



# A short introduction to cumulative cultural evolution (CCE)

Nicolas Claidière, CNRS

Laboratoire de Psychologie Cognitive

Aix-Marseille University, France

# Introduction to cumulative cultural evolution



Part 1: Definition and historical background

Part 2: Evidence for CCE in non-human animals

Part 3: The origin of CCE

# PART 1: DEFINITION AND HISTORICAL BACKGROUND



Gould, 1980

# What is cumulative cultural evolution?



*“If I have seen further it is by standing on the shoulders of Giants.”*

Isaac Newton, 1676

*“To be ignorant of what occurred before you were born is to remain for ever a child. For what is the value of a human life, unless it is woven into the life of our ancestors by the records of history?”*

Marcus Tullius Cicero, 106-43 BC

# Cumulative cultural evolution



Definition: *Cumulative cultural evolution is the gradual accumulation of cultural modifications.*

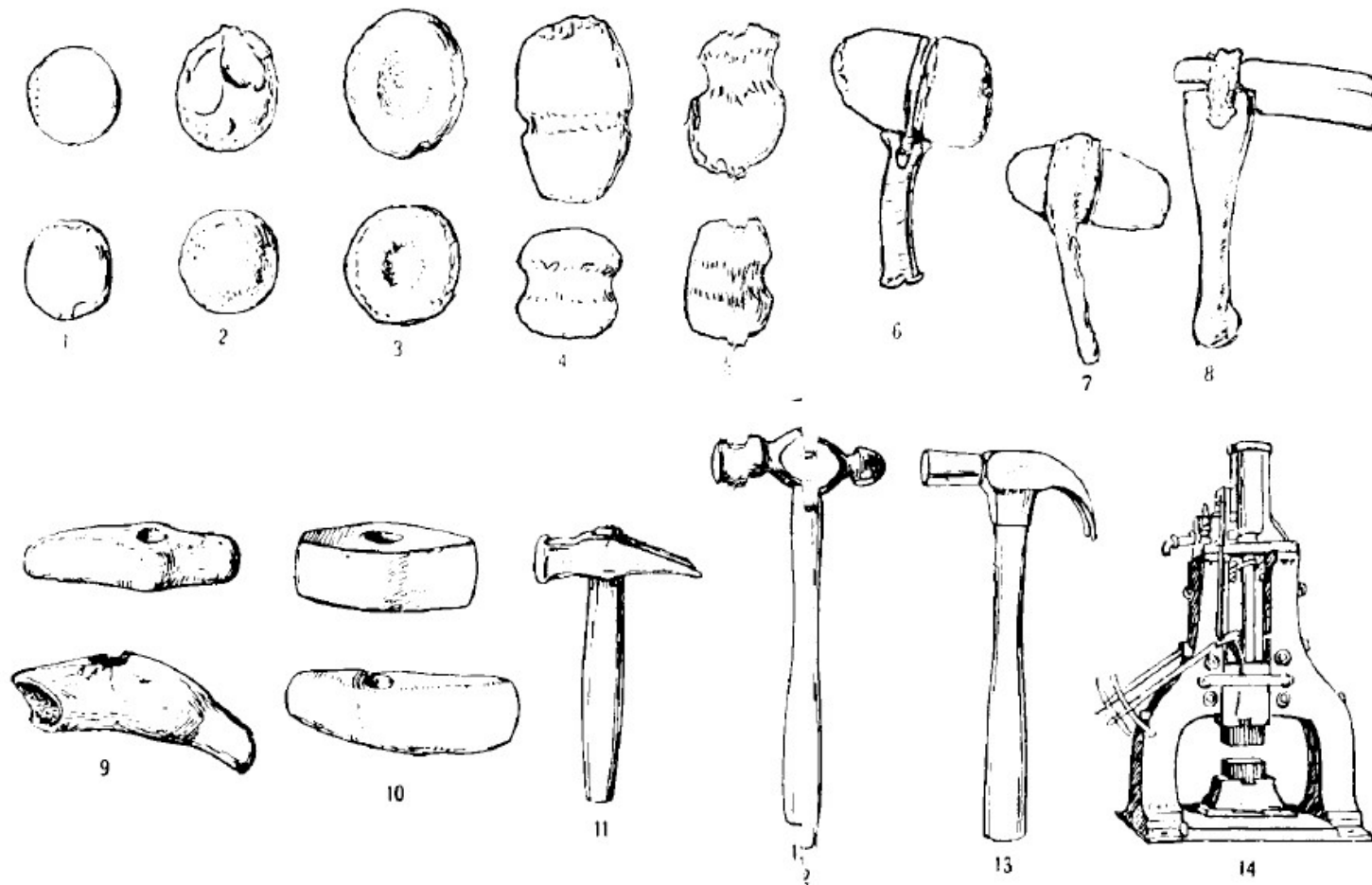
Tomasello, 1993,1996

*“the accumulation of knowledge and skills over generations”*

Caldwell & Millen 2008

Full discussion in Mesoudi and Thornton (2018). "What Is Cumulative Cultural Evolution?"

# Technological evolution



Basalla, 1988

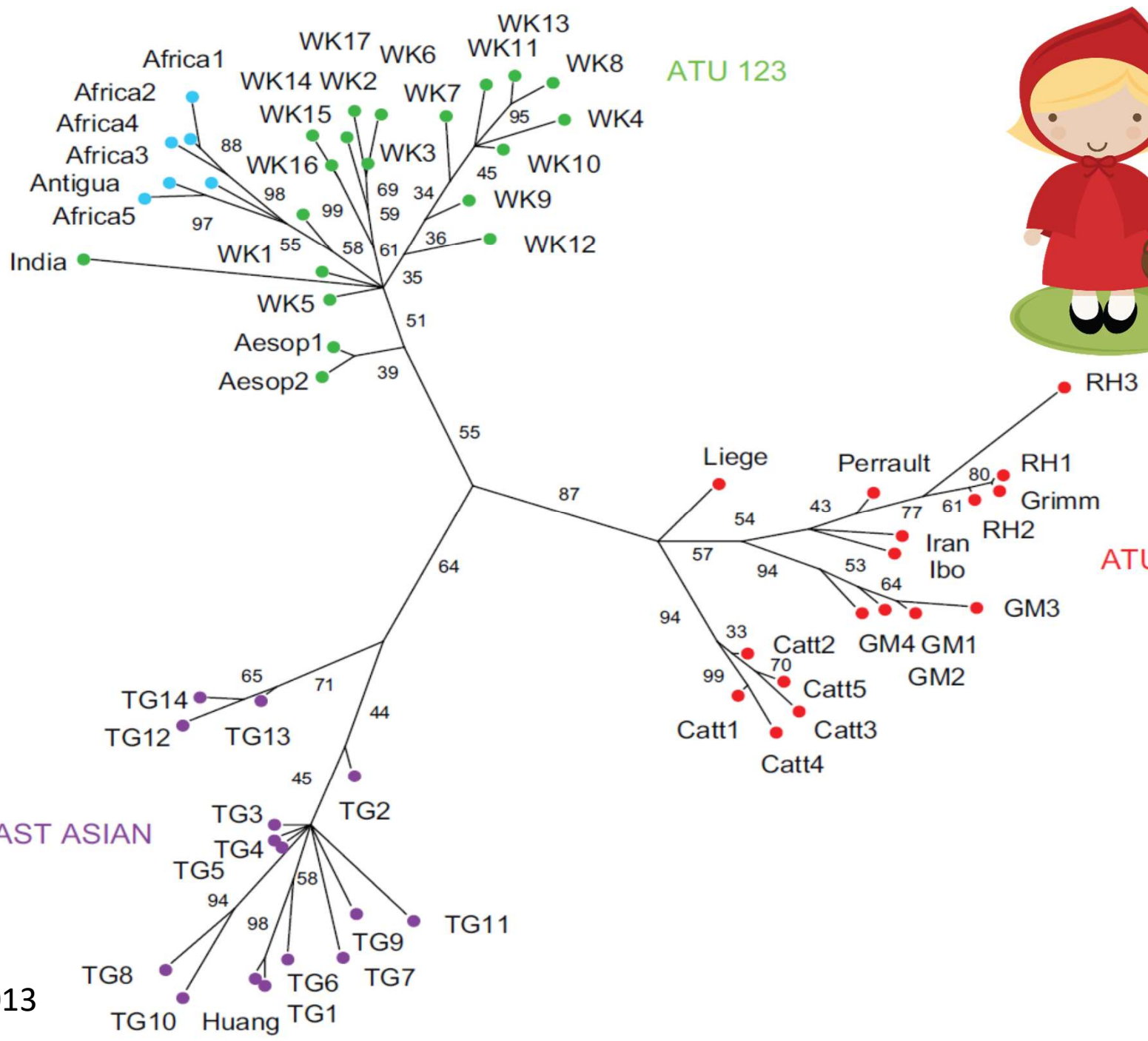
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AFRICAN

ATU 123



ATU 333



Tehrani 2013



Old Bellini  
(born c.1426)  
from 1500 to 1515

*averted  
gaze*



*direct  
gaze*

Young Titian  
(born c. 1485)  
from 1500 to 1540

*averted  
gaze*



*direct  
gaze*



Old Titian  
(born c. 1485)  
from 1540 to 1575

*averted  
gaze*



*direct  
gaze*



Tintoretto  
(born 1518)  
from 1540 to 1575

*averted  
gaze*



*direct  
gaze*





1. Medieval times (15<sup>th</sup> century): “Do not spit into the basin when you wash your hands, but beside it”
2. 16<sup>th</sup> century: “Turn away when spitting, lest your saliva fall on someone. If anything purulent falls on the ground, it should be trodden upon, lest it nauseate someone”.
3. 17<sup>th</sup> century: “Formerly it was permitted to spit on the ground before people of rank, and was sufficient to put one’s foot on the sputum. Today that is an indecency”.
4. 18<sup>th</sup> century: “When you are with well-born people, and when you are in places that are kept clean, it is polite to spit into your handkerchief while turning slightly aside”
5. 19<sup>th</sup> century: “Spitting is at all times a disgusting habit. I need say nothing more than – never indulge in it”

# Summary part 1



1. Cumulative cultural evolution is the gradual accumulation of cultural modifications.
2. Culture is made of:
  - Ideas (e.g. norms)
  - Behaviours (e.g. telling stories)
  - Objects (e.g. paintings)
3. In humans, CCE is widespread

## Is CCE also common in non-human animals?



Boyd and Richerson (1996), *Why culture is common, but cultural evolution is rare.*

*“There are only a few well documented cases in which cultural change accumulates over many generations leading to the evolution of behaviors that no individual could invent—the only well documented examples are song dialects in birds, perhaps some behaviors in chimpanzees, and, of course many aspects of human behavior”*



## **PART 2: EVIDENCE OF CCE IN NON-HUMAN ANIMALS**

# Where shall we look for CCE in animals?



- Chimpanzee nut cracking
- Evidence of nut cracking for thousands of years at the same site\*
- Yet, no evidence of change



\* Mercader, Panger, & Boesch (2002); Mercader et al. (2007)

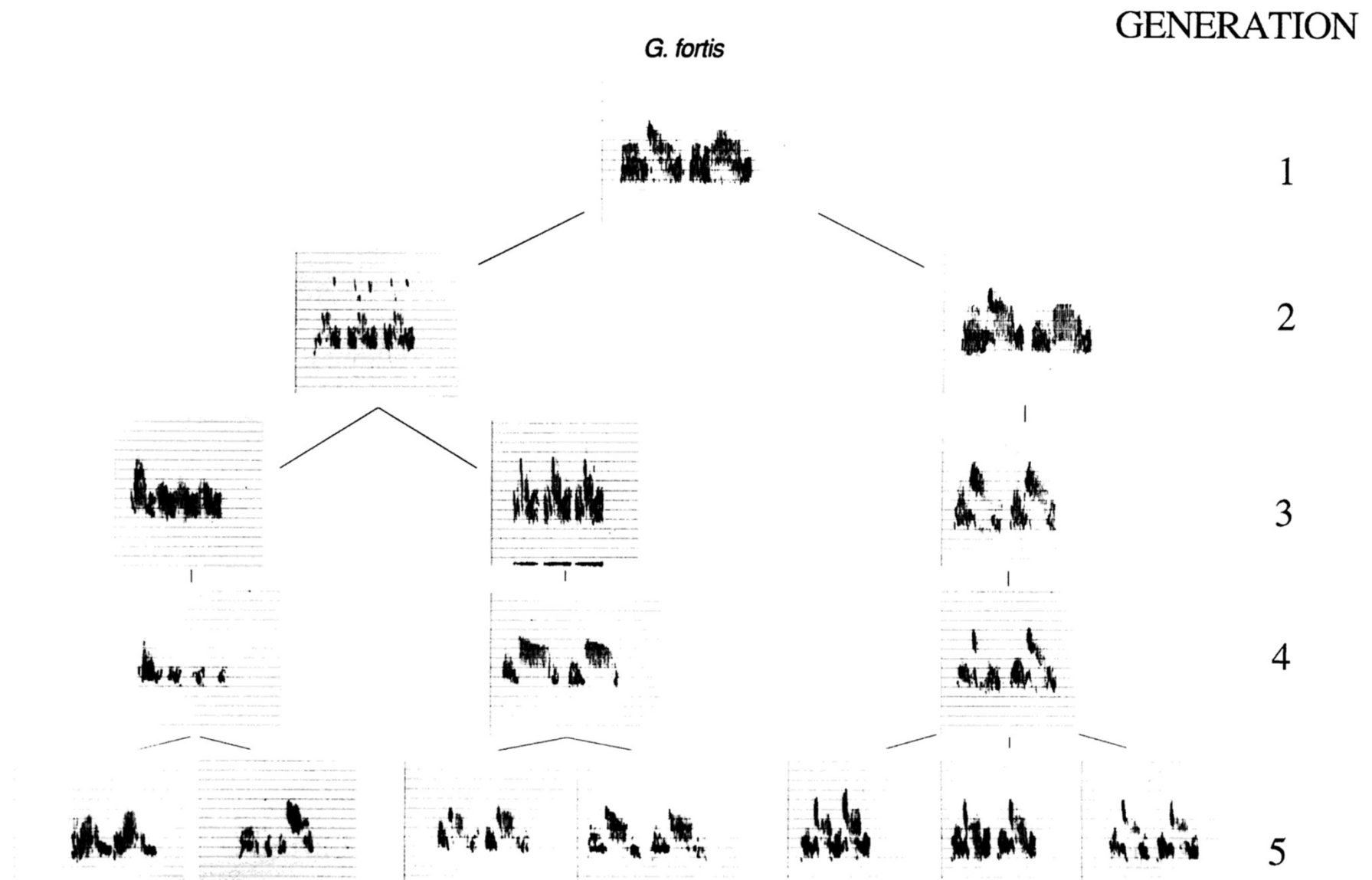
# Cultural evolution of humpback whale songs



Year	East Australia	New Caledonia	Tonga	American Samoa	Cook Islands	French Polynesia
1998						
1999						
2000						
2001						
2002						
2003						
2004						
2005						
2006						
2007						
2008						

See lecture 5 by Rendell

Garland, et al. (2011)

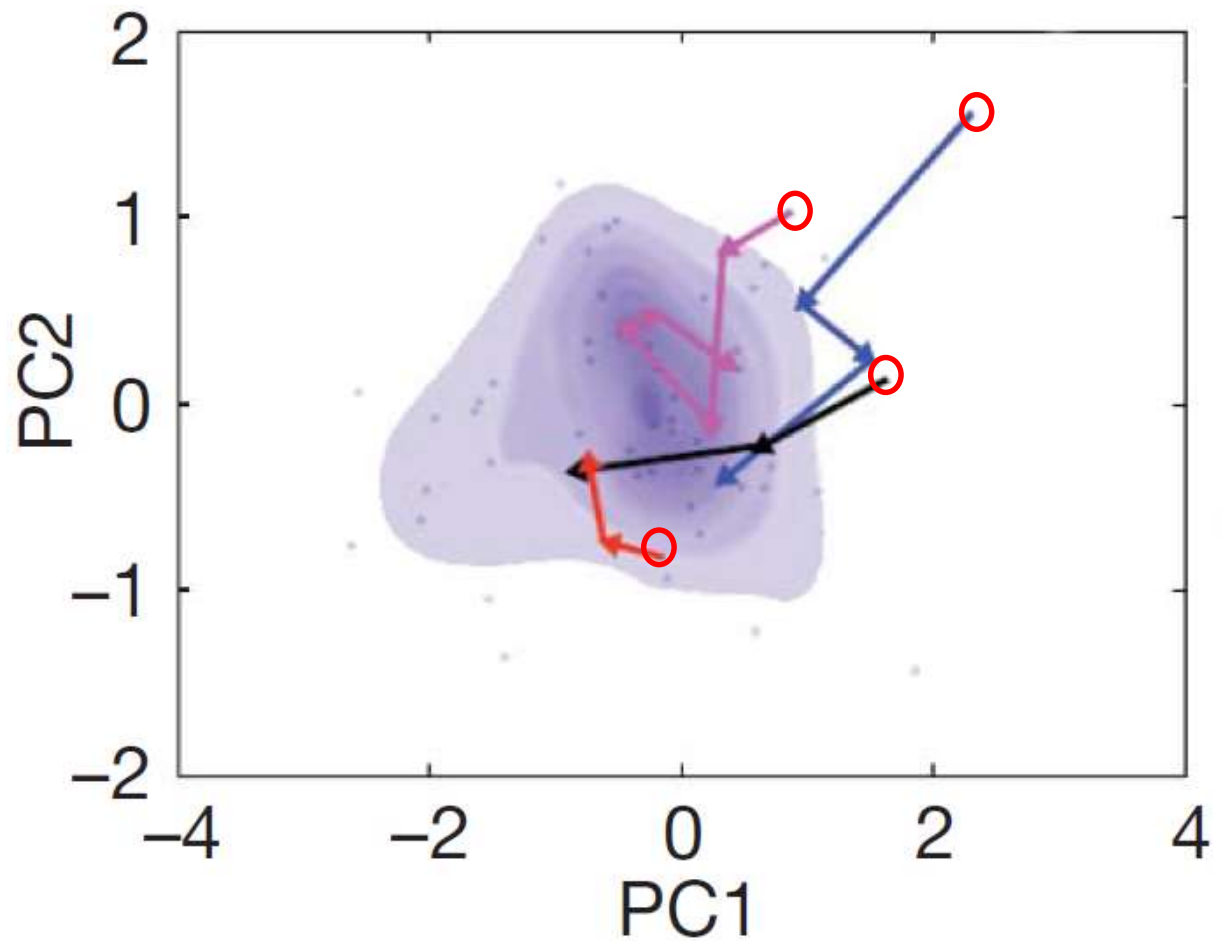
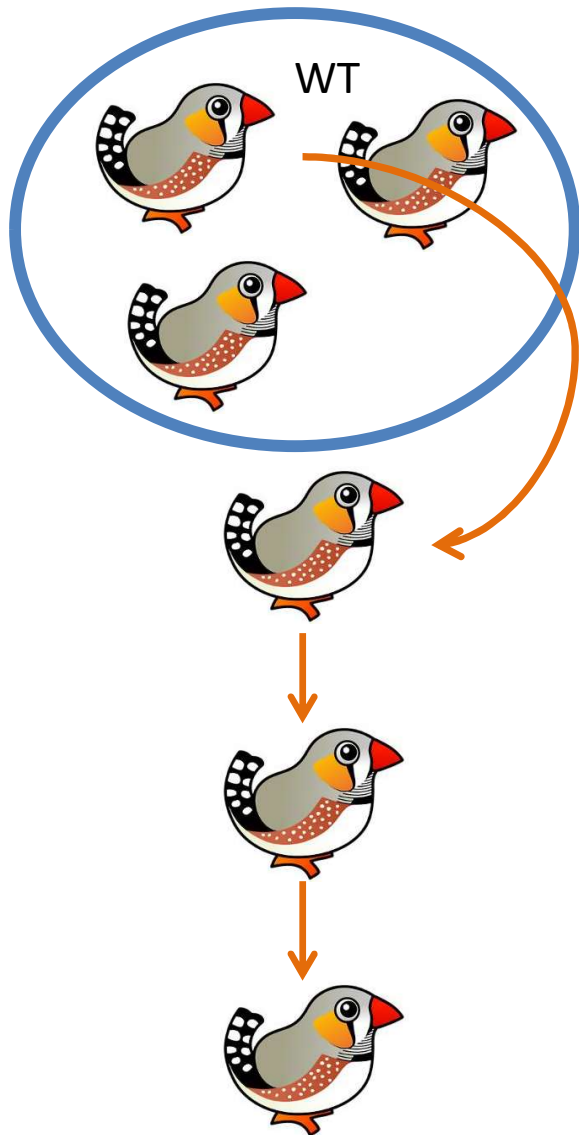


Grant & Grant, 1996, 1997, 2009, 2010

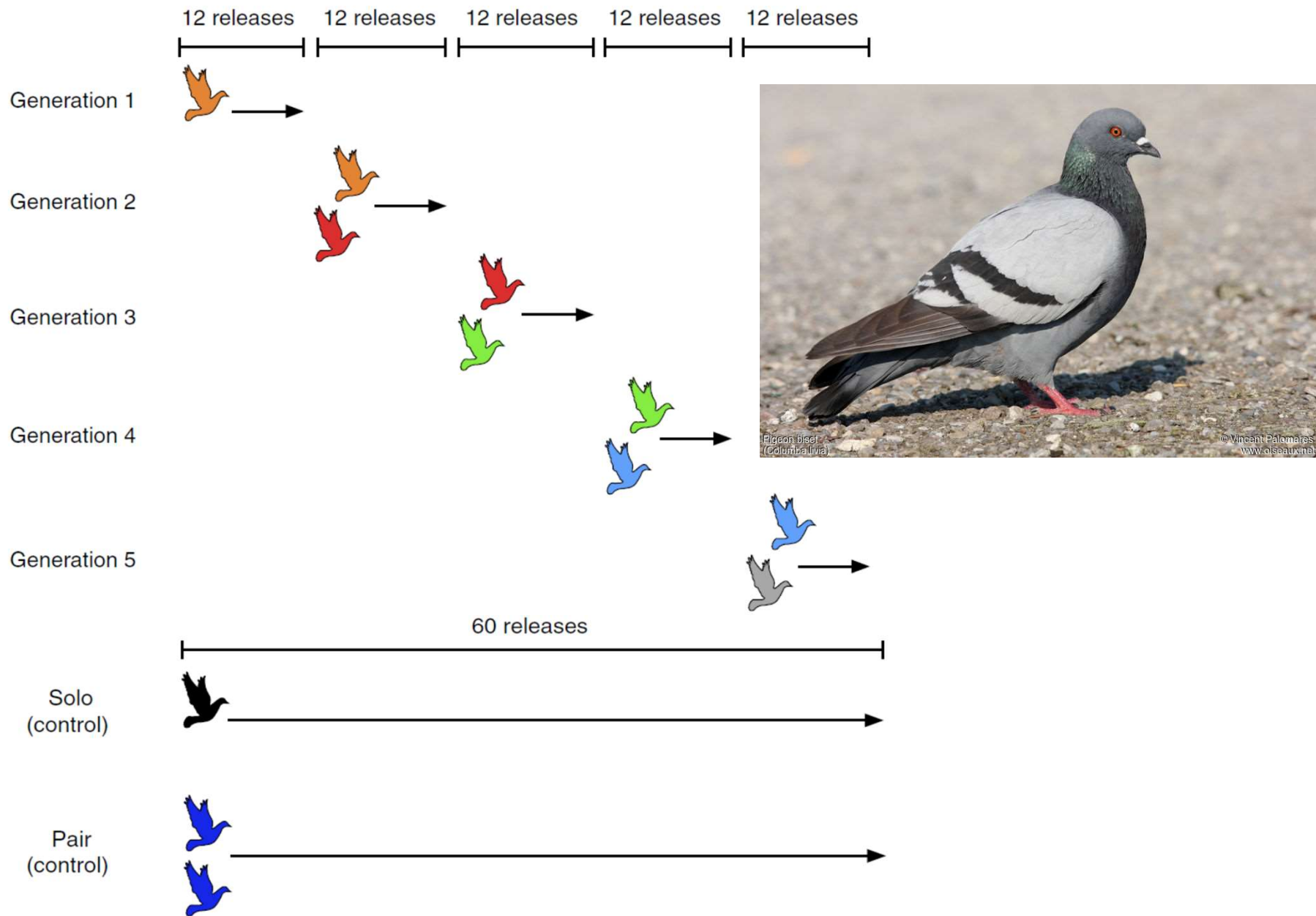
See lecture 6 by Aplin and 10 by Whiten



# Evolution of songs in songbirds

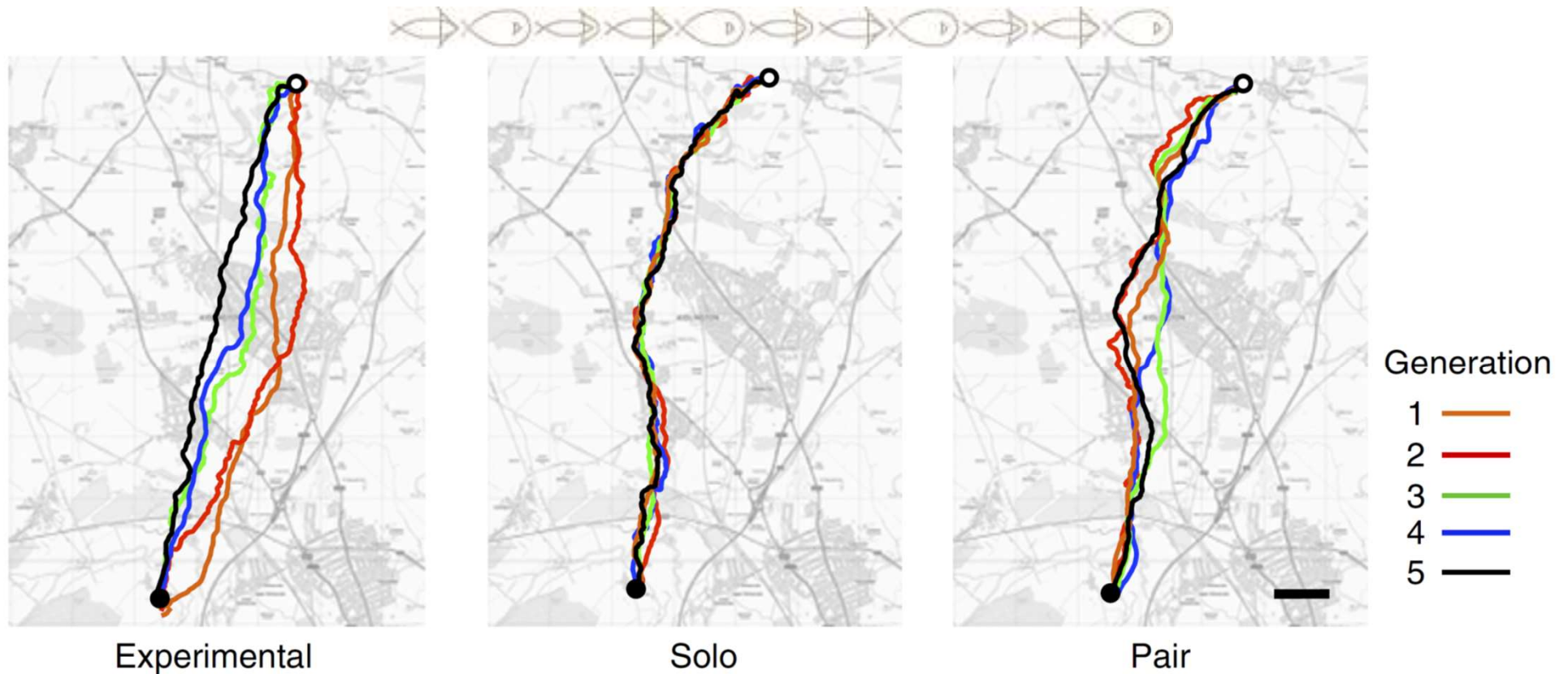


Feher et al. 2009

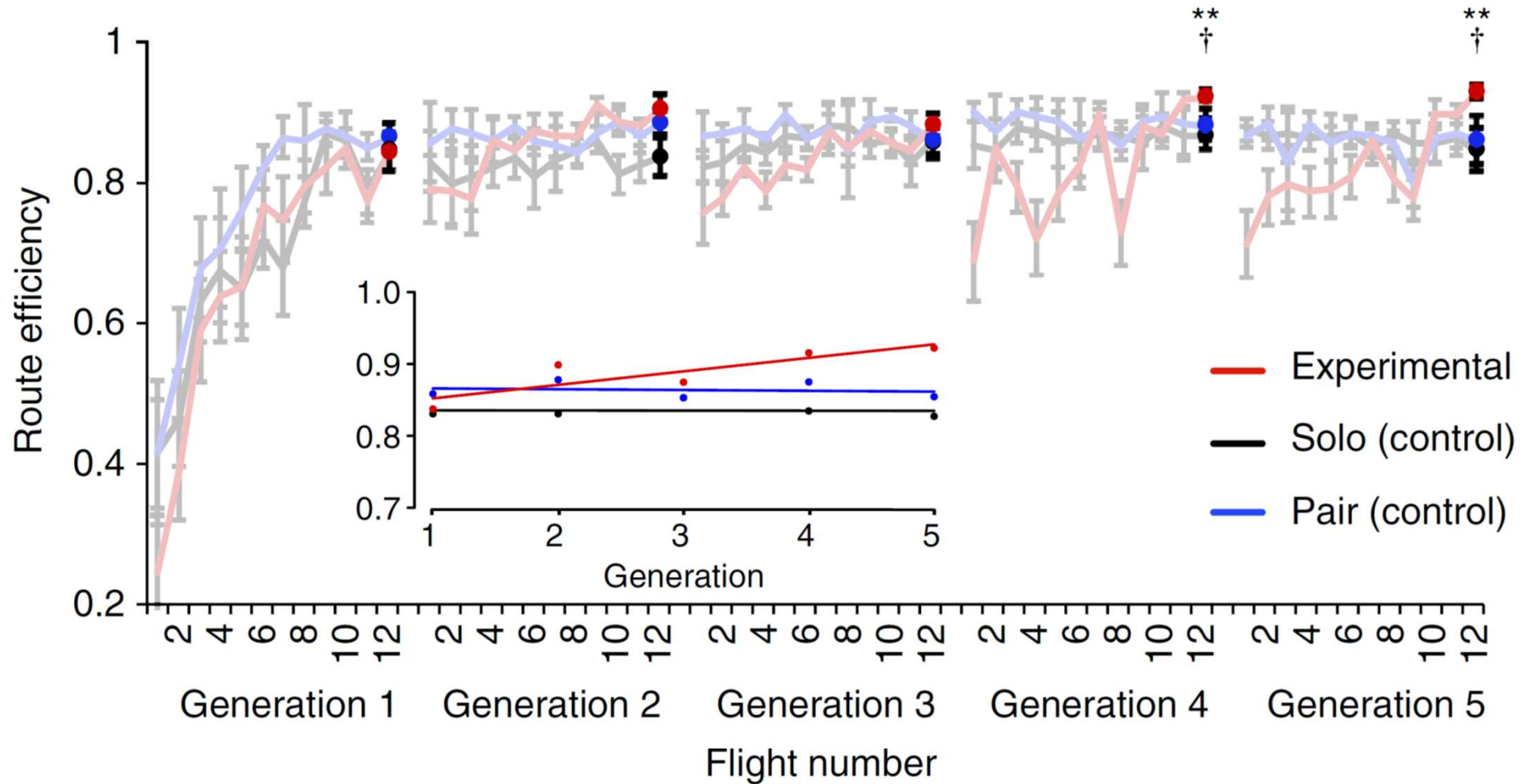


Sasaki & Biro, 2017

# Cumulative improvement of flight route



# Cumulative improvement of flight route



## Summary part 2



1. Animal culture is widespread and stable through time
2. However, not all animals solve problems in the same way humans do
3. The few suggestions of CCE in animals are not where we might expect (not technology, not apes) despite intense research

WHY?????

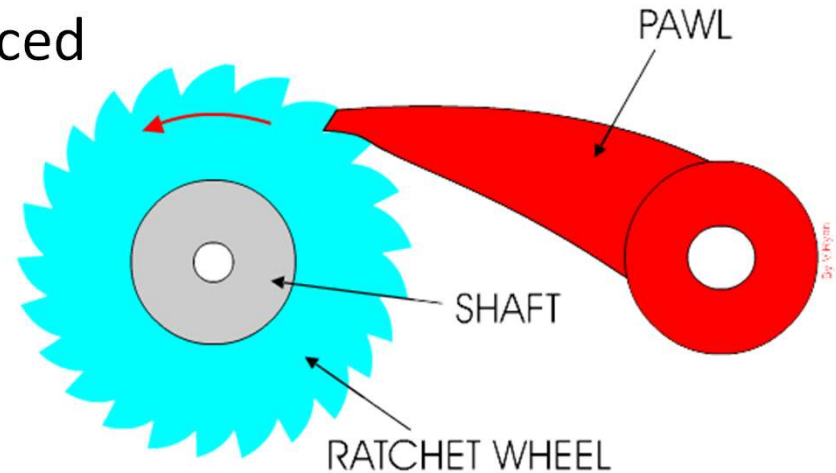


## **PART 3: THE ORIGIN OF CCE**

# Tomasello (1993): The ratchet effect



1. Once a new modification is introduced it can easily be passed on to other individuals
2. Faithful transmission prevents the loss of modifications and therefore produce cultural accumulation
3. Eventually, what is socially transmitted goes beyond what a single individual could invent on their own
4. Tennie et al. (2009). "Ratcheting up the ratchet" further extend the notion with the zone of latent solutions (ZLS)





**A**

Guard to prevent visual access to food rewards before they are placed in feedtubes.

Dial to open stage 3, which can be turned using either blue or red finger holes.

Door in fully closed position. Door is pushed to reveal stage 1 feedtube. Following manipulation of buttons and dial, door can be pushed wider to reveal stage 2 and 3 feedtubes.

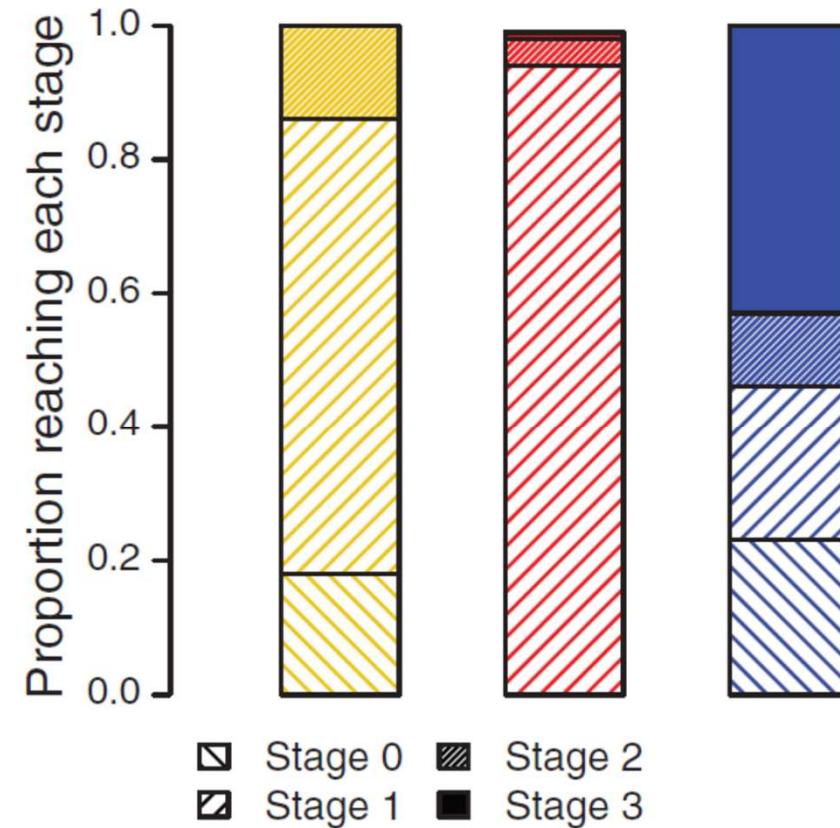


**B**



**A**

**Performance**



See Vale study in lecture 10 by Whiten

Dean et al. 2012



Capuchins



Chimpanzees

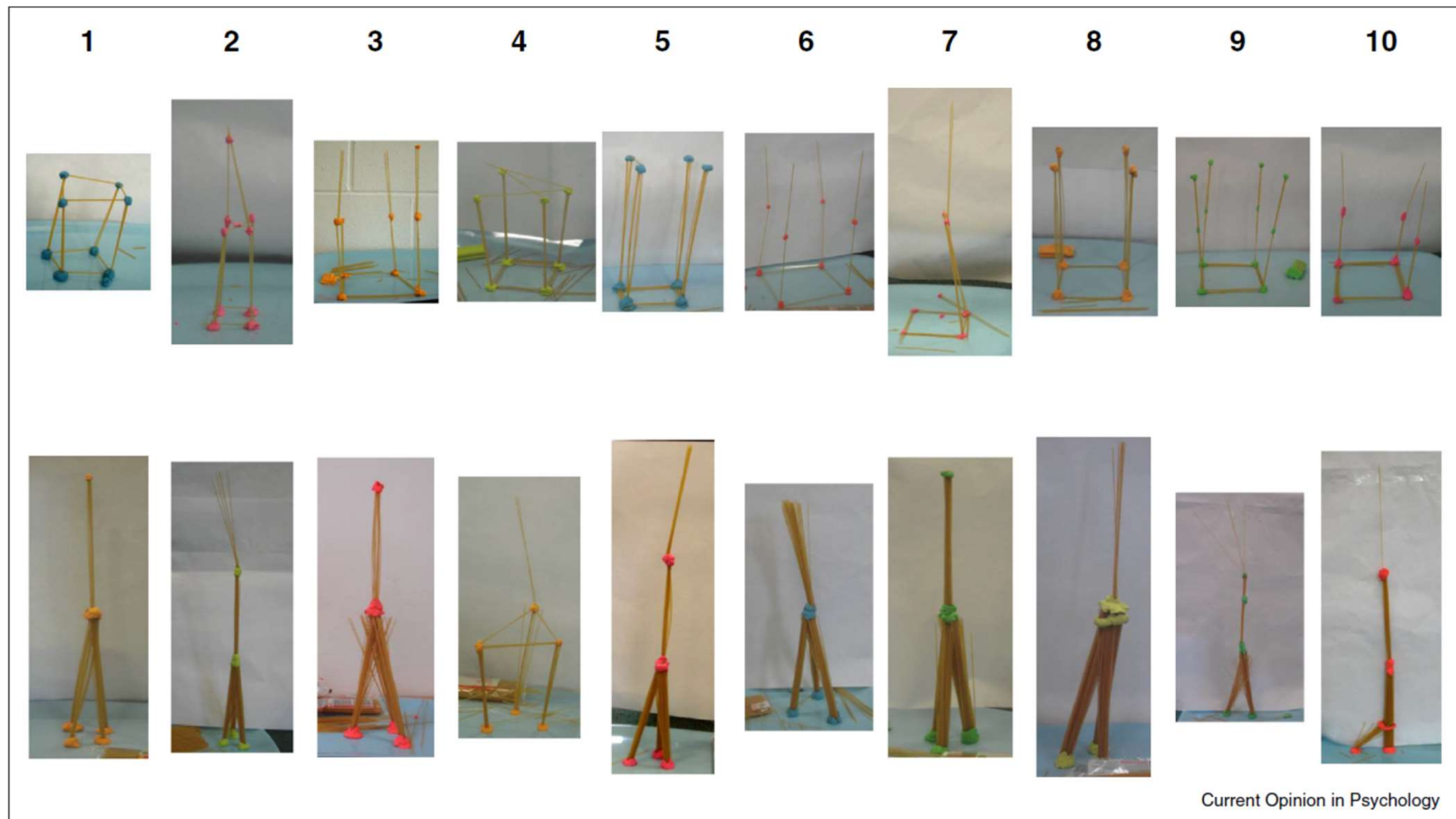


Children

# Why is human social learning faithful?



- Tomasello et al's 1993: *Cultural learning*
- Humans share with other animals many social learning mechanisms
- Humans are unique in their capacity to take the perspective of others
- Perspective taking allows *faithful* cultural transmission



Caldwell and Millen 2010

# Cultural transmission in baboons

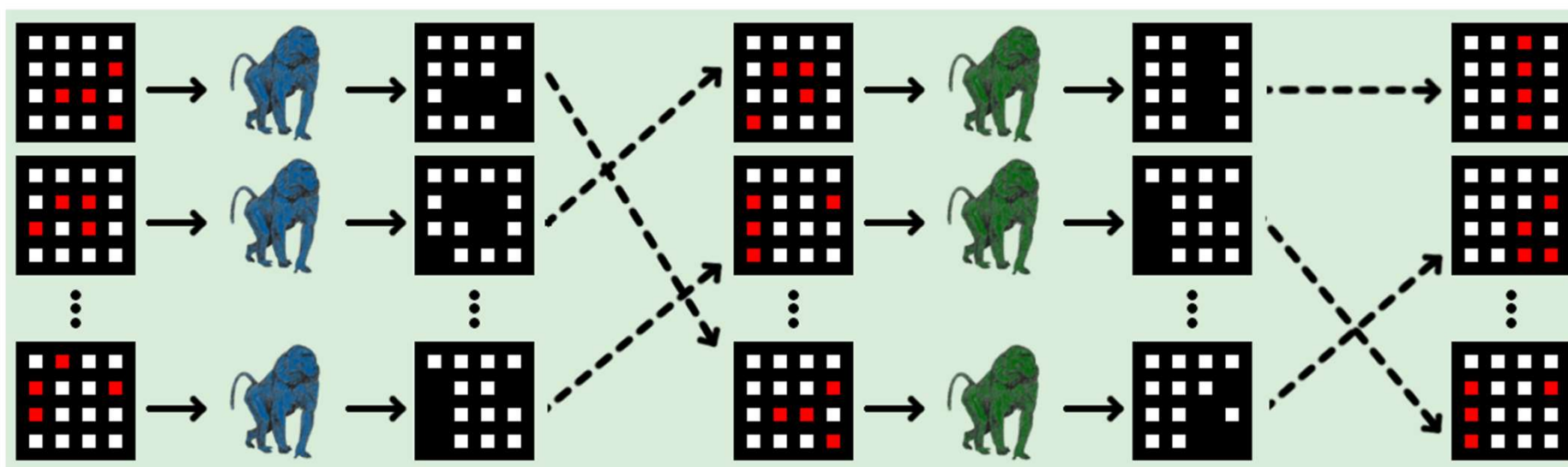




Fagot & Bonté (2010)

Fagot & Paleressompoulle (2009)

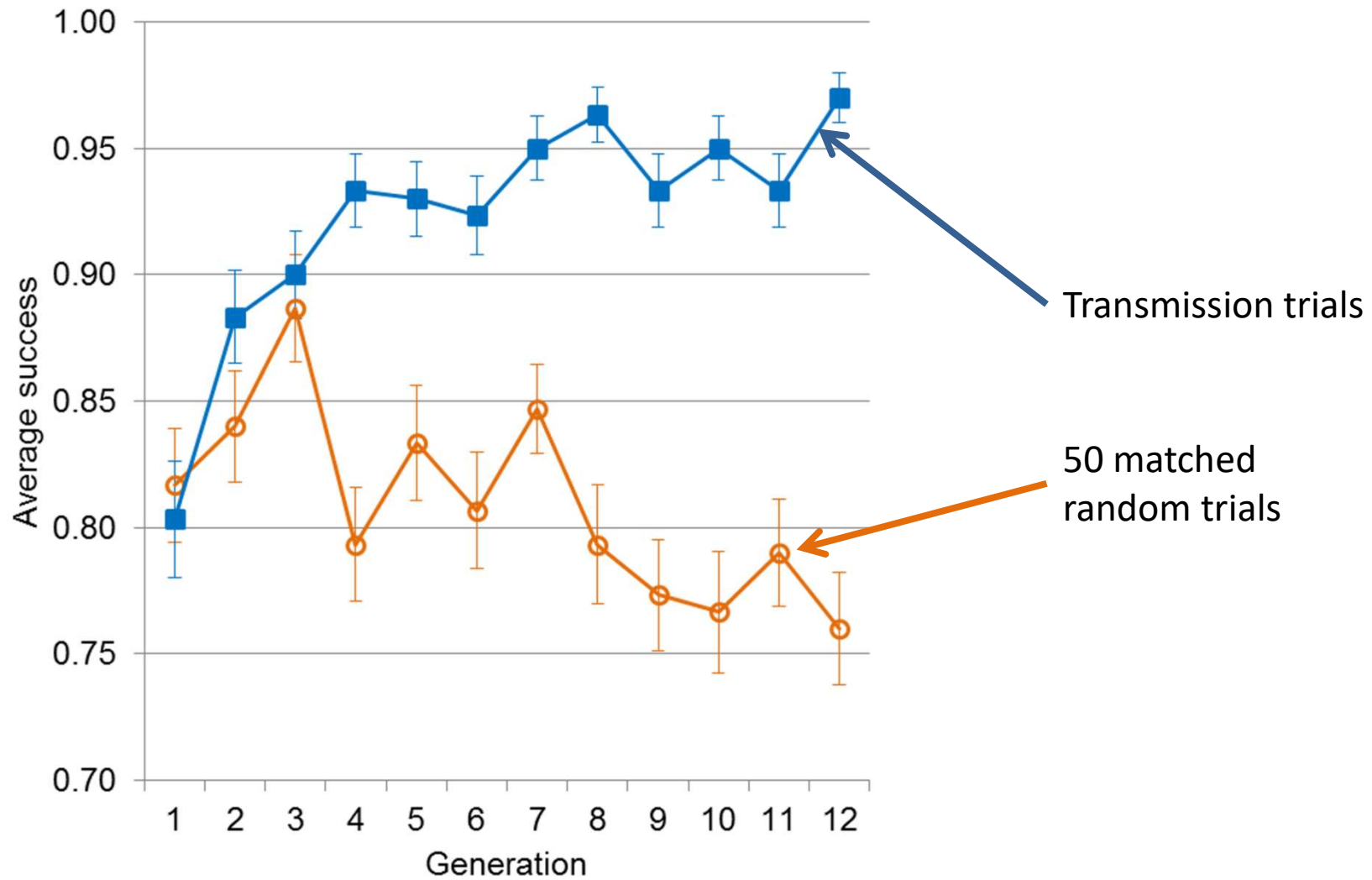




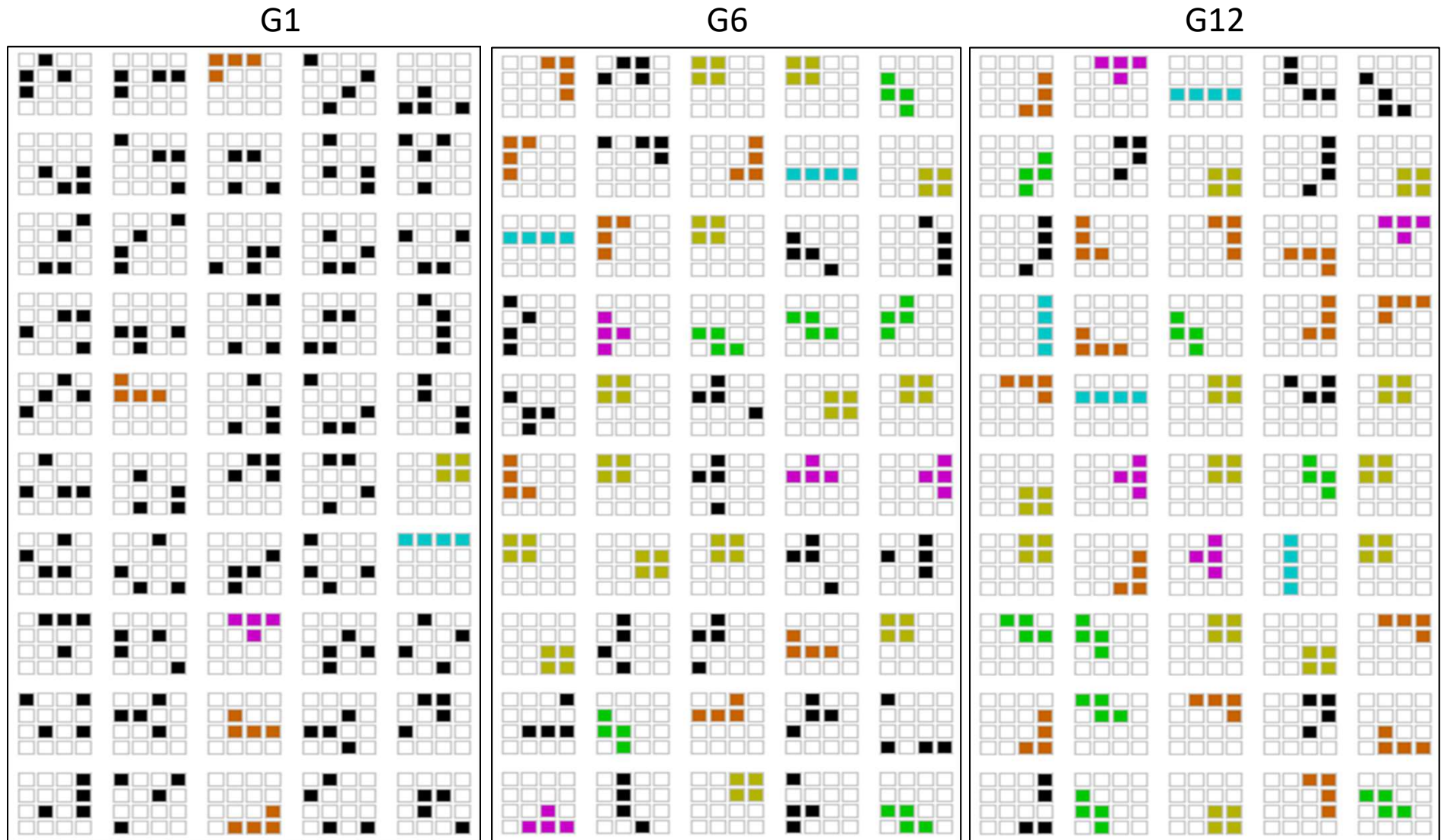
—→ See/Produce      Transmission trials      Baboon Gn  
 - - - → Transmit      Random trials      Baboon Gn+1



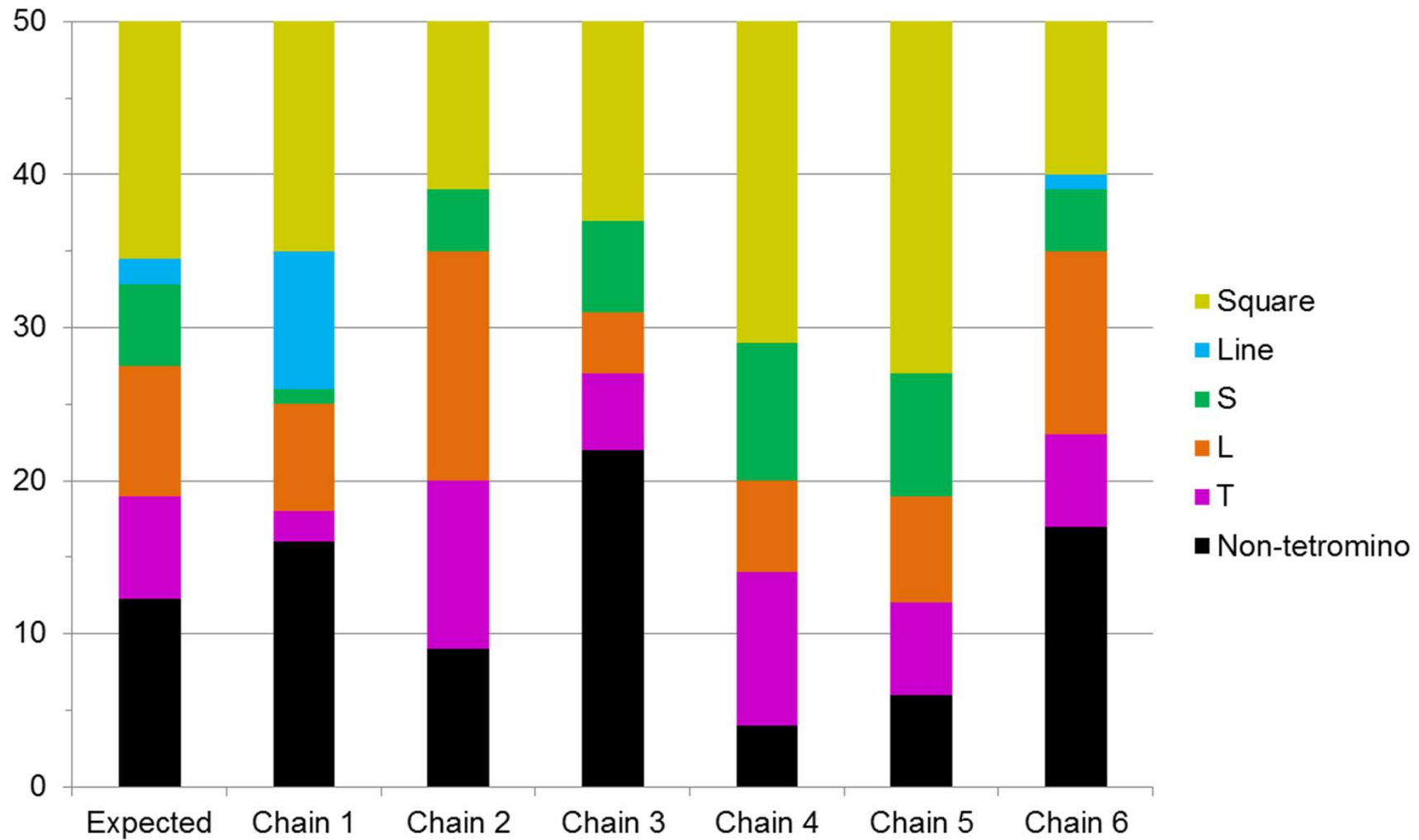
# Increase in success



# Emergence of structures



# Lineage specificity



# What about fidelity?



We found:

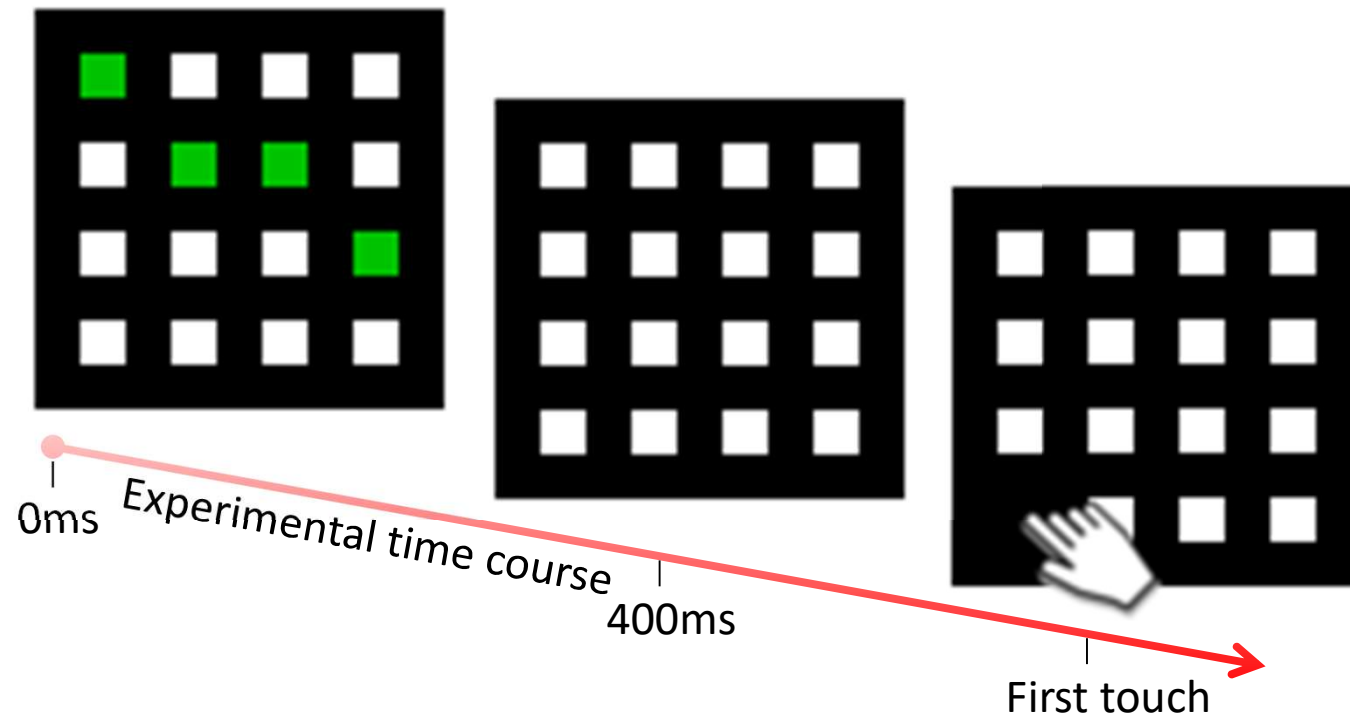
- Increase in score
- Emergence of structures
- Lineage specificity

... with very low fidelity. Initially 37% of grids were reproduced without errors in the 1st generation.

Fidelity also increased sharply to reach 72% in the last generation.

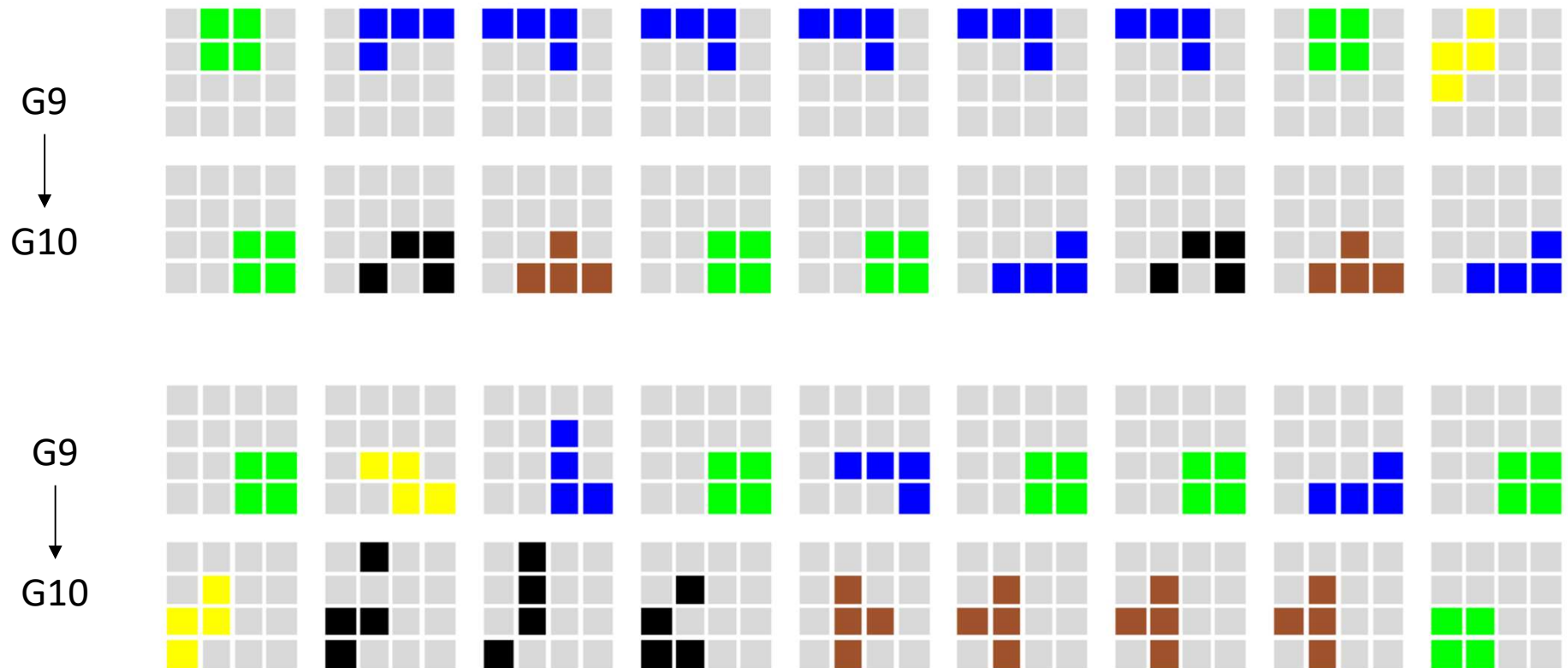
=> These results suggest that Hi-Fi can be the *result* of CCE, not necessarily its *source*.

# Do not copy task!



Touch anything but the four green squares

# Structure: alternating patterns



# What is the origin of CCE?



*My opinion* is that it comes back to the question of the evolution of language.

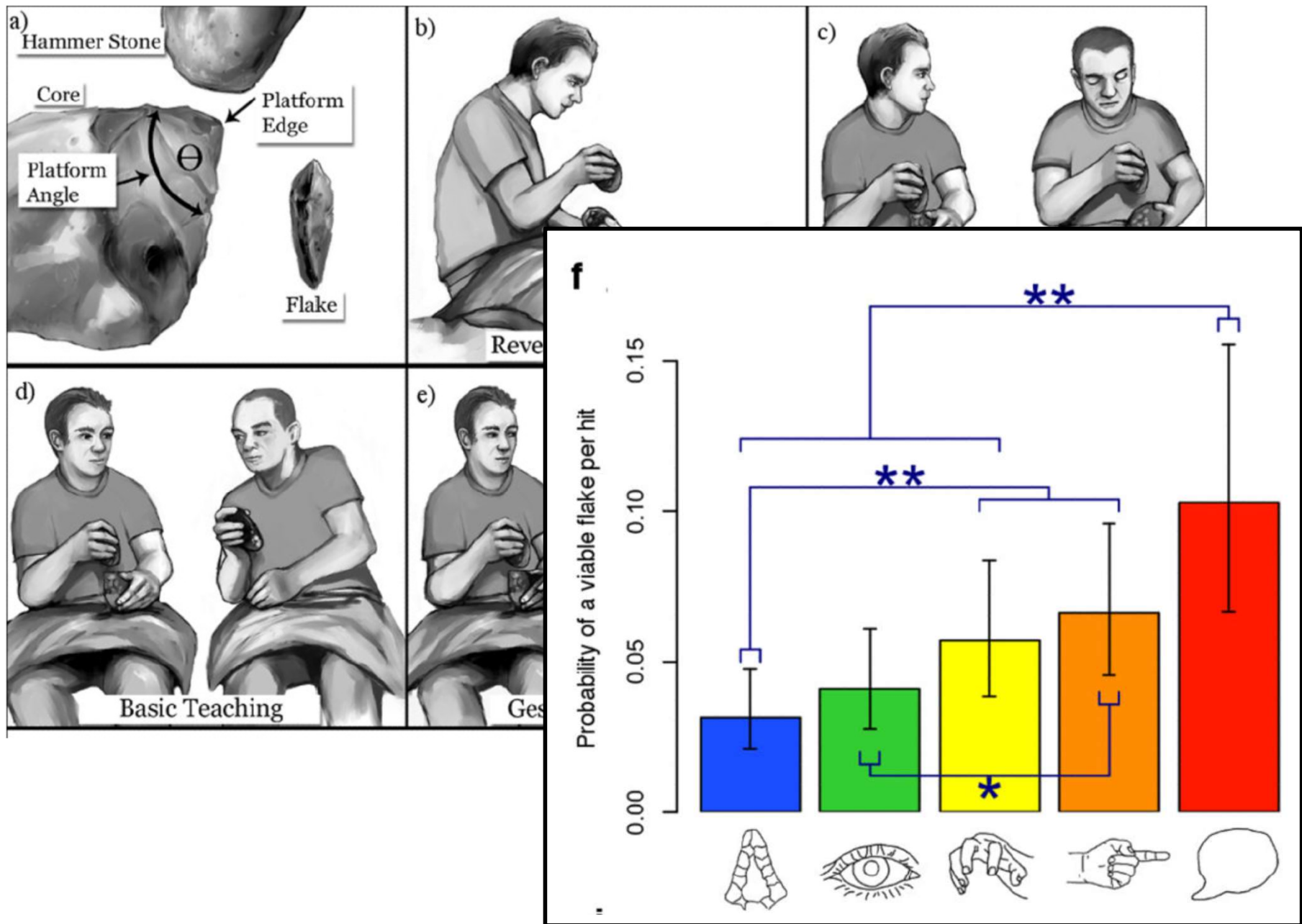
## 1. Social hypothesis: evolution of social intelligence

Cumulative cultural evolution evolved through the complexification of social life and social cognition

## 2. Ecological hypothesis: evolution of technologies

Cumulative cultural evolution evolved as a response to a challenging environment





# Two distinct evolutionary scenarios



## Social hypothesis:

- Environment created selection for
- Increasingly complex social life
- Unique set of socio-cognitive abilities
- Increased communication (language)
- Gave rise to CCE

## Ecological hypothesis:

- Environment created selection for
- Increased reliance on tools and technologies
- More tolerance, coordination, cooperation
- Developed social learning mechanisms
- Gave rise to CCE

## Summary part 3: Where does CCE come from?



1. We don't know!
2. But CCE can emerge with a variety of social learning mechanisms
3. CCE does not require high-fidelity cultural transmission



**THANK YOU!**

Nicolas Claidière

[nicolas.claidiere@normalesup.org](mailto:nicolas.claidiere@normalesup.org)

[www.nicolas.claidiere.fr](http://www.nicolas.claidiere.fr)