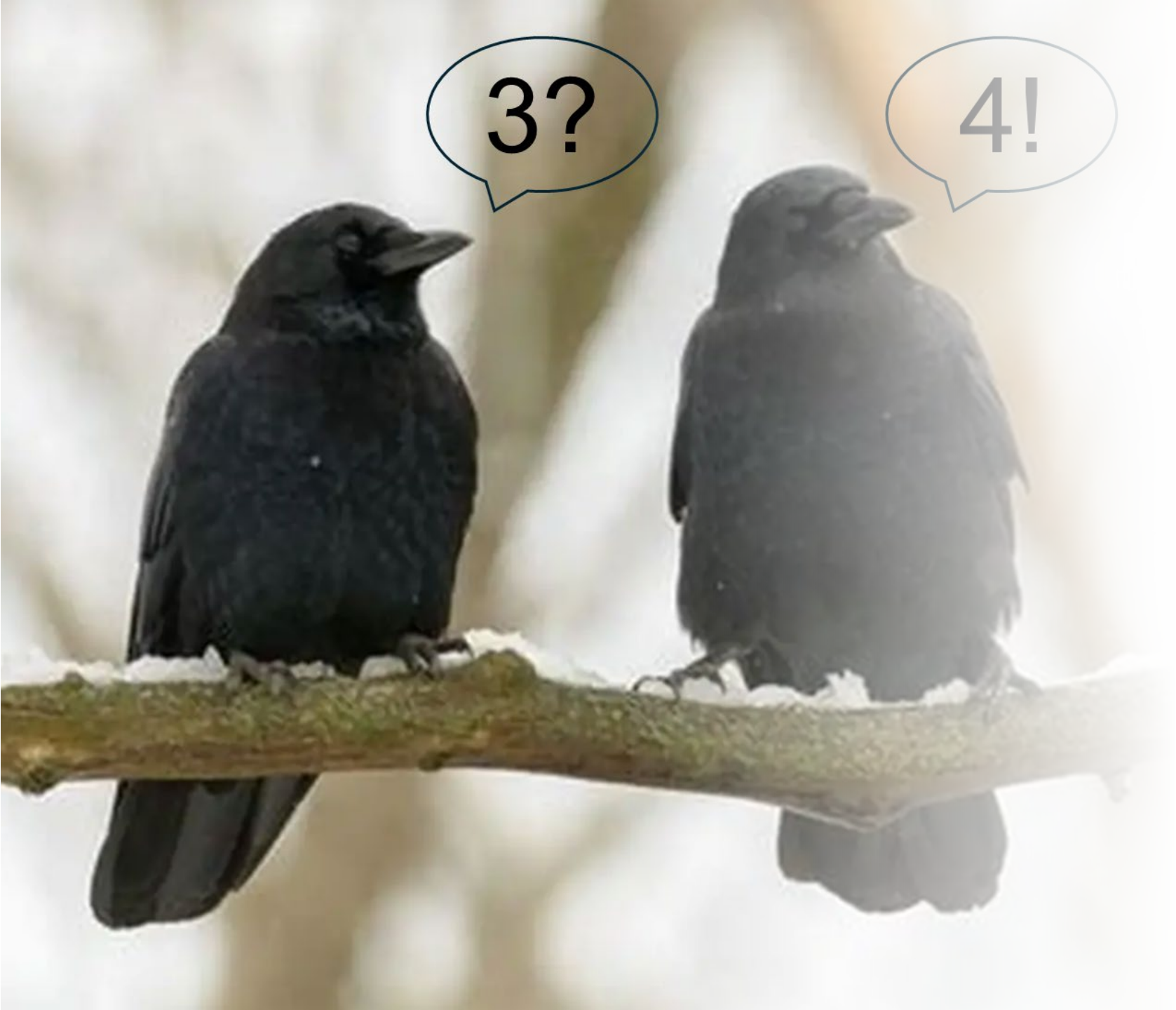


Can crows really

COUNT?

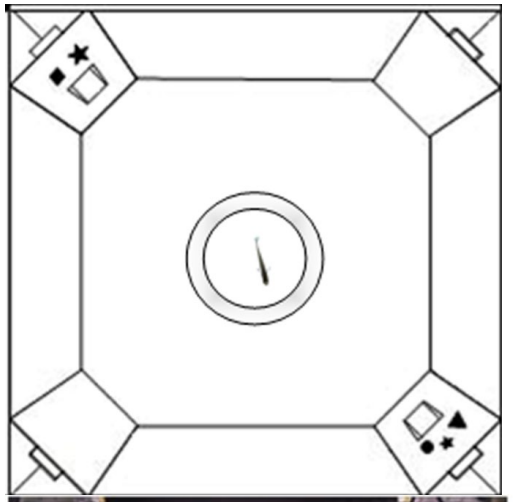
Baohua Chen

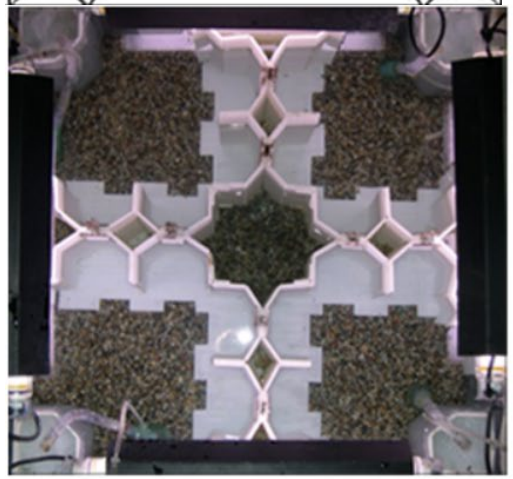
05/07/25

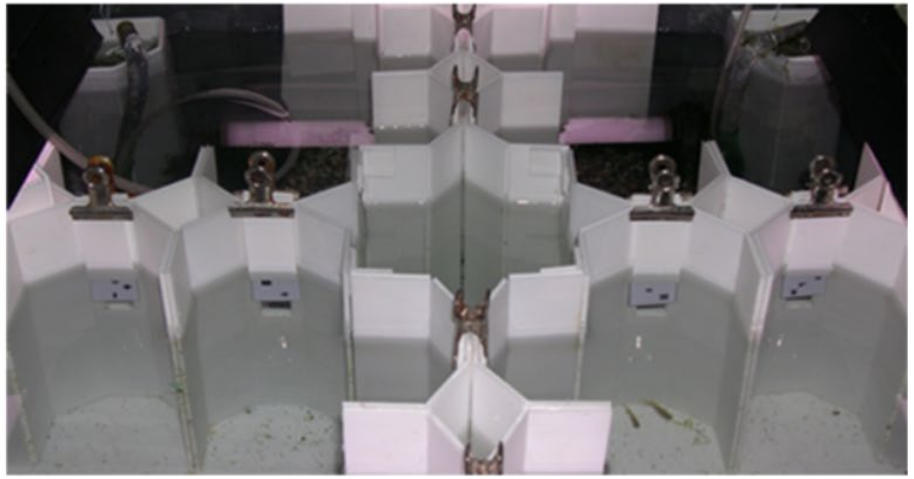
Counting is difficult

Age	Ability	Numerical awareness
1	Walk independently	More and less
2	Hum simple melodies	
3	Speak sentences	Recites number words in order
4	Count objects	Understands number meanings

Many animals know “much” and “less”, but not numbers

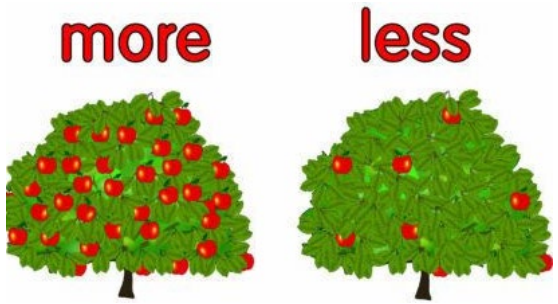






(Christian, 2009)

How to exam whether fish know “more and “less”?



VS

Science

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RESEARCH ARTICLE | COMPARATIVE BEHAVIOR

Crows "count" the number of self-generated vocalizations

EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN

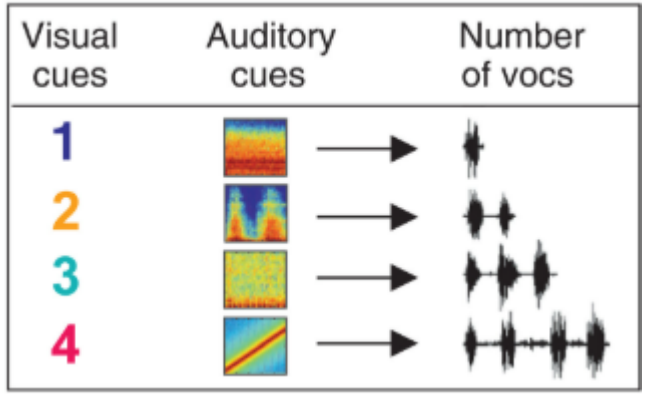
Diana A. Liao

Andreas Nieder

Training a crow two identify numeric cues

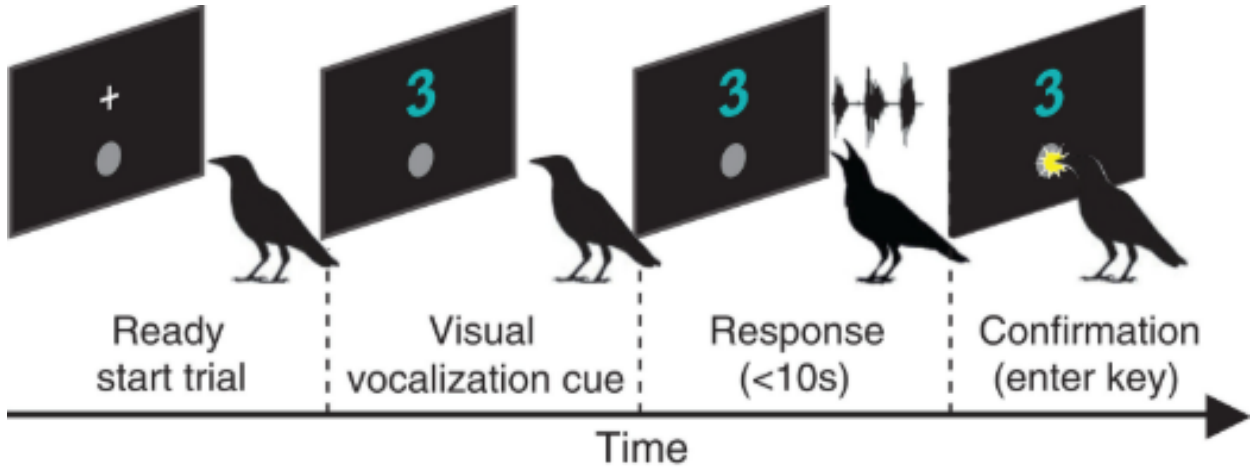
Three crows were trained by both visual and auditory cues

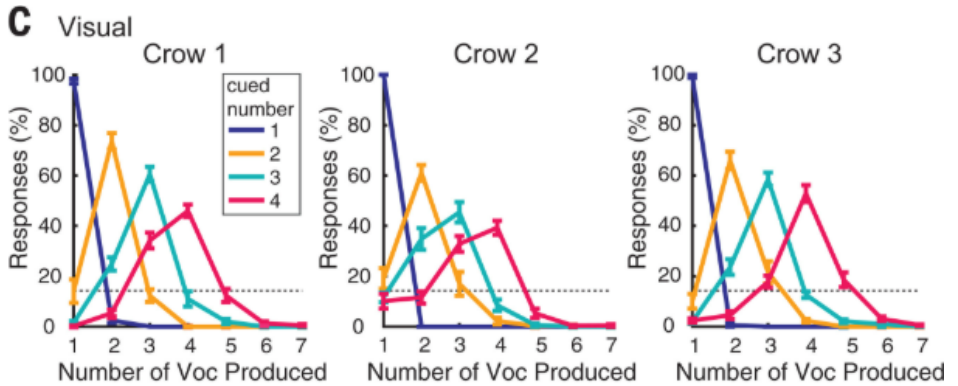
Two types of cues

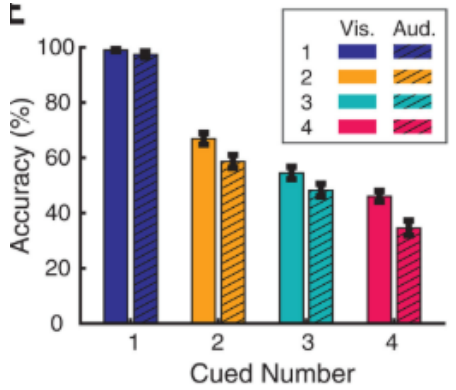


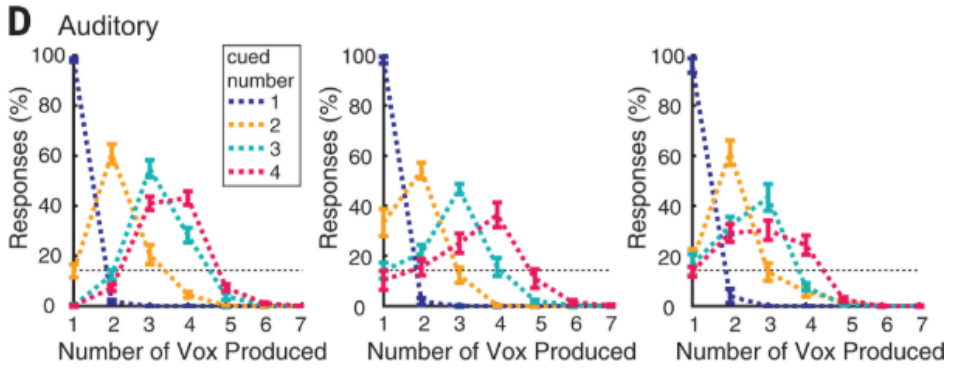
Thousands-of-trials training

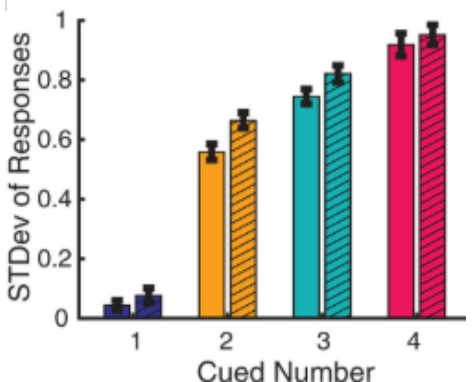
Examination (100-300 trials for each crow and each type of cues)











Reactive behaviors or Planned behaviors?

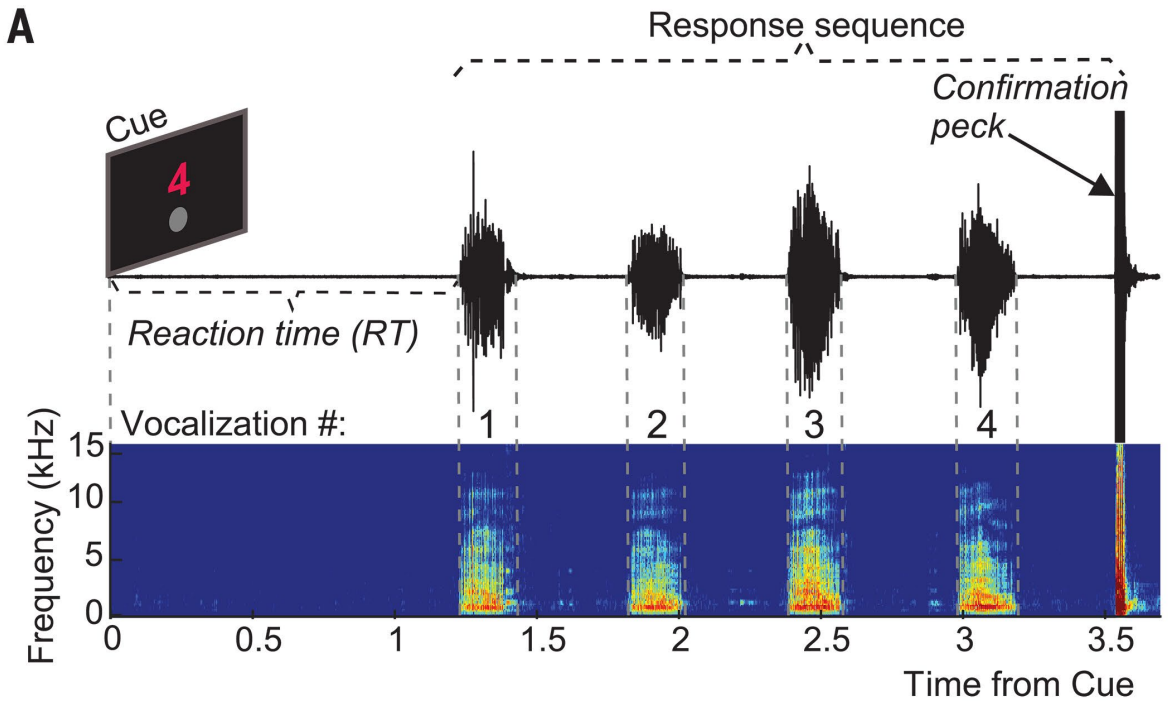
Reactive behaviors

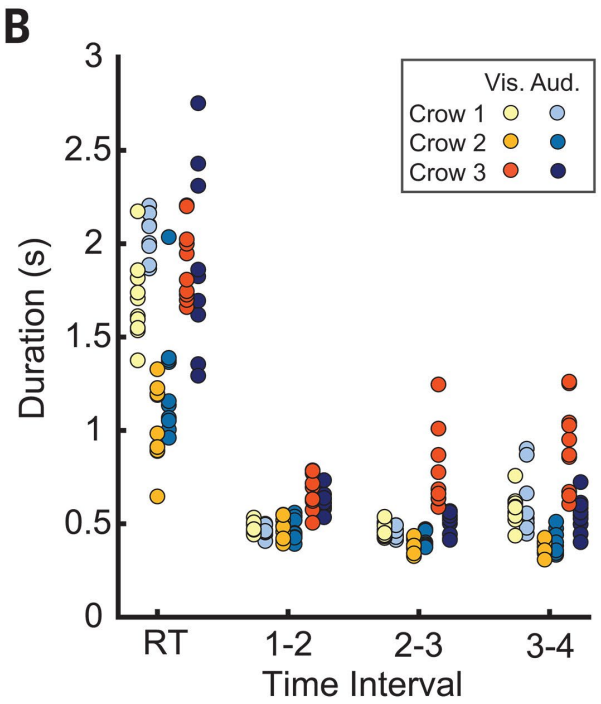
(conditional reflex)

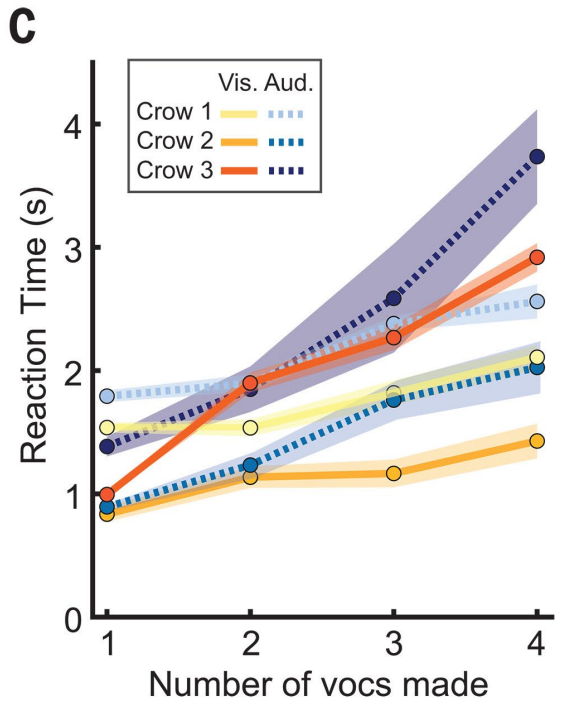
VS

Planned behaviors

(intentional action)

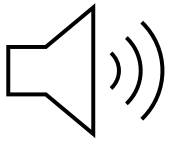






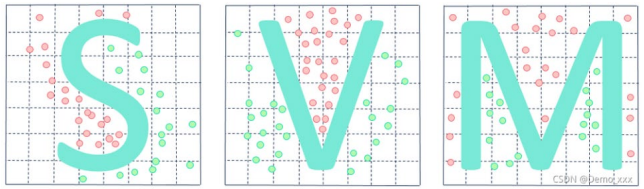
Predict the number of calls by the first call

23 acoustic features of the first call

- Duration 
- Tone 
- Loudness 
- Spectrum 
- Other features 

Supervised machine learning

Classifier (分类器)



Support Vector Machine

Total number of calls

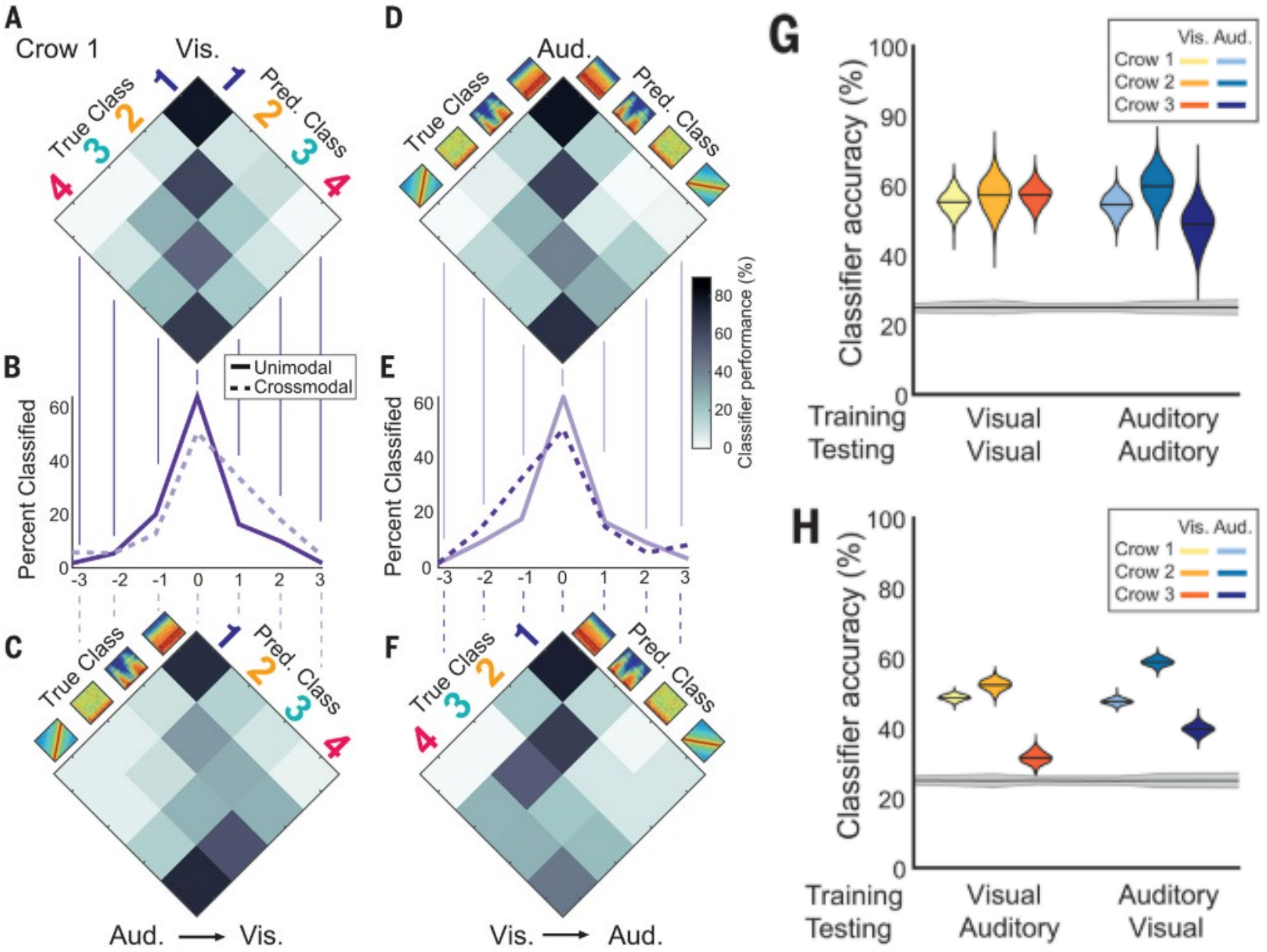
1

2

3

4

Predict the number of calls by the first call



Unimodal prediction

A&D: Predict accuracy of SVMs

G: Average accuracy of SVMs

B: Deviation of predicted number

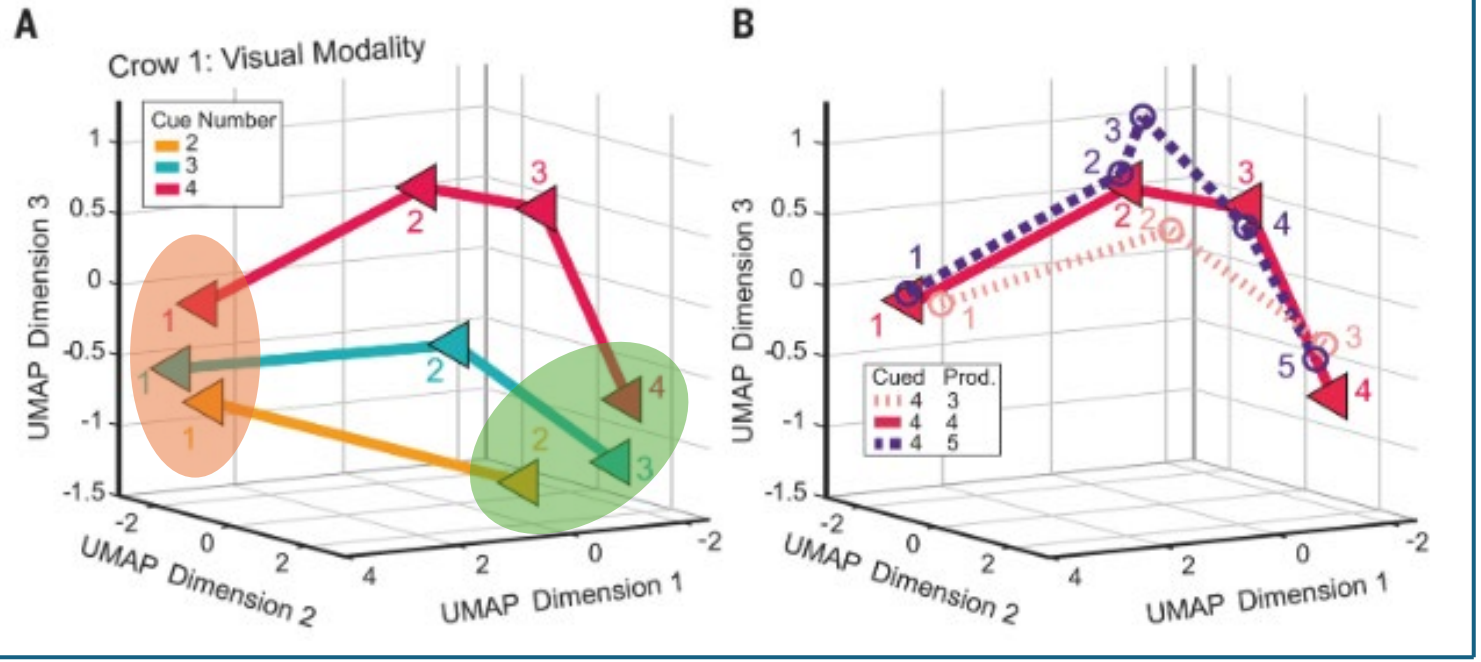
Cross-modal prediction

C&F: Predict accuracy of SVMs

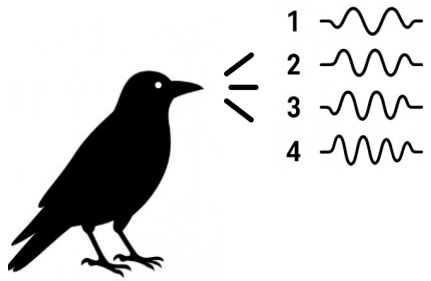
H: Average accuracy of SVMs

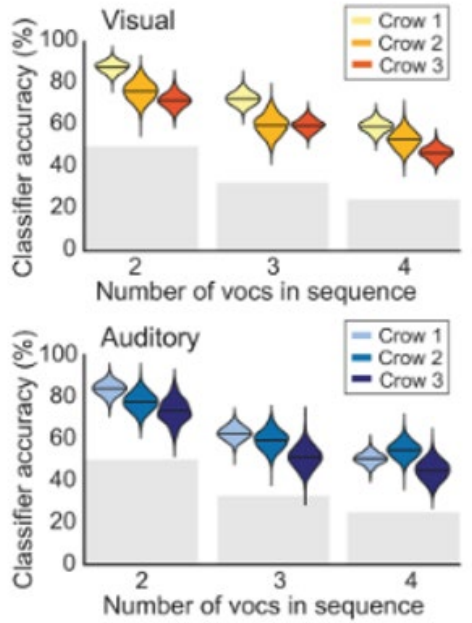
E: Deviation of predicted number

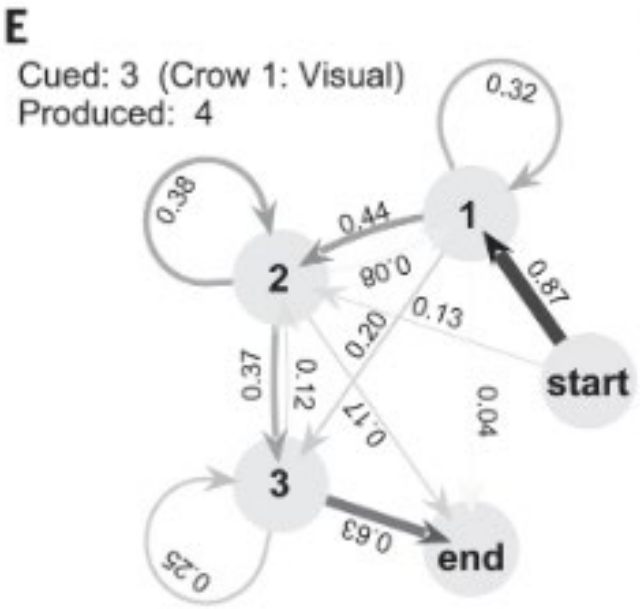
Why and how crows made mistakes?

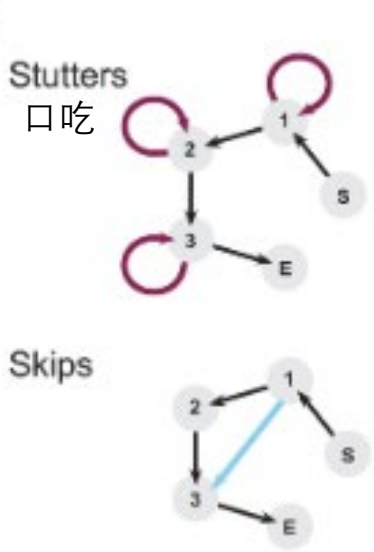


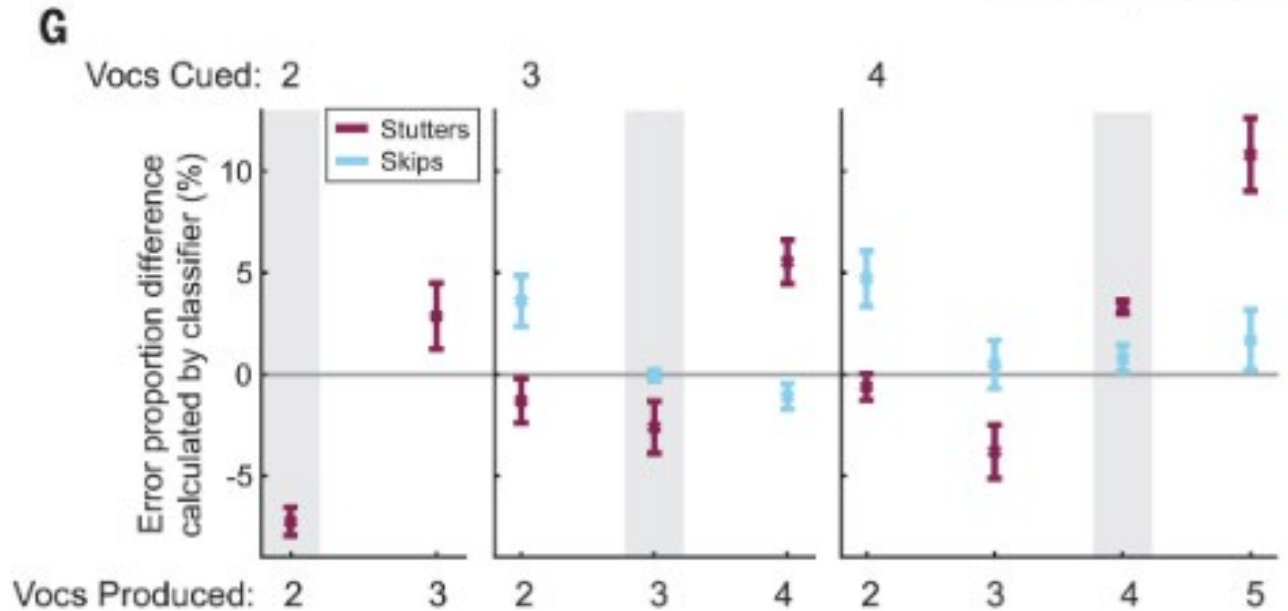
A new SVM to distinguish different calls











Very simple discussion

1. Crows can deliberately produce instructed numbers of vocalizations

    a. Behavior guided by **approximate number system** (ANS), which is shared by human, primates, bees, angel fish, and zebrafish

    b. (**Not mentioned in this article**) However, most of animals can only use the ANS to distinguish “more” and “less”. Real counting are only found in human, primates, and bees before

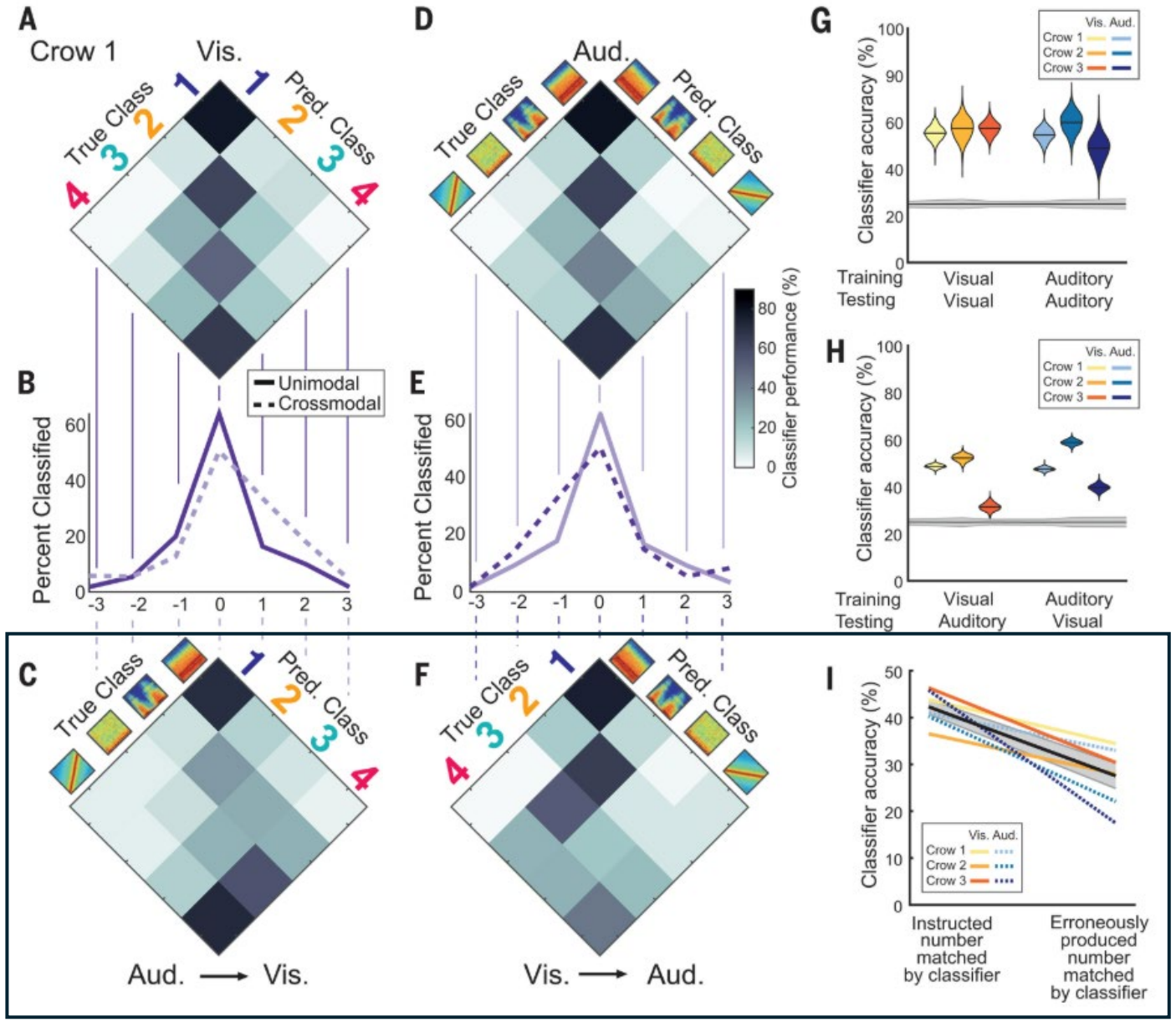
    c. Vocal response requires **longer reaction time** (~1–2s) than pecks and head movements (hundreds of millisecond), implies that the counting of crows is a complex behaviors like primates and human

2. Neural Basis and Evolutionary Significance

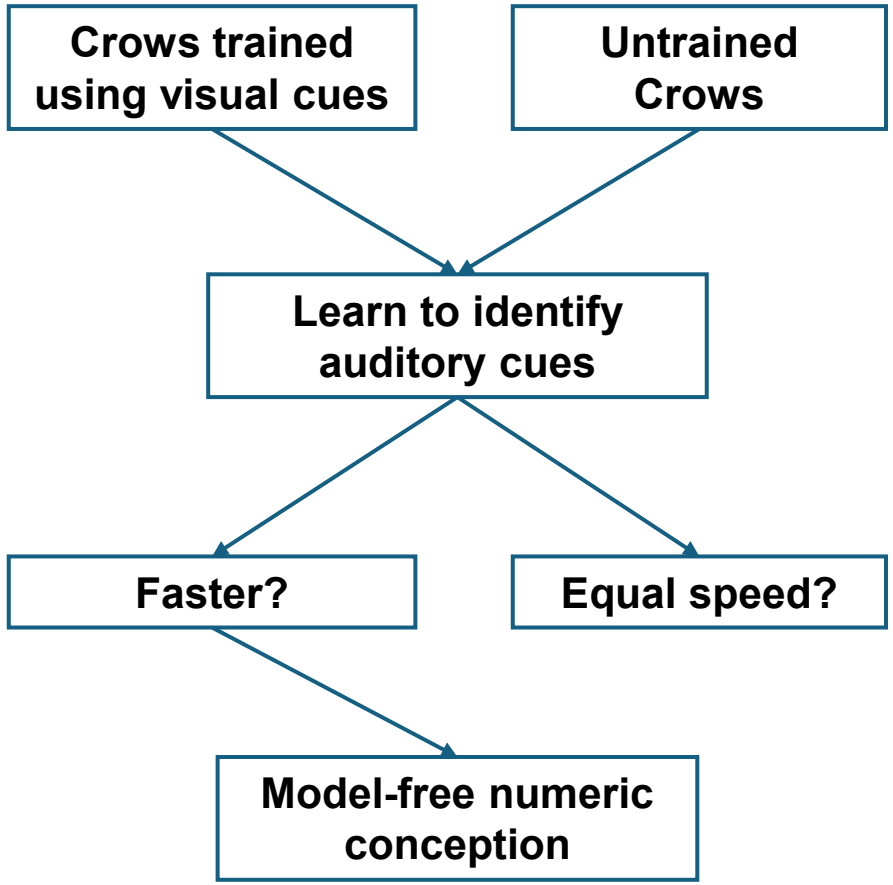
    a. Crows, like other songbirds, have song nuclei in their brains that control vocal repetition and support cognitive functions

    b. Better vocal learning in songbirds is associated with stronger problem-solving skills, suggesting overlap between communication and cognition systems

Omissions



Cross-modal transfer learning



Take home messages

Not only humans can count

We can design a very interesting experiment, and publish a *Science* without sequencing

Lunch is very important

Thanks for your attention!