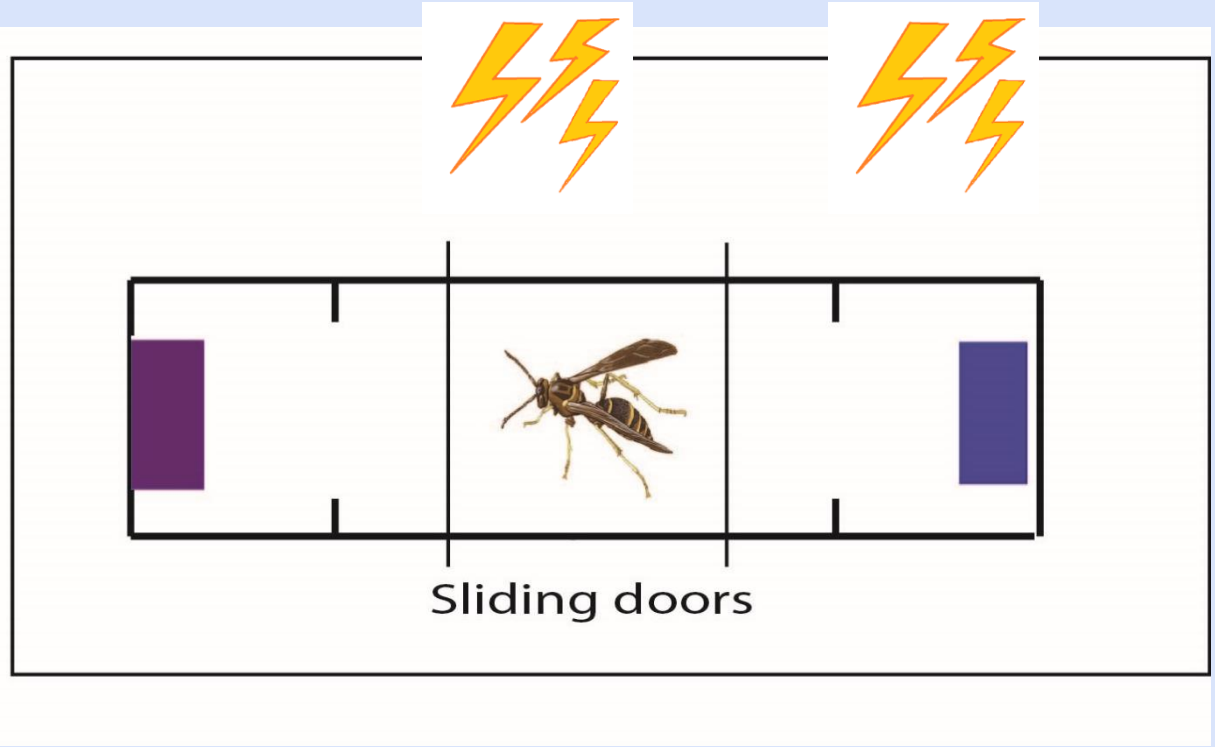
1. Learn 4 premise pairs
2. Remember 4 premise pairs for the whole experiment
3. Choose B over D

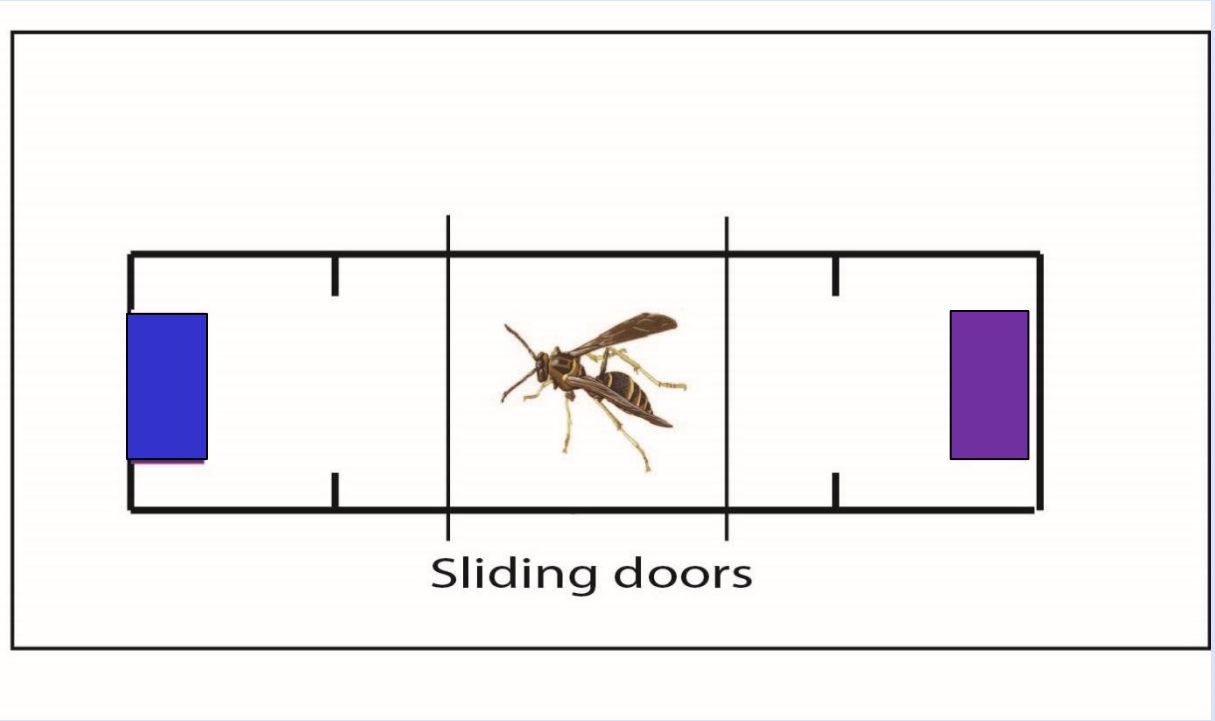


Trained with shock for 6 30sec trials

Jessica Riojas

Jorge Agudelo

Sohini Pandit



Trained with shock for 6 30sec trials

Tested without shock for 10 trials

Jessica Riojas

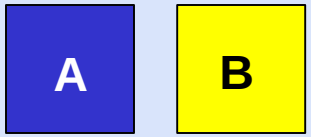
Jorge Agudelo

Sohini Pandit

Testing transitive inference

A > B, B > C, C > D, D > E

B > D



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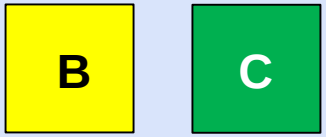

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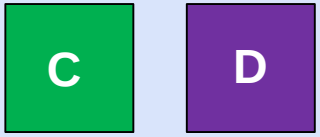

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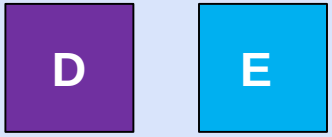

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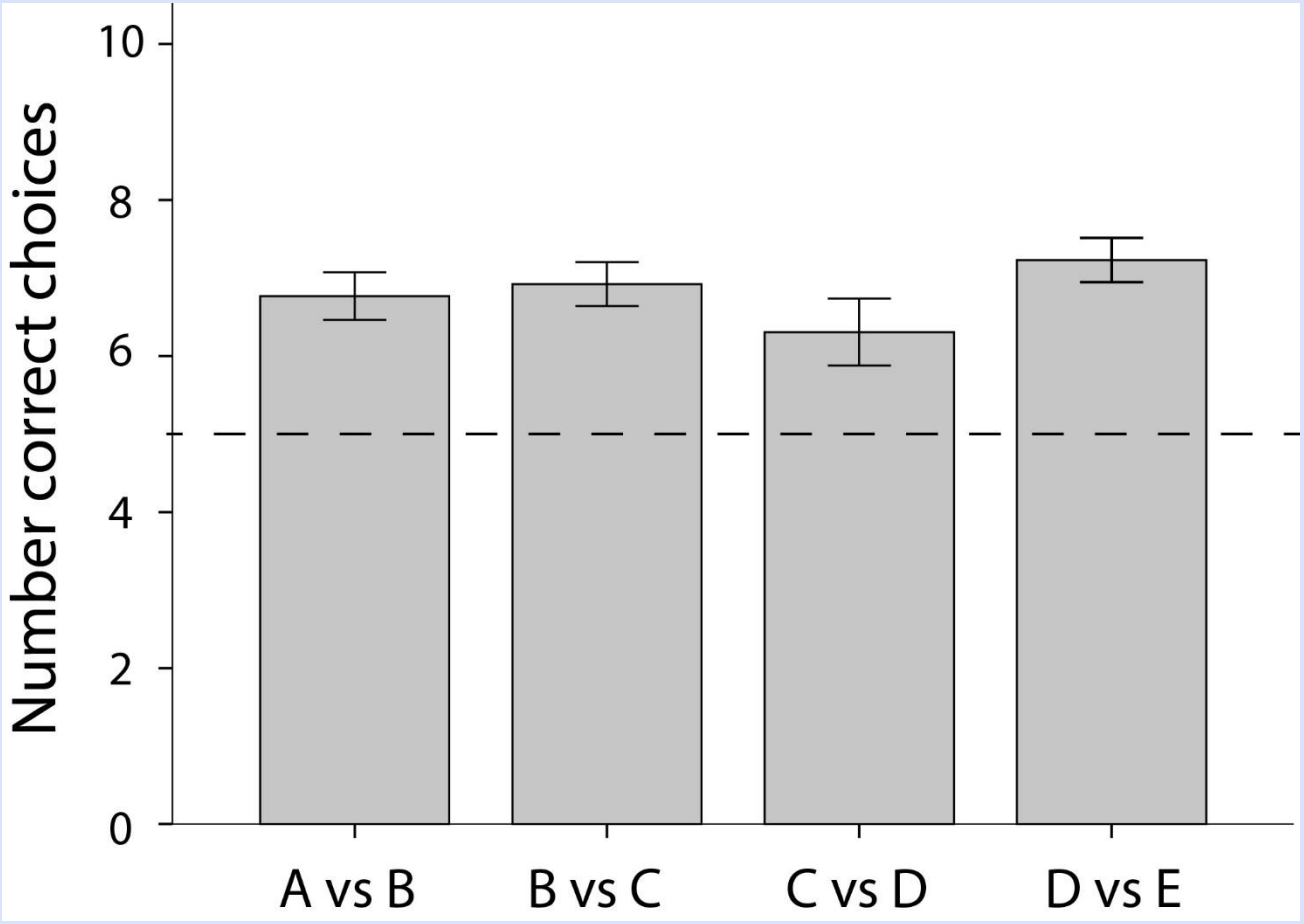
Wasps learned to discriminate all 4 pairs of colors

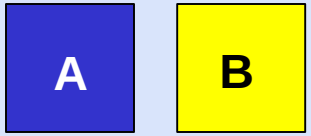


All $p<0.01$, $n=26$

Testing transitive inference

A > B, B > C, C > D, D > E

B > D



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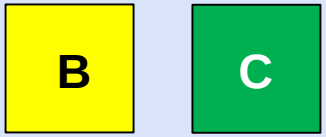

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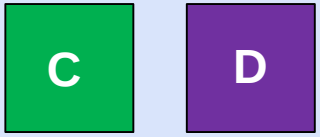

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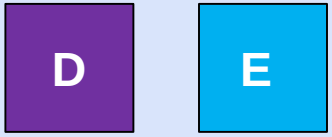

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1. Learn 4 premise pairs
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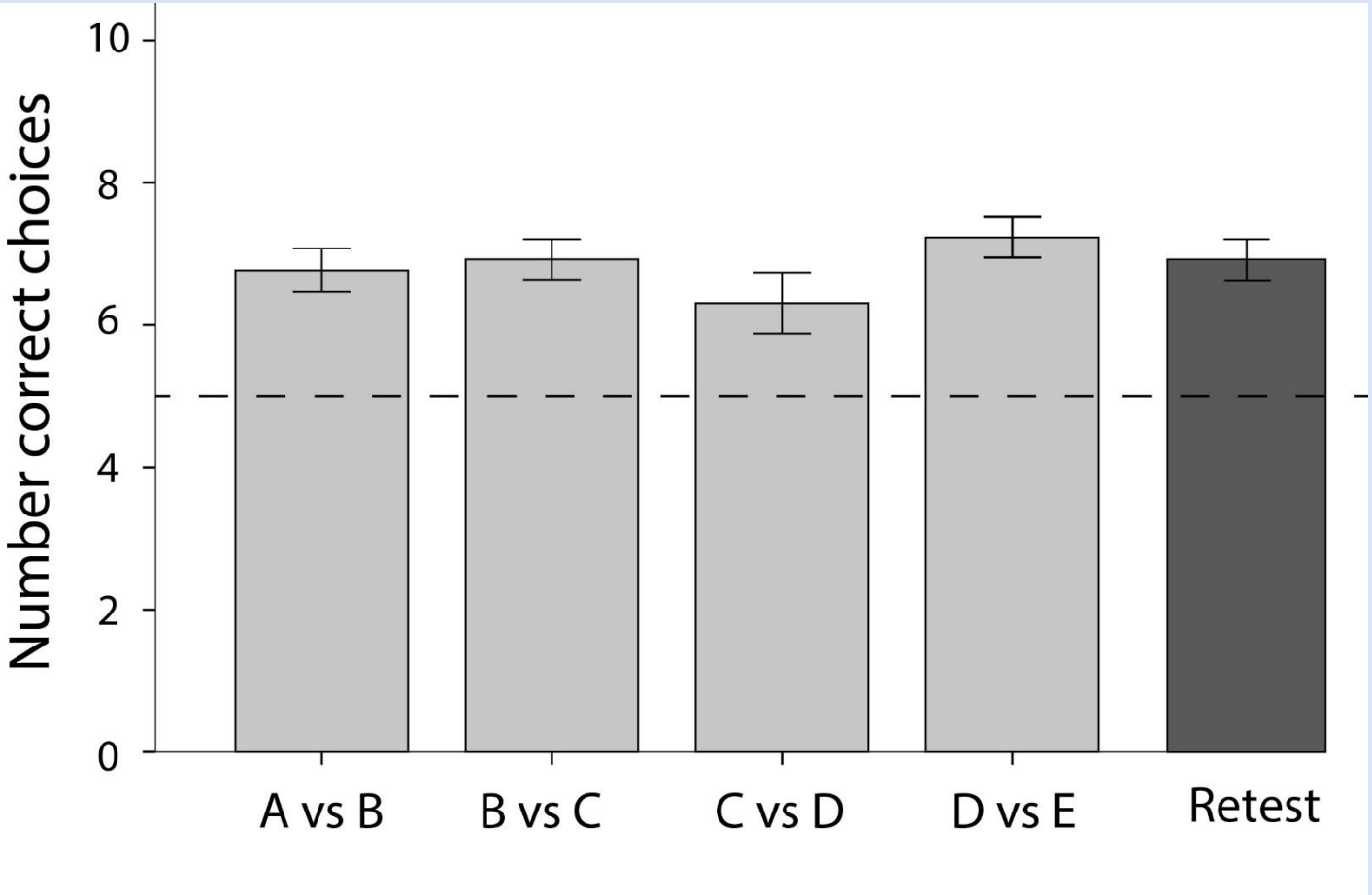
3. Choose B over D

Wasps remembered the first color pair at the end of the experiment



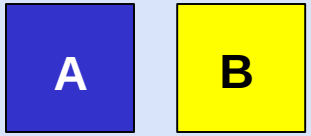
All $p<0.01$, n=26

Tibbetts et al 2019 Biology Letters

Testing transitive inference

A > B, B > C, C > D, D > E

B > D



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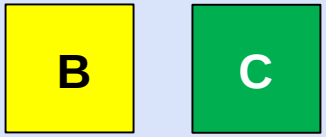

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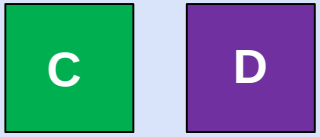

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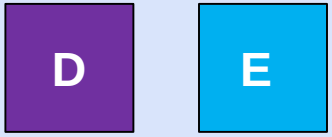

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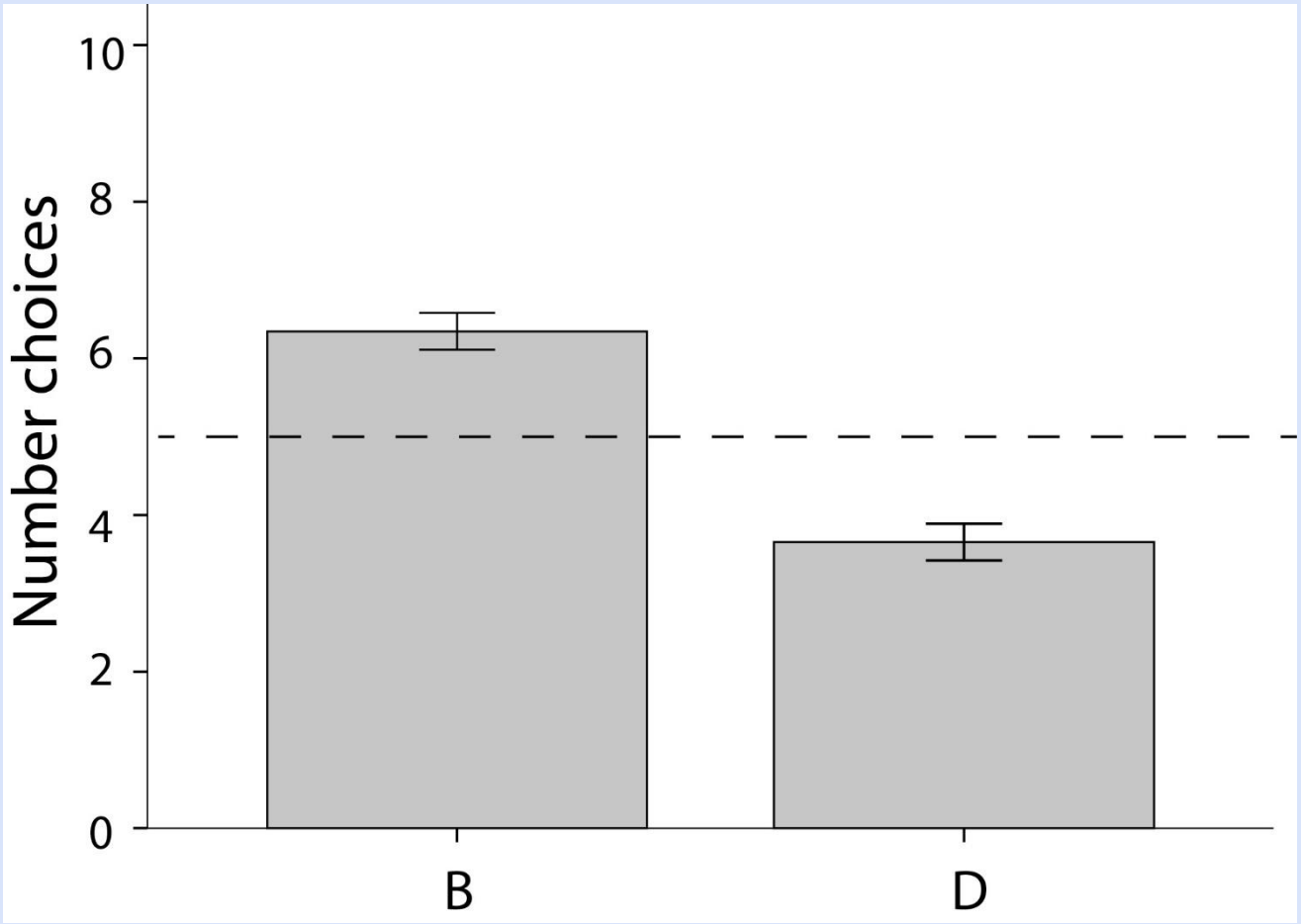
1. ✓ Learn 4 premise pairs
2. ✓ Remember 4 premise pairs for the whole experiment
3. Choose B over D

Wasps performed better than chance on the untrained, inferential pair



P=0.002, n=26

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Transitive inference may be common in species with linear dominance hierarchies

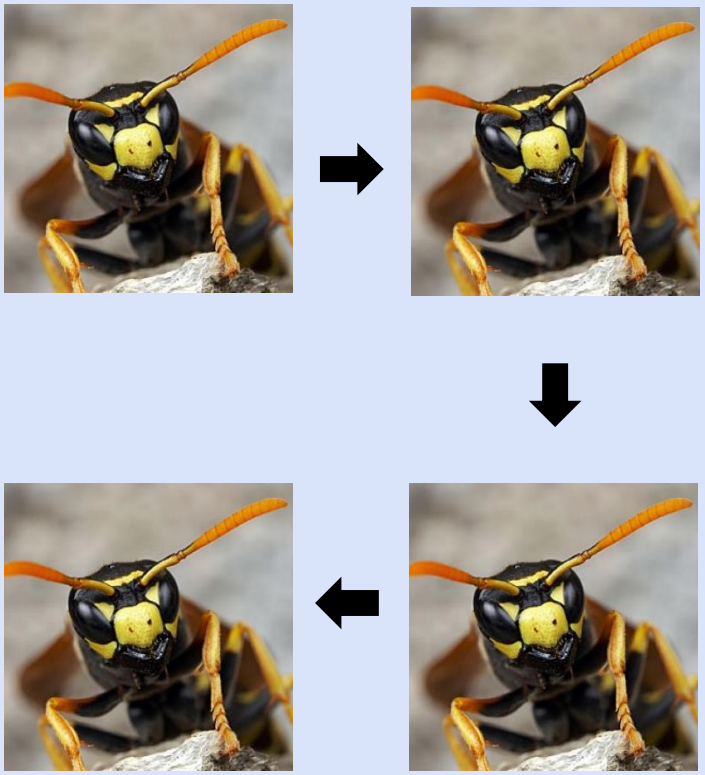
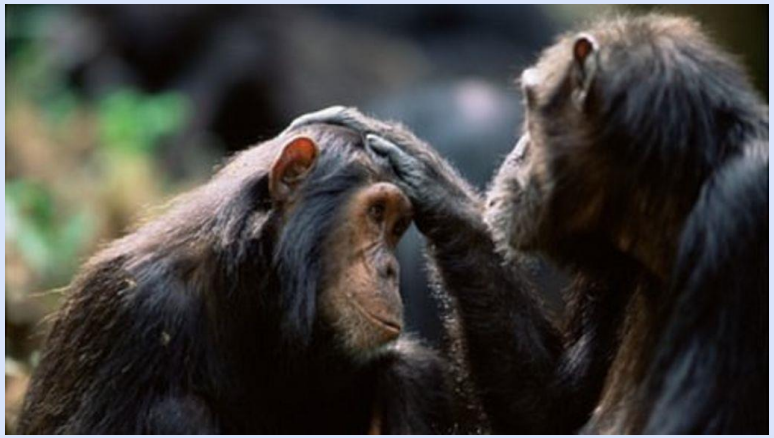


Photo: Tanya Pennell

Social Intelligence Hypothesis:

Individually differentiated social relationships = smart animals?



Social Intelligence Hypothesis:

Individually differentiated social relationships = smart animals?

Does learning and memory evolve in a specialized or generalized manner?

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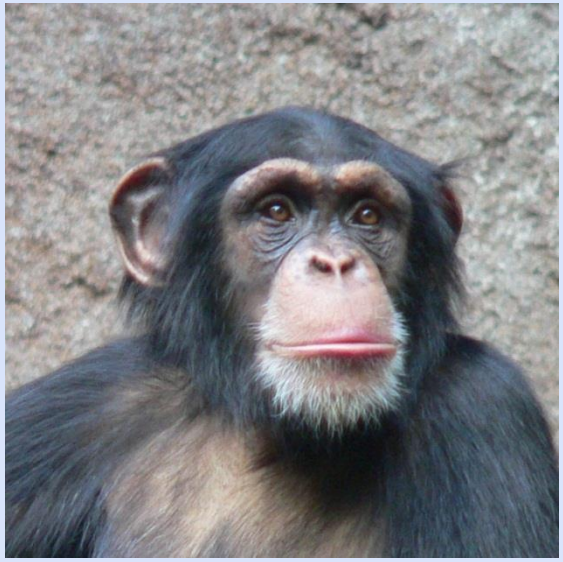


Primates with individual face recognition are specialized for face learning

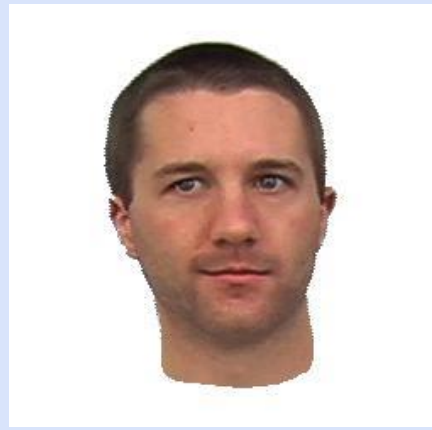














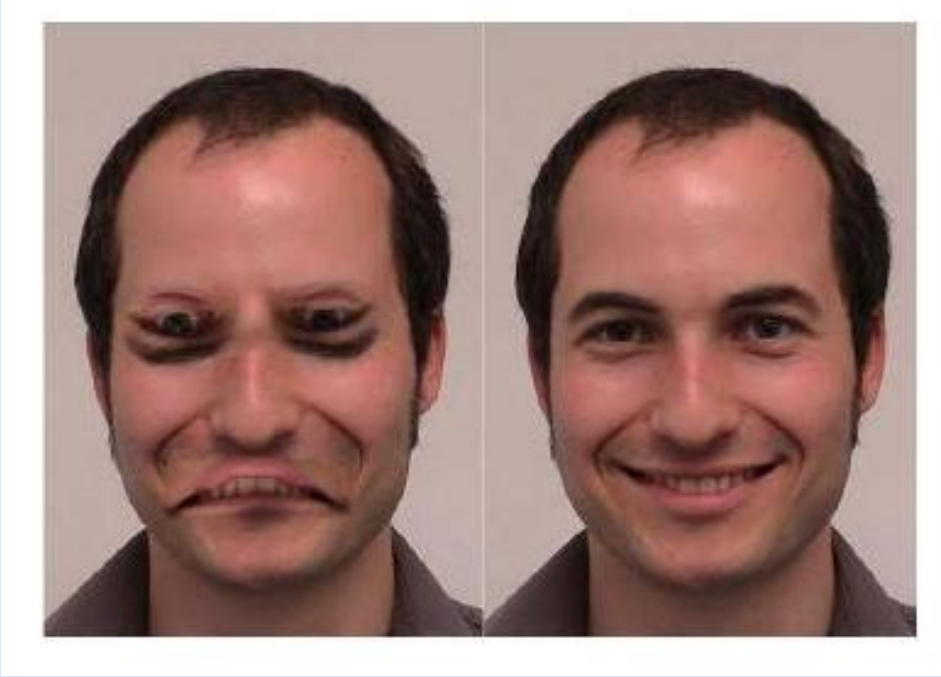




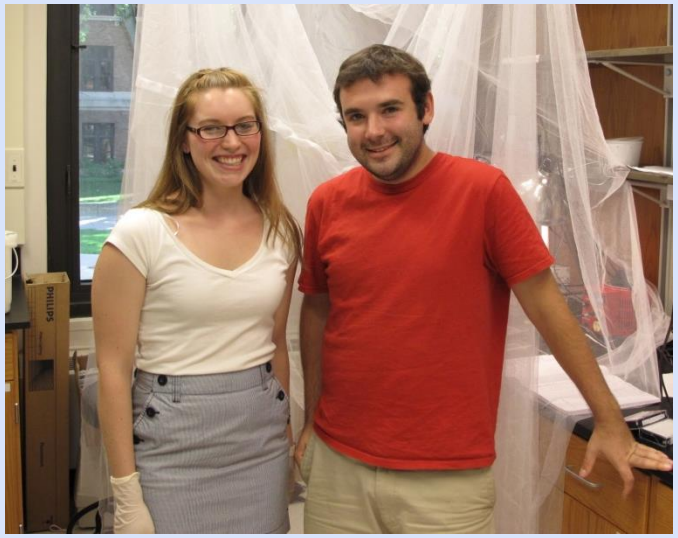








Are *P. fuscatus* foundresses specialized for face learning?



If *P. fuscatus* are specialized for face learning:

- Individuals will learn faces better than other visual stimuli.

Sheehan & Tibbetts, 2011 Science

Are *P. fuscatus* foundresses specialized for face learning?

If *P. fuscatus* are specialized for face learning:

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  - Non-face patterns

Sheehan & Tibbetts, 2011 Science

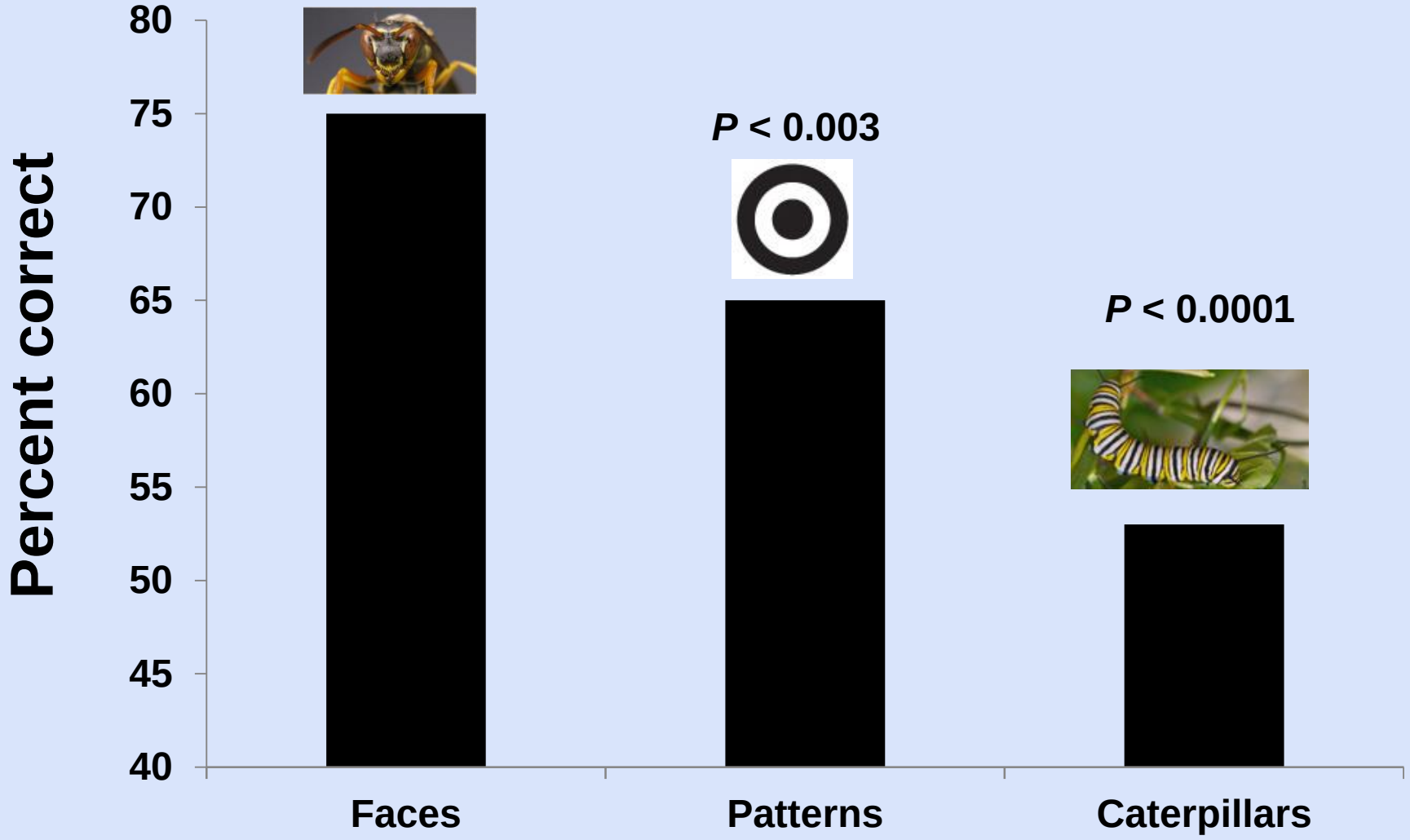
Are *P. fuscatus* foundresses specialized for face learning?

If *P. fuscatus* are specialized for face learning:

- Individuals will learn faces better than other visual stimuli.
  - Non-face patterns
  - Manipulated faces

Sheehan & Tibbetts, 2011 Science

P. fuscatus learn conspecific faces more quickly and accurately than non-face patterns



Sheehan & Tibbetts, 2011 Science

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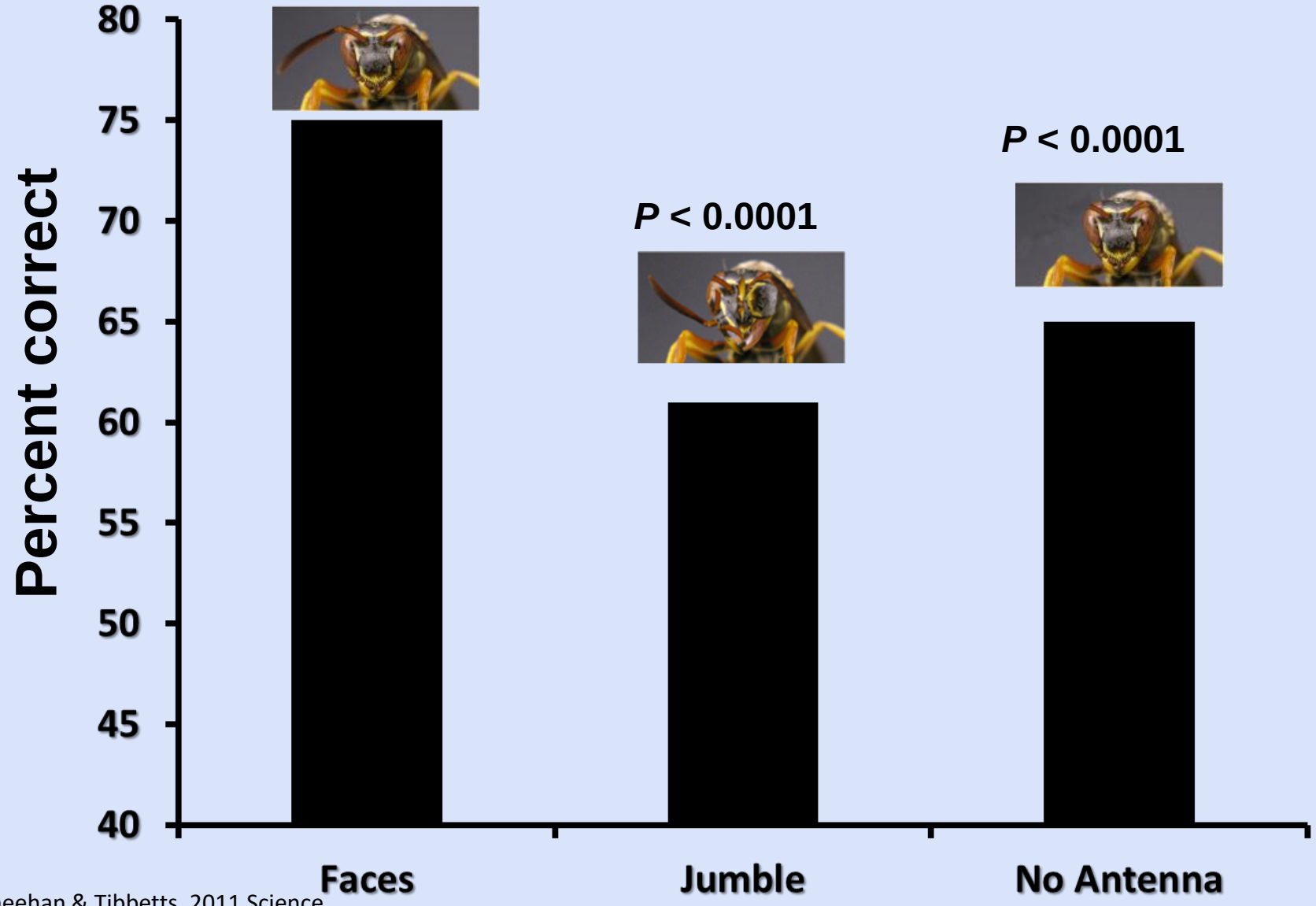


Sheehan & Tibbetts, 2011 Science

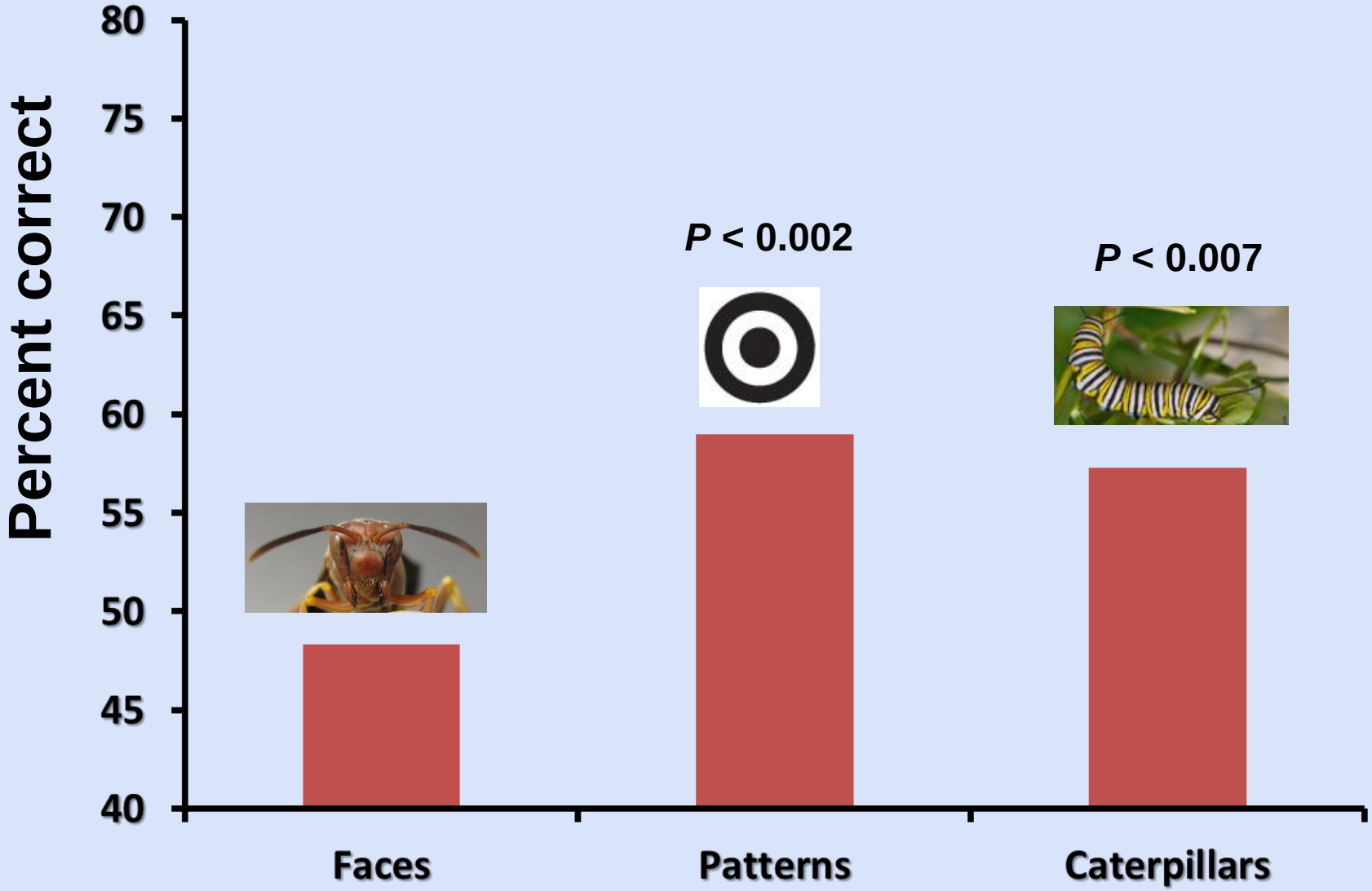
Do species without face recognition also lack specialization for face learning?

If the requirements of individual recognition have selected for specialized face learning:

-Species that lack individual recognition will lack specialization for face learning.

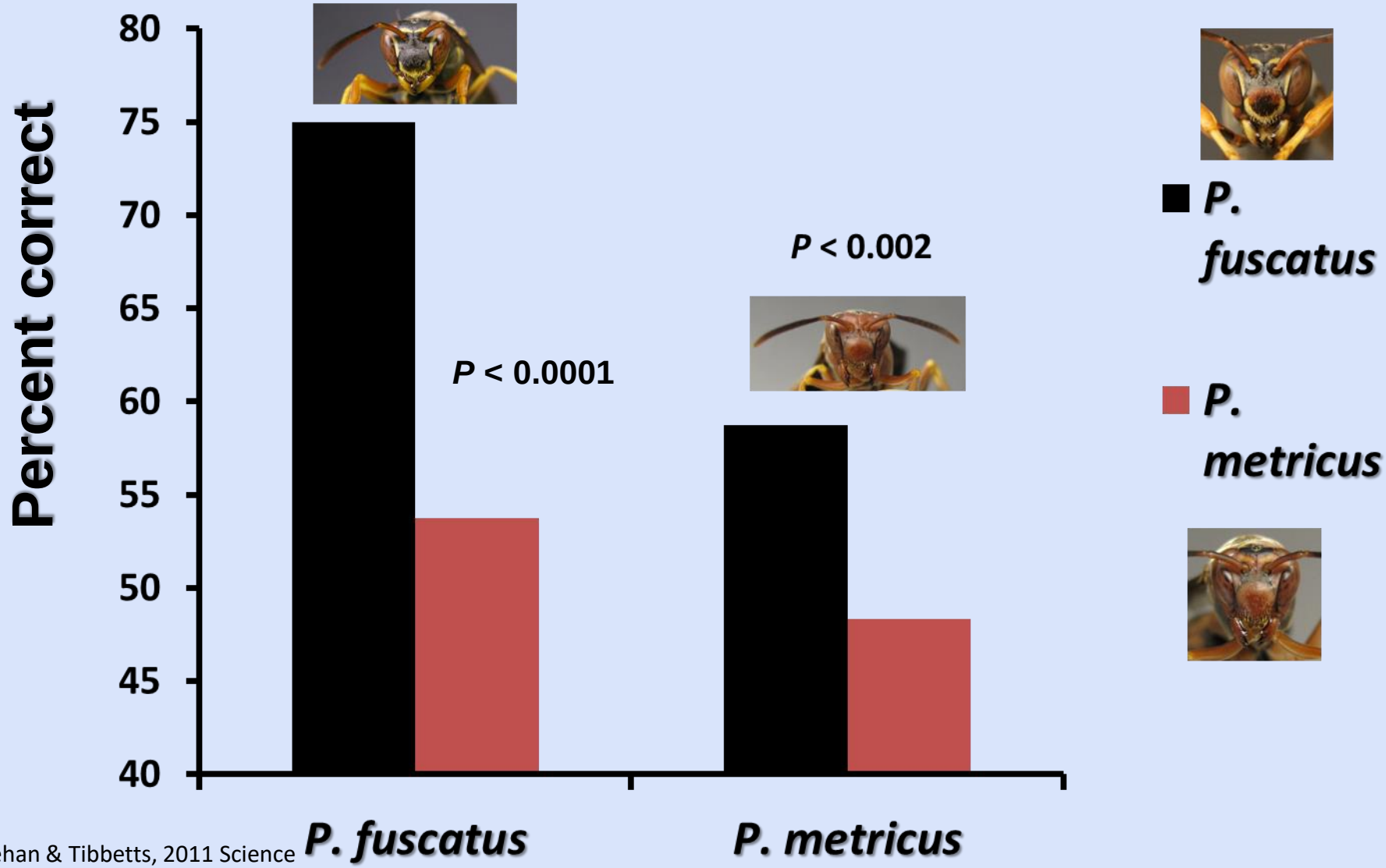
Sheehan & Tibbetts, 2011 Science

P. metricus learn faces less quickly and accurately than non face patterns



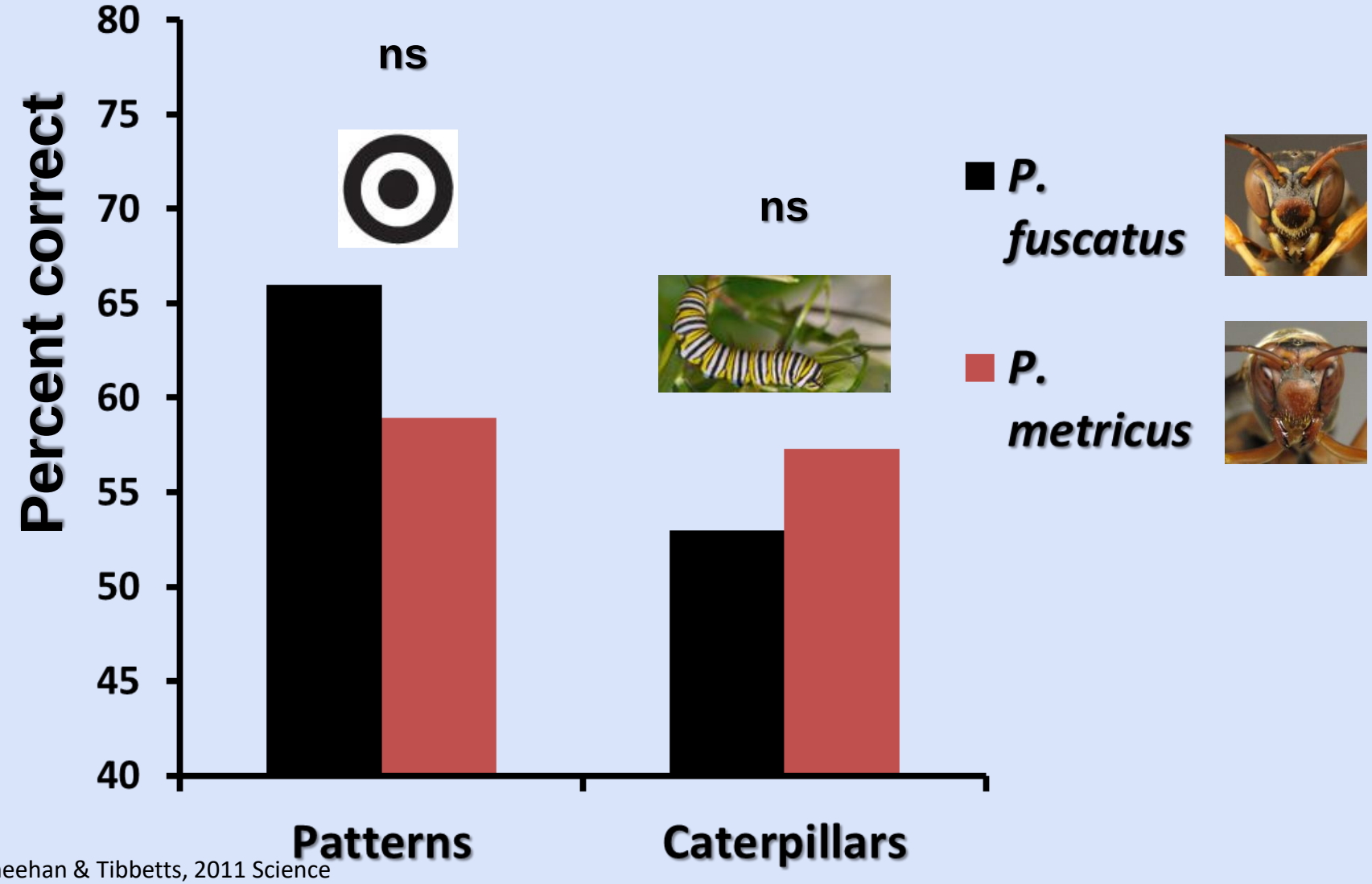
Sheehan & Tibbetts, 2011 Science

P. fuscatus learn both species' faces better than *P. metricus*



Sheehan & Tibbetts, 2011 Science

There is no difference in general learning ability



Sheehan & Tibbetts, 2011 Science

The challenge of individual recognition has shaped cognitive evolution in paper wasps largely via specialization.

Sheehan & Tibbetts, 2011 Science

Thanks!

<u>Graduate students:</u>
Christian Cely
Katherine Crocker
Emily Laub
Meagan Simmons
Michelle Fearon
Amanda Izzo
Mike Sheehan

Many undergraduates

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IOS-1146139