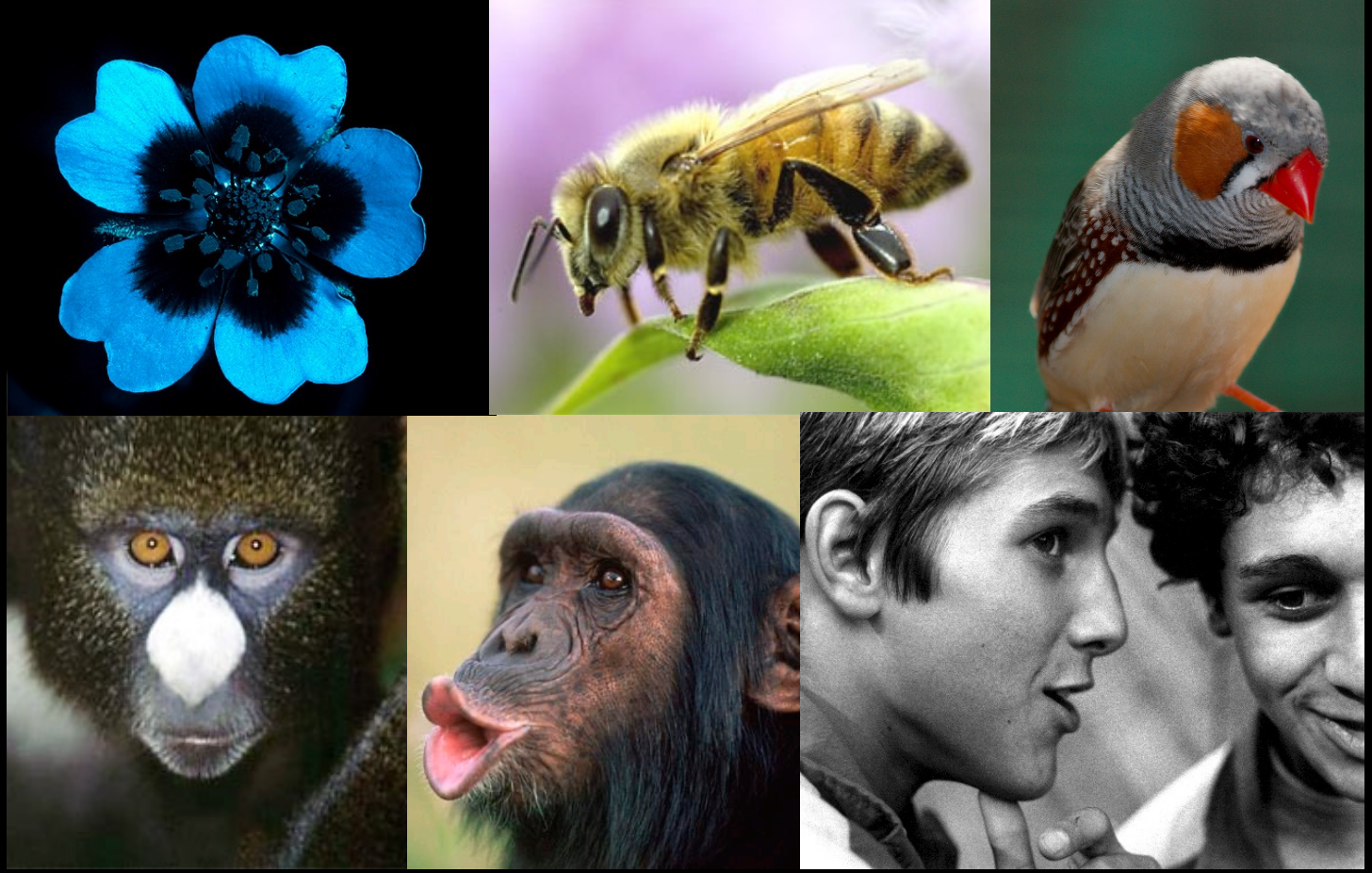
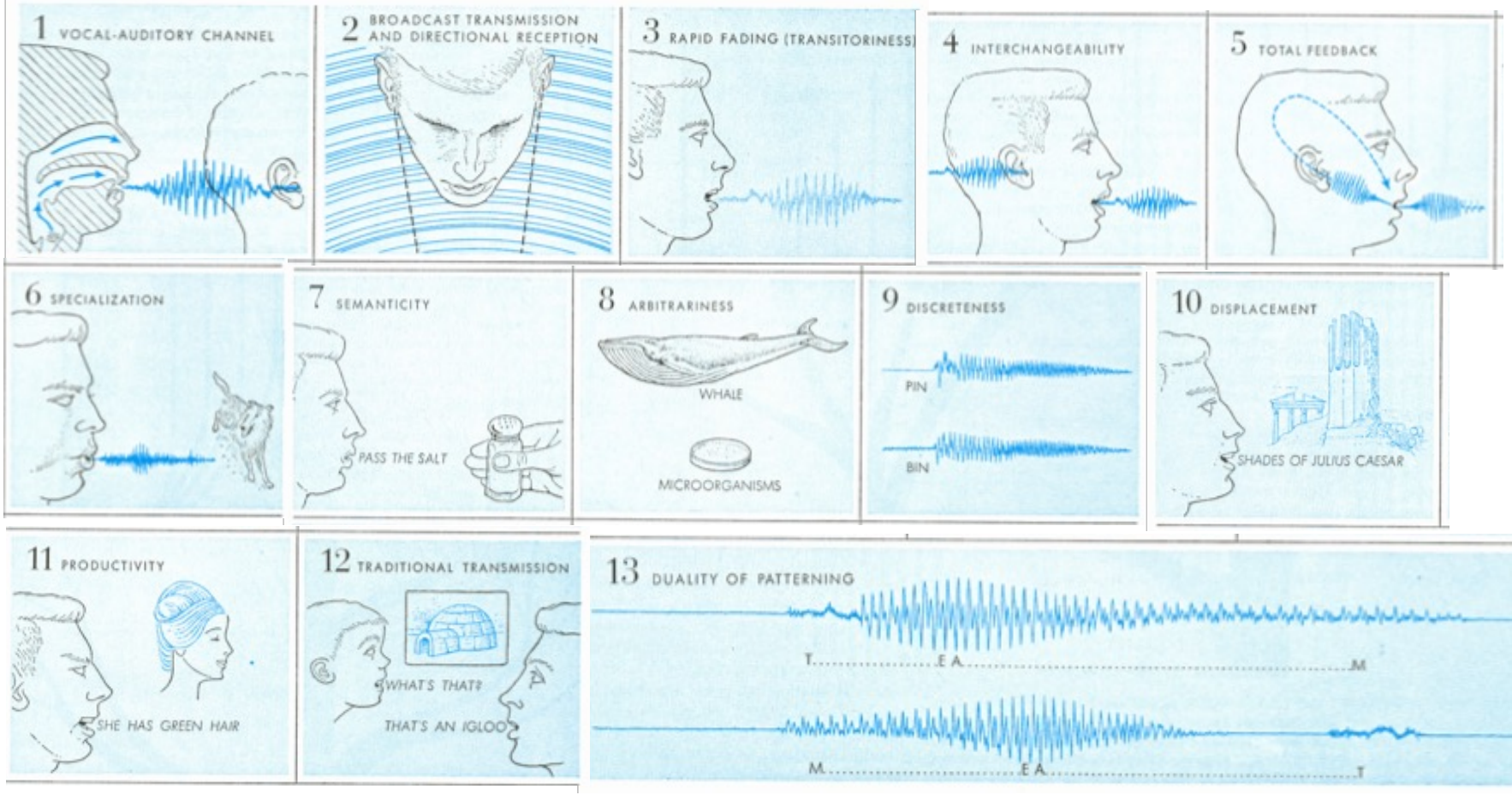
Origins and Evolution of Language
Week 1: Introduction

Kenny Smith

kenny.smith@ed.ac.uk



Communication is widespread, but language is unique



Hockett's **design features**

Hockett, C. F. (1960). The origin of speech. *Scientific American, 203,* 88–96.

Language’s communicative power comes from its **structure**

Language's communicative power comes from its **structure**

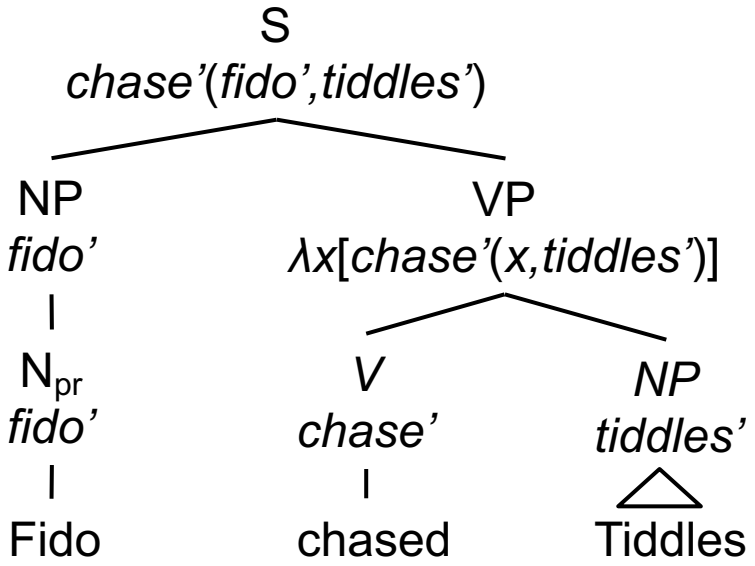
Duality of patterning: meaning-bearing units composed of (re)combinations of meaningless differentiating units

Word	**Meaning**
log	*"Noun; an unhewn portion of a felled tree"*
dog	*"Noun; A domesticated carnivorous mammal"*
dig	*"Verb; To work in making holes or turning the ground"*
dim	*"Adjective; Faintly luminous"*

Language's communicative power comes from its **structure**

Compositionality: the meaning of an expression is a function of the meaning of its parts and the way in which they are combined

S → NP VP	*VP'*(*NP'*)
NP → N_{pr}	*N'*$_{pr}$
N_{pr} → Fido	*fido'*
N_{pr} → Tiddles	*tiddles'*
VP → V NP	*V'*(*NP'*)
V → chased	*λx* [*λy* [(*chase'*(*x,y*)]]



Language's communicative power comes from its **structure**

Inventory of meaningless units (10s)

p t d s ð k g ɔ ə a …

Inventory of meaningful units (1000s)

ə	ðə	-əd	dɔg	kat	ðat	spɔt	…
(a)	*(the)*	*(past tense)*	*(dog)*	*(cat)*	*(that)*	*(spot)*	

Inventory of meaningful sentences (∞)

the cat spotted the dog
a dog spotted the cat
a cat spotted the dog
the dog spotted the cat
the cat spotted the cat that spotted a dog
the dog spotted the cat that spotted the dog
…

How did language evolve?

Language is **universal** in our species

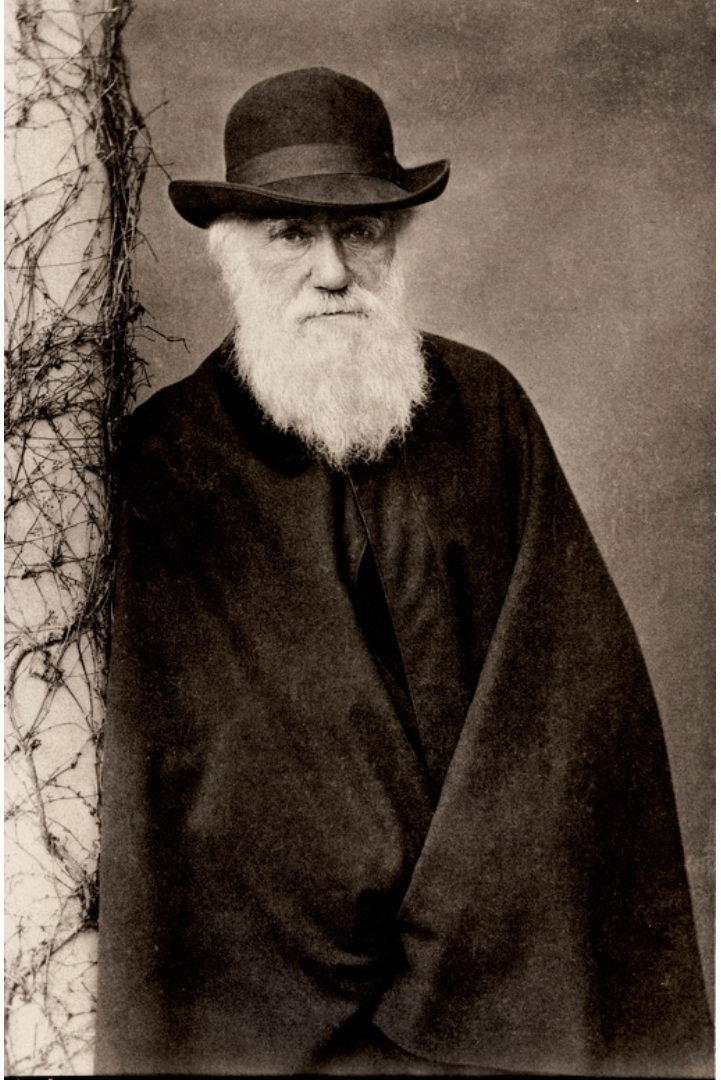
Language is a hugely **adaptive** trait

A tool for the communication of knowledge and internal states

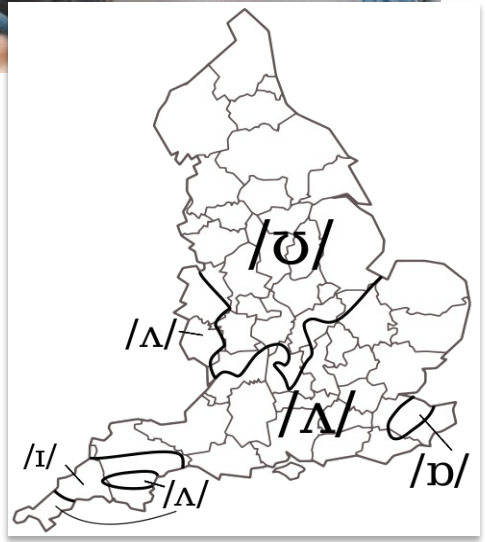
One possible explanation

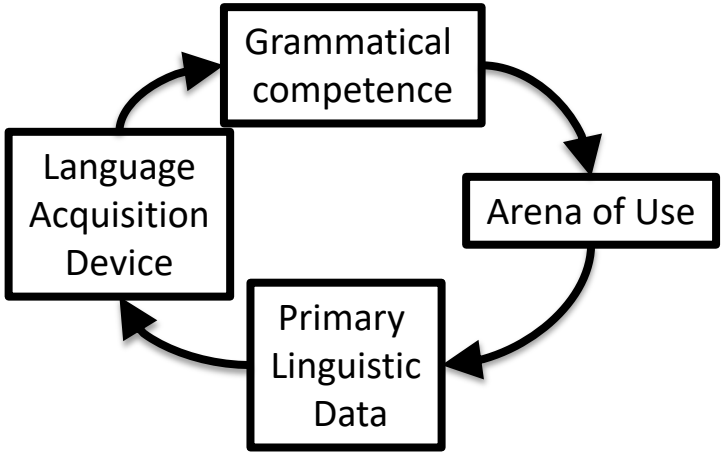
- Language is just like any other adaptive feature of an organism's biology
- It's an **innate** feature of the human mind
- It evolved by natural selection under pressure for communication

More on this in the next lecture



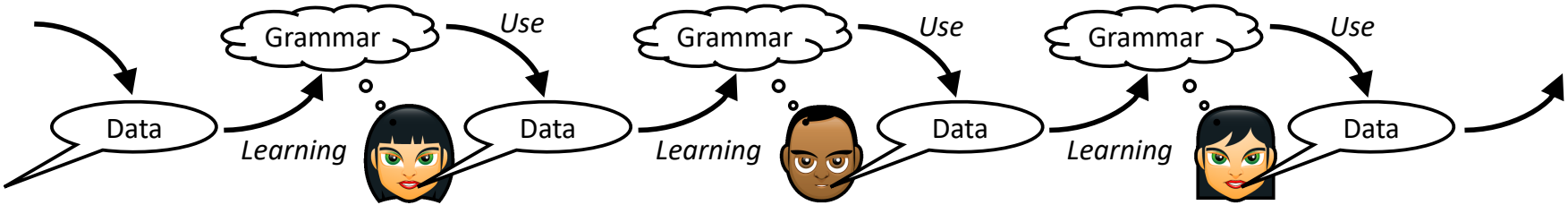
Social learning is ubiquitous in humans





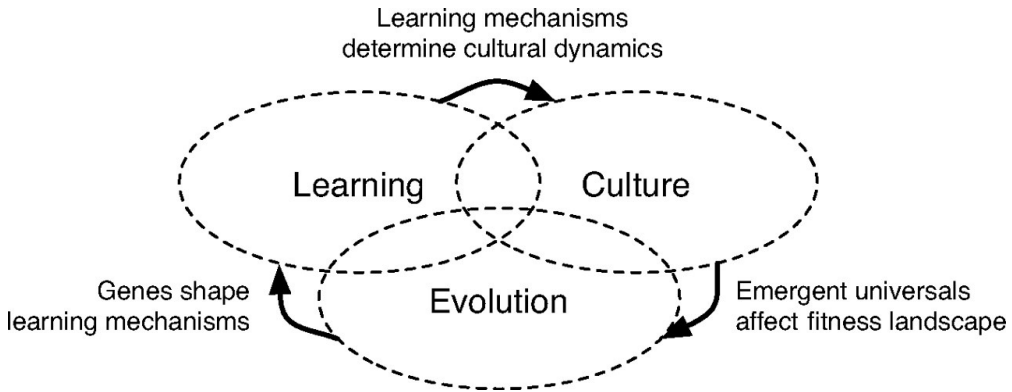
Language is transmitted via repeated **learning** and **use**

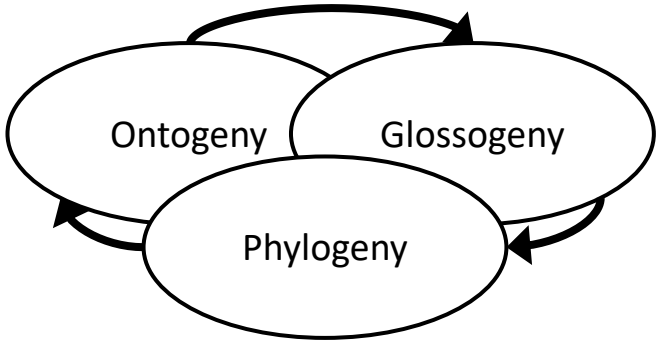
Language is shaped as a consequence of these processes



Upper: from Hurford, J. R. (1990). Nativist and functional explanations in language acquisition. In I. M. Roca (Ed.), *Logical issues in language acquisition* (pp. 85–136). Dordrecht: Foris.
Lower: from Smith, K. (2022). How language learning and language use create linguistic structure. *Current Directions in Psychological Science, 31,* 177-186.

Learning, culture and biology





Upper: from Kirby, S., Dowman, M., & Griffiths, T. (2007). Innateness and culture in the evolution of language. *PNAS, 104,* 5241-5245.
Lower: adapted from Fitch, W. T. (2010). *The Evolution of Language.* Cambridge: Cambridge University Press

https://kennysmithed.github.io/origins23/

Bad news: Strike action this semester

UCU, the main union for academics and support staff, is in dispute with the University employers over **pay, casualization, pay inequality**

No classes (no lecture, no tutorials) in **week 2, i.e. next week.**

All other content will move back 1 week.

We lose 1 week of content.

I will update the course pages this week (just in case it gets called off).

You can respectfully email your views to our Principal, Prof Peter Mathieson, principal@ed.ac.uk

We would much rather be teaching and getting paid!

Schedule (assuming strikes)

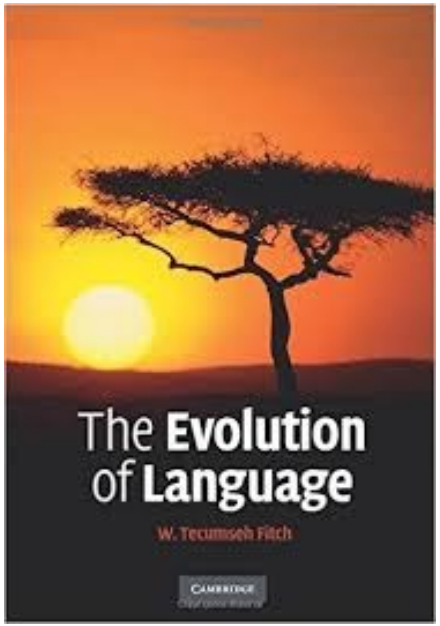
Week	Topic
1	Introduction
2	*No class – strike (TBC)*
3	Natural selection, adaptation and language
4	Intention and structure in animal communication
5	*No class*
6	Social learning and cumulative culture
7	Speech, vocal learning, grammar learning
8	Evolution of social cognition
9	Cultural evolution of language
10	Sign language and language origins
	~~Gene-culture co-evolution~~

Pre-lecture preparation

- **Readings must be done in advance**
- Do the reading, answer the quiz questions on Learn
  - Most useful bit for me is the free comment box at the end
- I will assume you have done the readings, we'll talk about them in class

Tecumseh Fitch

The Evolution of Language



wooclap.com for in-class voting

I am:

1. An undergraduate student
2. A postgraduate student
3. Something else (e.g. here by mistake)

Tutorials

- Tutorials will start in ~~week 2~~ week 3
- First tutorial: an easy start
- Later weeks: two contrasting/conflicting papers, **rota for introducing papers**, papers link to assessment topics

Maisy Hallam

Ponrawee Prasertsom

Lauren Fletcher

Tell us when you are available for tutorials!

Link on Learn page

Deadline: 12 noon, Thursday 21st September

I will do the allocation of students to tutorial slots on Thursday afternoon

Assessment

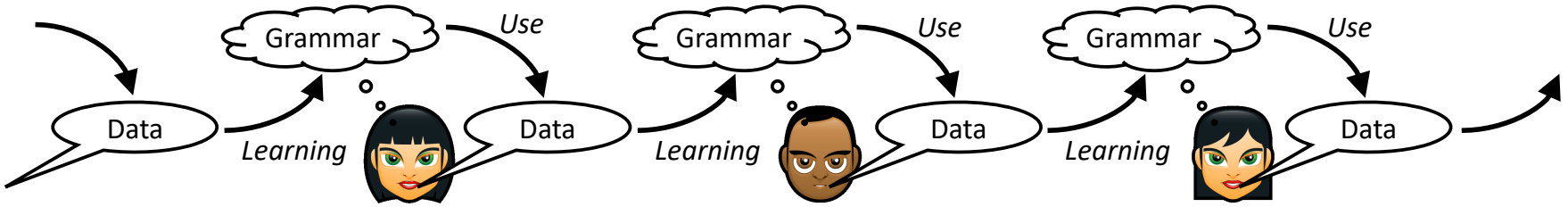
- 1.5k word essay (50% for undergrads, 40% for postgrads)
  - List of topics to be provided (end of week 3 at the latest)
  - **Due 26th October**

- 1.5k word essay (50% for undergrads, 60% for postgrads)
  - Same list of topics, postgrads can set their own topic (see instructions)
  - **Due 14th December**

Any questions on course structure, assessment, admin etc?

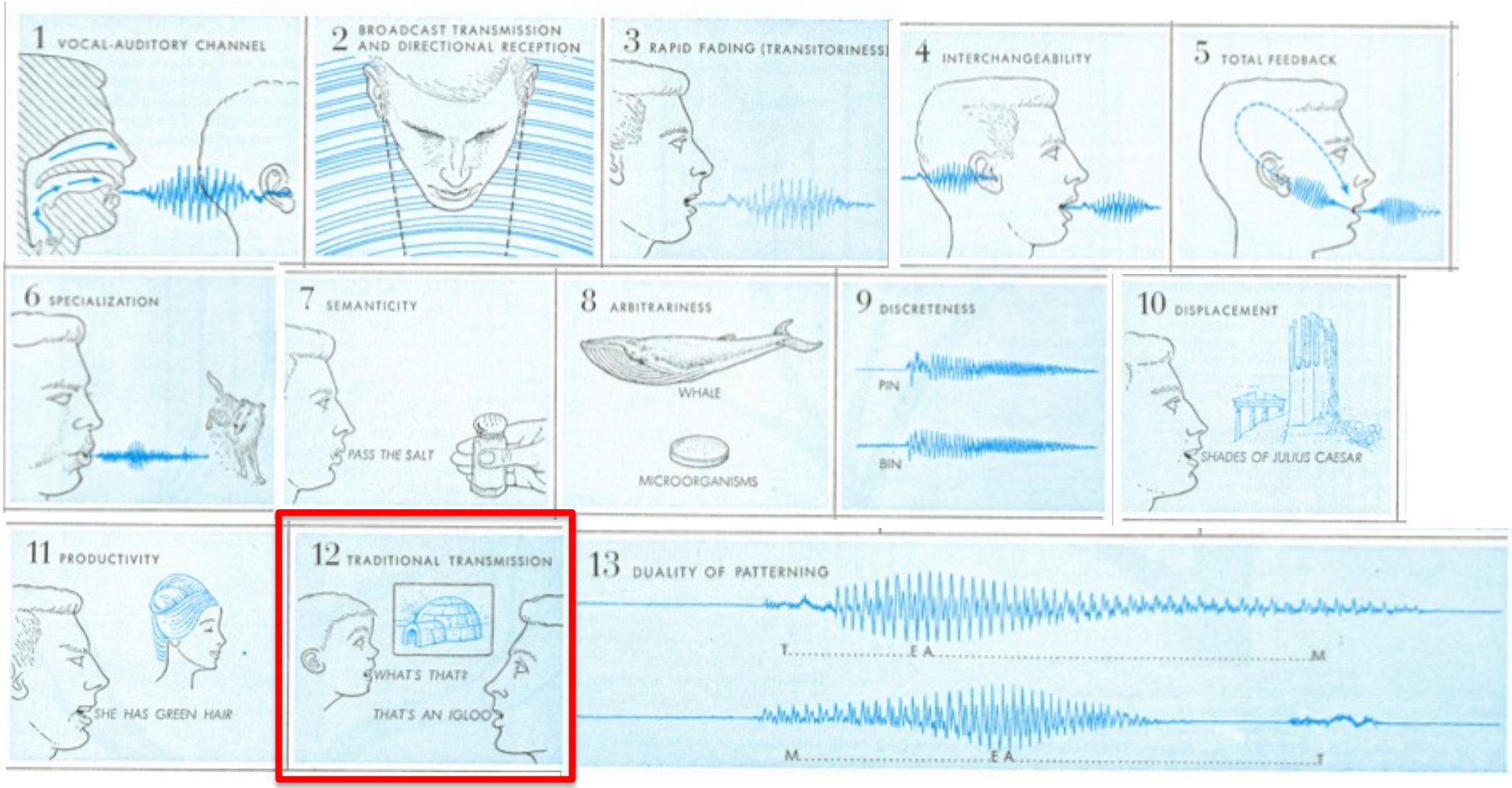
A short preview of where we are headed

Learning, use, and language design



- Language is passed from person to person by **learning**
- People learn from language as it is **used in communication**
- Language **evolves** in response to its learning and use
- Structure allows language to learnable yet communicatively powerful

Rather than us being adapted for language, language has adapted to us



Hockett's **design features**

Hockett, C. F. (1960). The origin of speech. *Scientific American, 203,* 88–96.

What's required for this to happen?

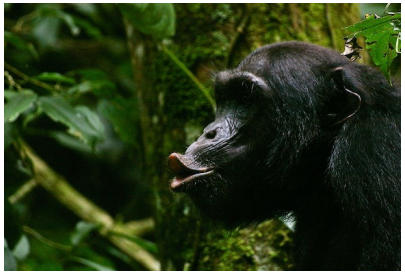
Social learning,
vocal learning,
grammar learning

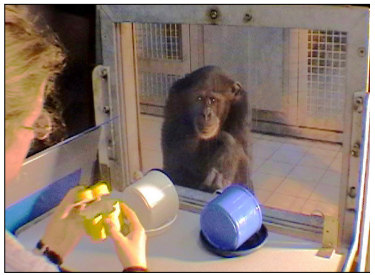
Mitteilungsbedürfnis
and mindreading

What’s required for this to happen?

Social learning,
vocal learning,
grammar learning

Mitteilungsbedürfnis
and mindreading





The idea

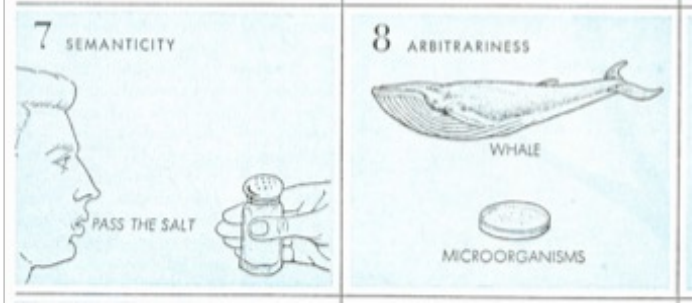
- Humans ended up with an unusual combination of traits: ubiquitous social learning (including of vocal signalling) and deep mental interpenetration
- This set in place a cultural evolutionary process that shaped how language works

What’s the evidence?

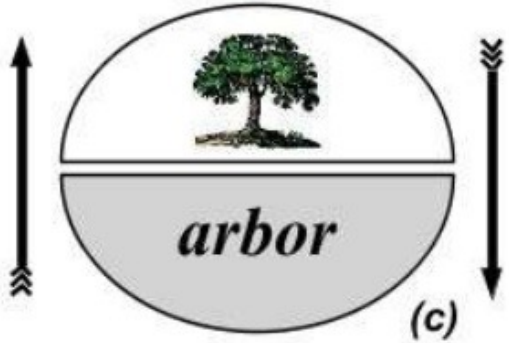
- We’ll look at social learning and mental interpenetration in humans and other animals
- We’ll look at how learning and use of linguistic (or pseudo-linguistic) systems shapes their structure

Some fun examples of what learning and use can do (with a focus on Hockett’s design features)

Where do symbols come from?

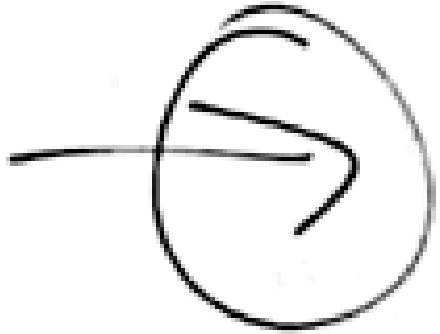


- **Icon:** signals resemble meanings
- **Symbol:** *arbitrary* relationship between signal and meaning



Ritualization in the lab, with humans

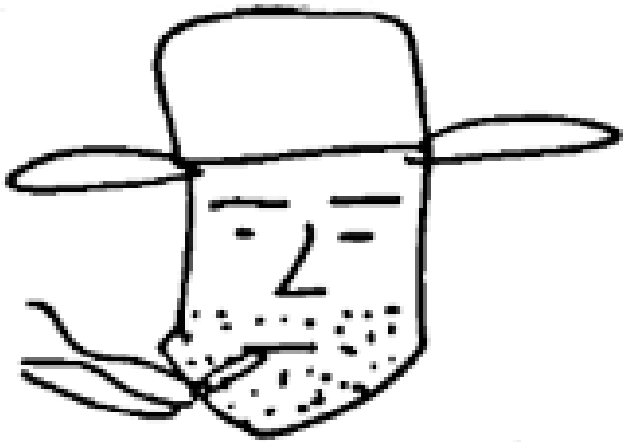
Repeated interaction in a Pictionary-like communication task



Garrod, S. et al. (2007). Foundations of Representation: Where Might Graphical Symbol Systems Come From? *Cognitive Science, 31*, 961-987

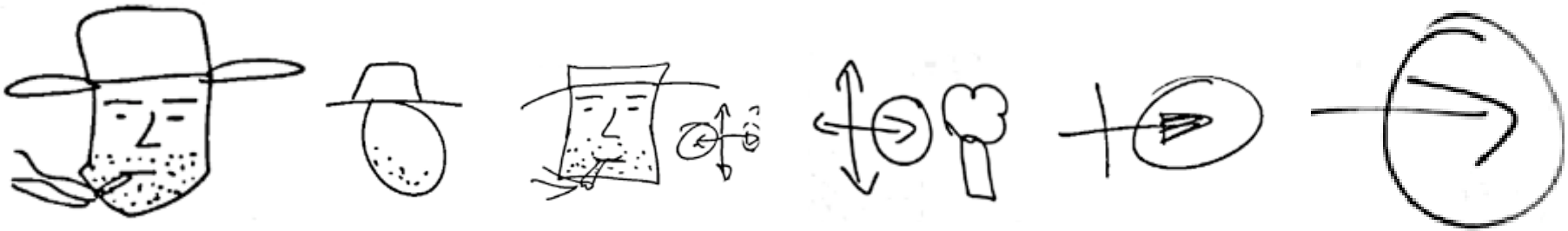
Ritualization in the lab, with humans

Repeated interaction in a Pictionary-like communication task



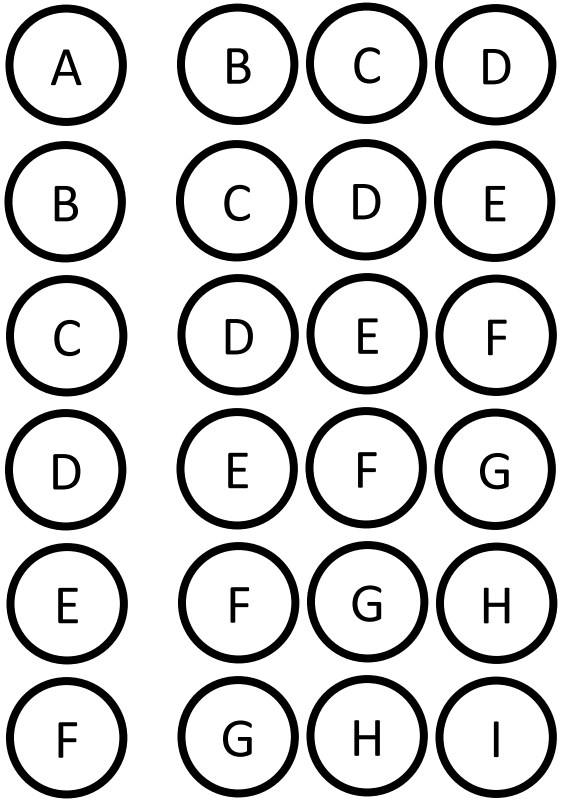
Garrod, S. et al. (2007). Foundations of Representation: Where Might Graphical Symbol Systems Come From? *Cognitive Science, 31*, 961-987

Ritualization in the lab



Garrod, S. et al. (2007). Foundations of Representation: Where Might Graphical Symbol Systems Come From? *Cognitive Science, 31*, 961-987

Transmission in laboratory ‘societies’

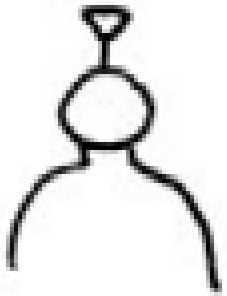


Caldwell, C. A., & Smith, K. (2012). Cultural evolution and the perpetuation of arbitrary communicative conventions in experimental microsocieties. *PLoS ONE, 7,* e43807.

Transmission in laboratory ‘societies’

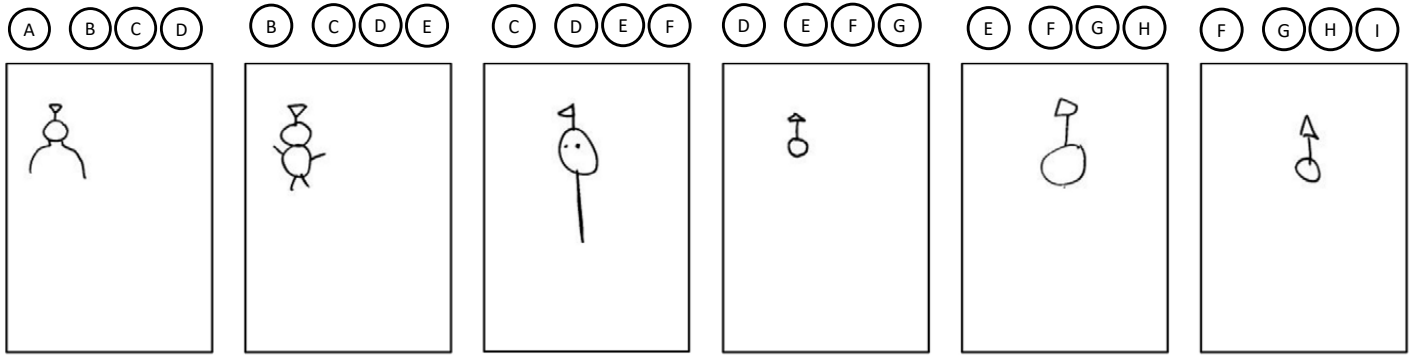
Caldwell, C. A., & Smith, K. (2012). Cultural evolution and the perpetuation of arbitrary communicative conventions in experimental microsocieties. *PLoS ONE, 7,* e43807.

Transmission in laboratory ‘societies’



Caldwell, C. A., & Smith, K. (2012). Cultural evolution and the perpetuation of arbitrary communicative conventions in experimental microsocieties. *PLoS ONE, 7,* e43807.

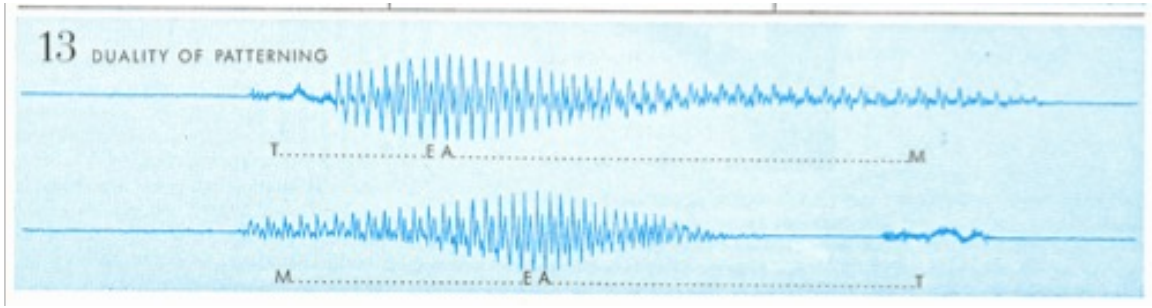
Transmission in laboratory ‘societies’



(potentially) truly arbitrary signals

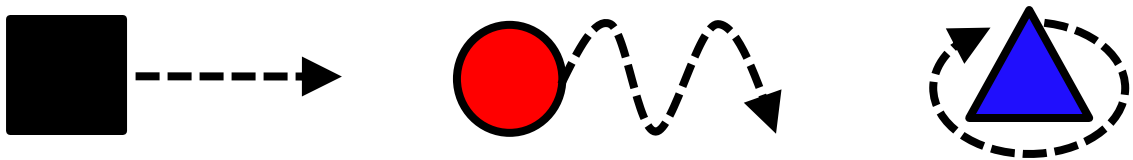
Caldwell, C. A., & Smith, K. (2012). Cultural evolution and the perpetuation of arbitrary communicative conventions in experimental microsocieties. *PLoS ONE, 7,* e43807.

So much for symbols – how about structure?



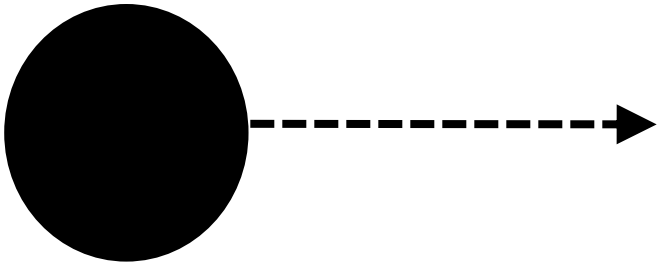
Artificial language learning in the lab

- Adult participants repeatedly trained on set of picture-label pairs
  - An ‘alien language’
- Tested repeatedly
  - Presented with picture, enter label

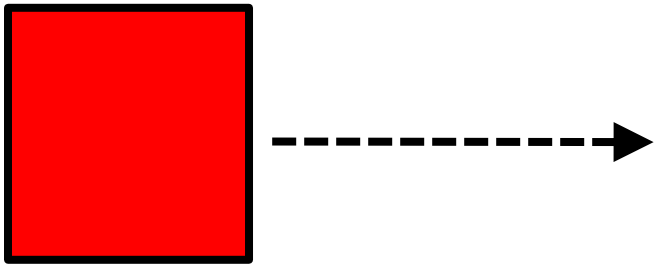


Kirby, S., Cornish, H., & Smith, K. (2008). Cumulative cultural evolution in the laboratory: an experimental approach to the origins of structure in human language. *Proceedings of the National Academy of Sciences, USA, 105,* 10681-10686.

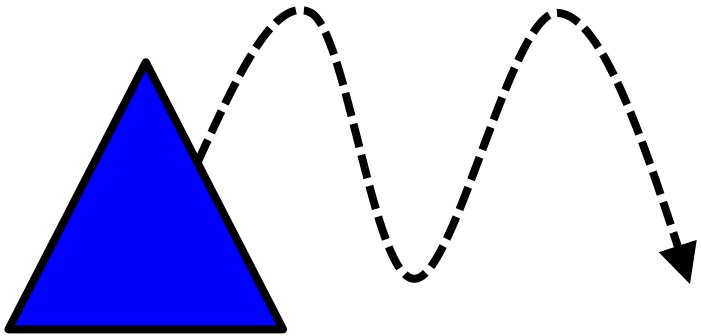
nihepi

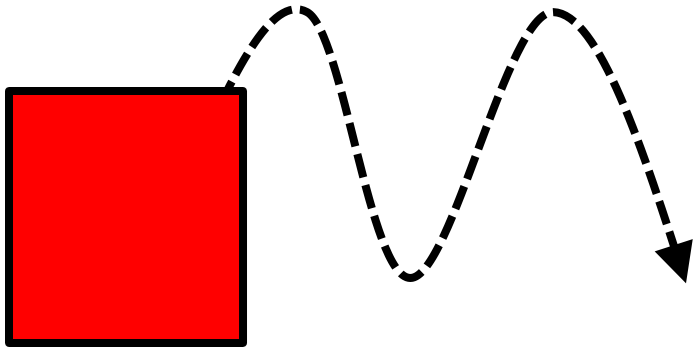


gepini



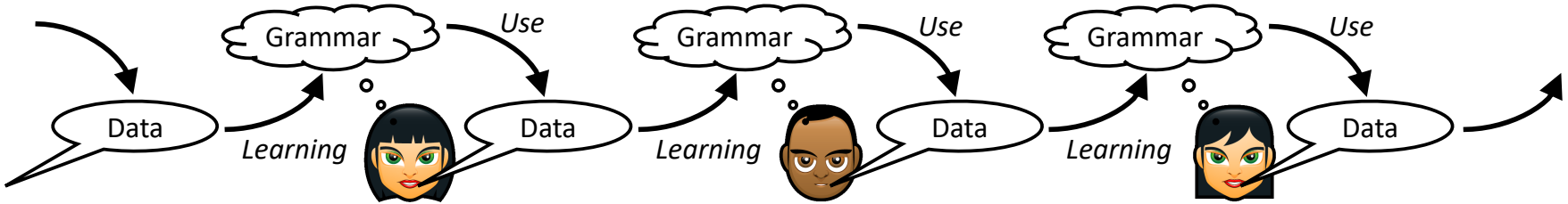
wige





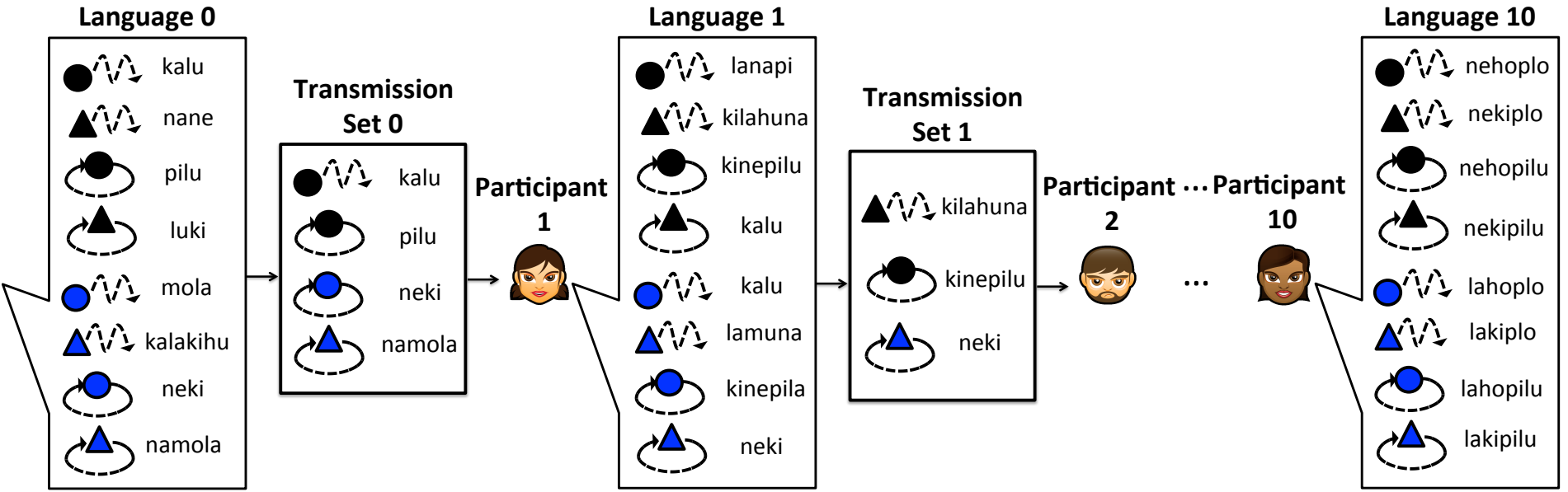
wimaku

Transmission in laboratory ‘societies’



From Smith, K. (2022). How language learning and language use create linguistic structure. *Current Directions in Psychological Science, 31,* 177-186.

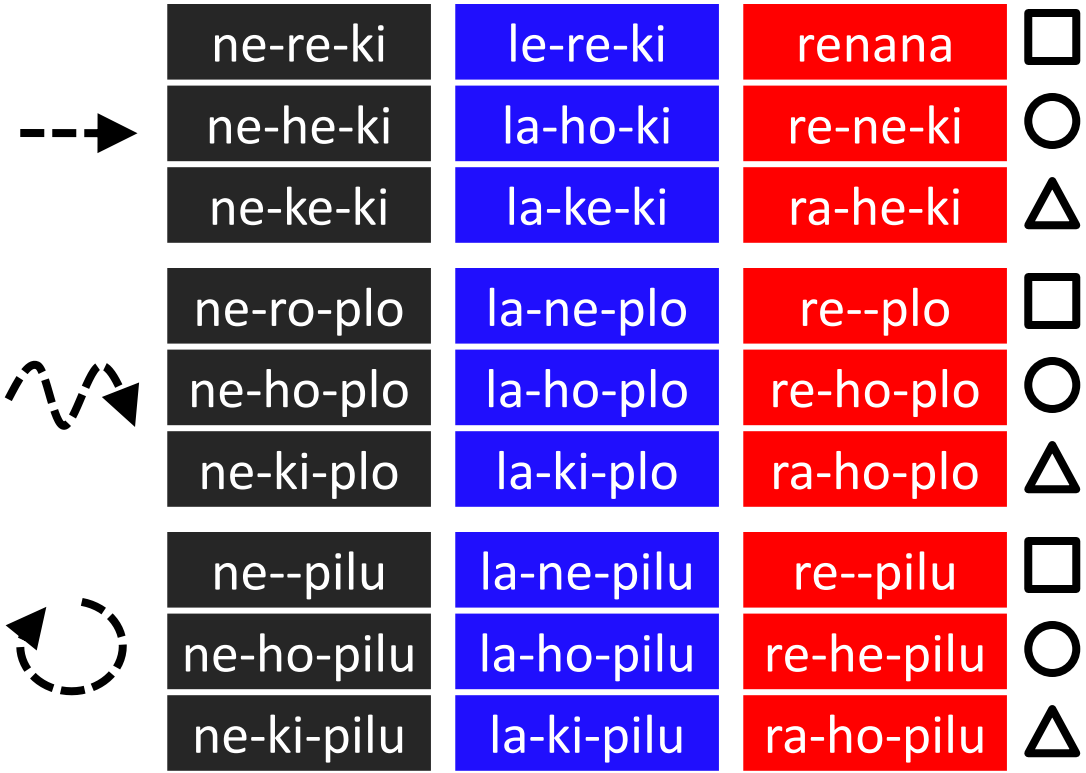
Transmission in laboratory ‘societies’



From Kirby, S., Griffiths, T. L., & Smith, K. (2014). Iterated learning and the evolution of language. *Current Opinion in Neurobiology, 28,* 108-114.

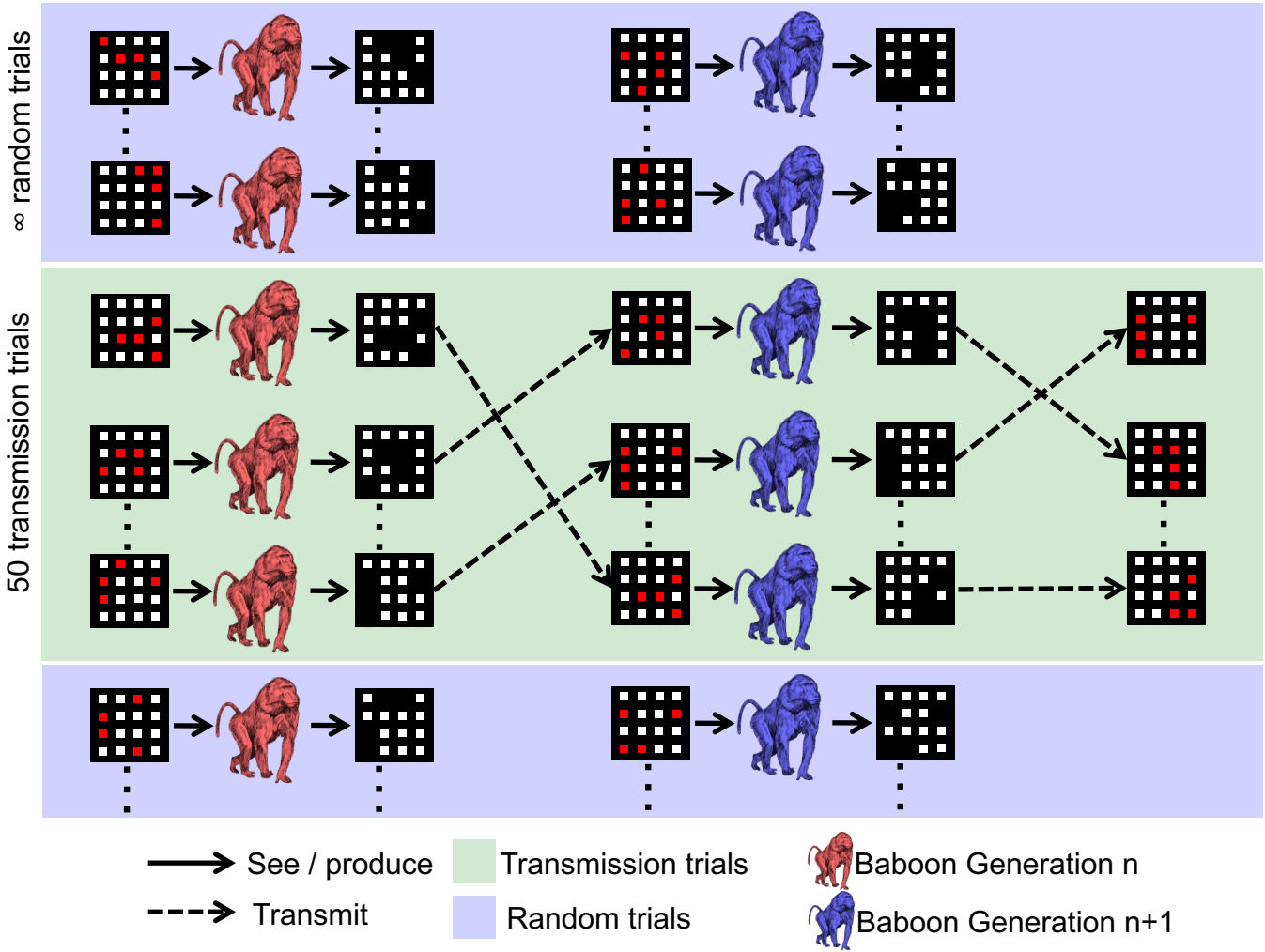
An initial **holistic** language

10 generations later…

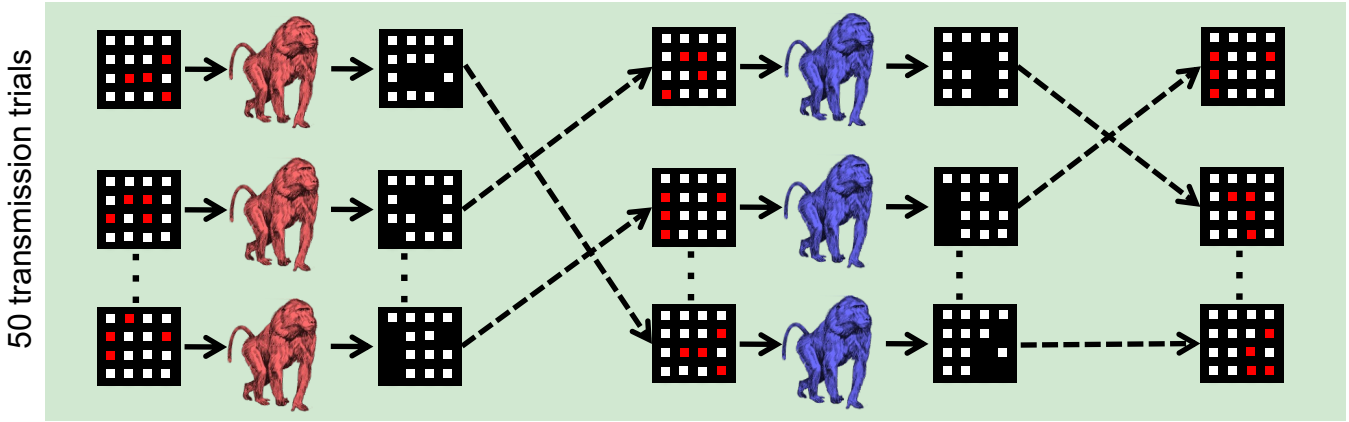


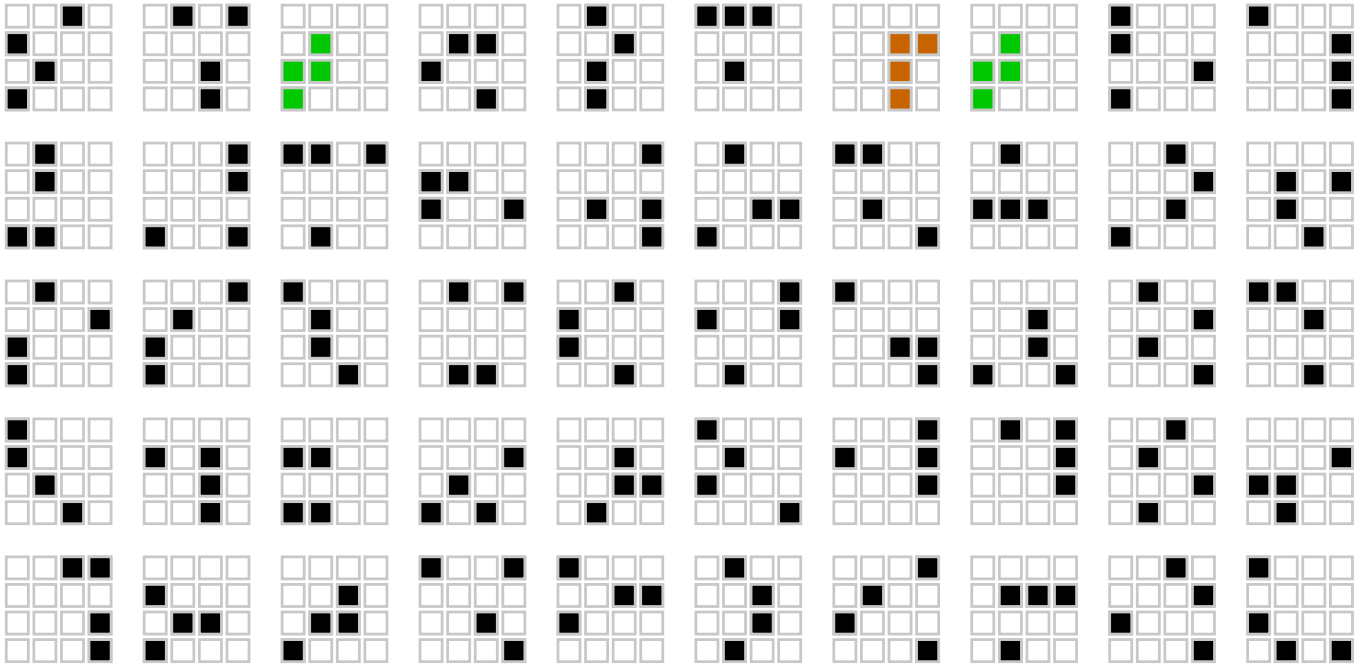
If structure arises from social learning, why isn’t it more common?

Claidière, N., Smith, K., Kirby, S., & Fagot, J. (2014). Cultural evolution of a systematically structured behaviour in a non-human primate. *Proceedings of the Royal Society B, 281,* 20141541.

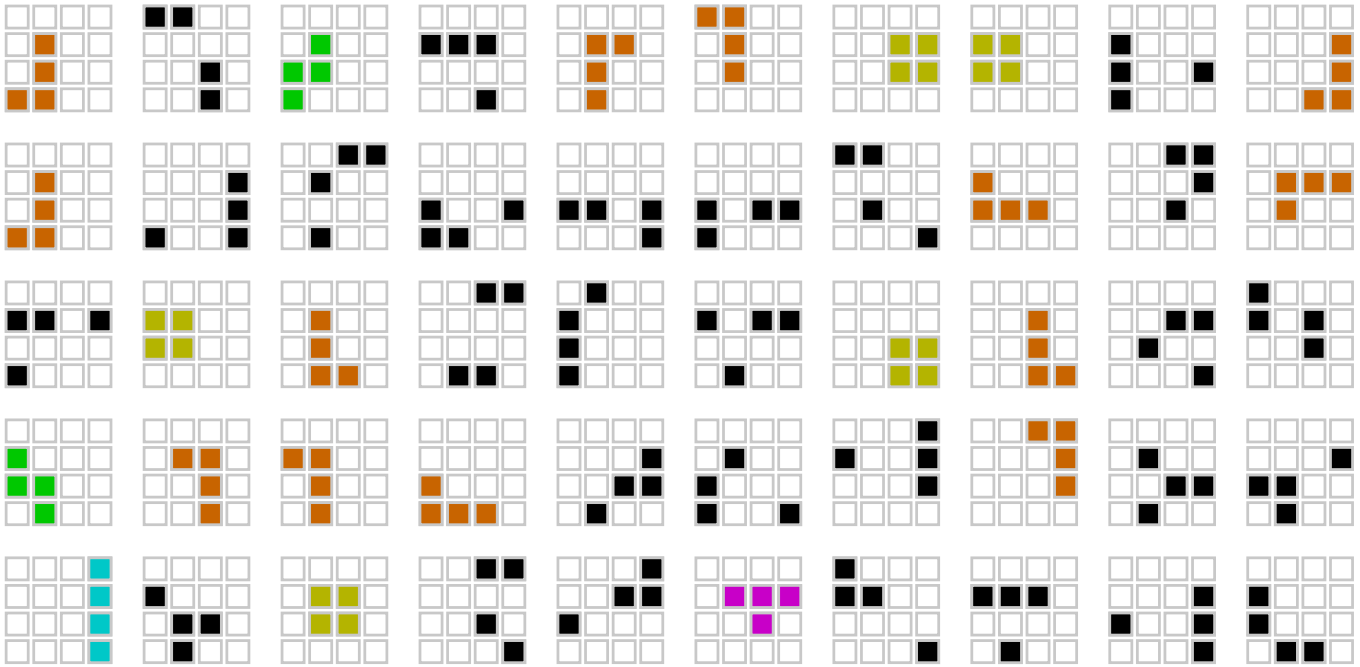

∞ random trials
50 transmission trials
See / produce
Transmit
Transmission trials
Random trials
Baboon Generation n
Baboon Generation n+1

What do you think will happen?

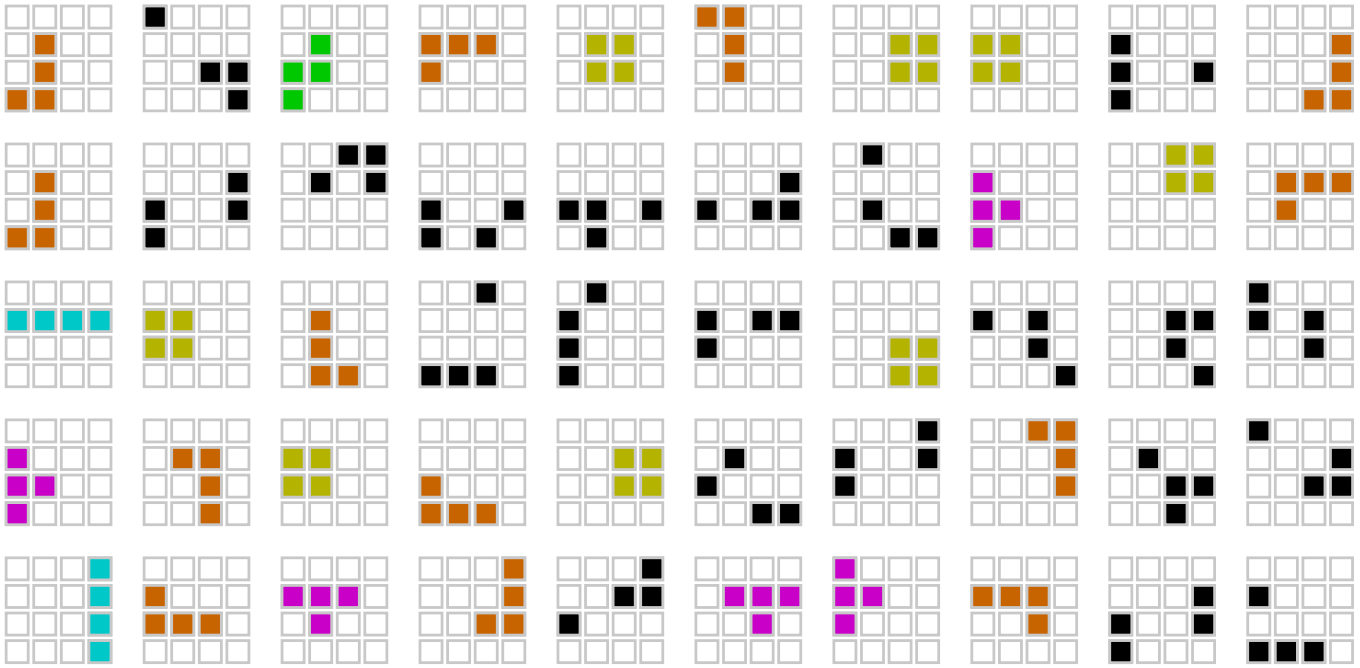




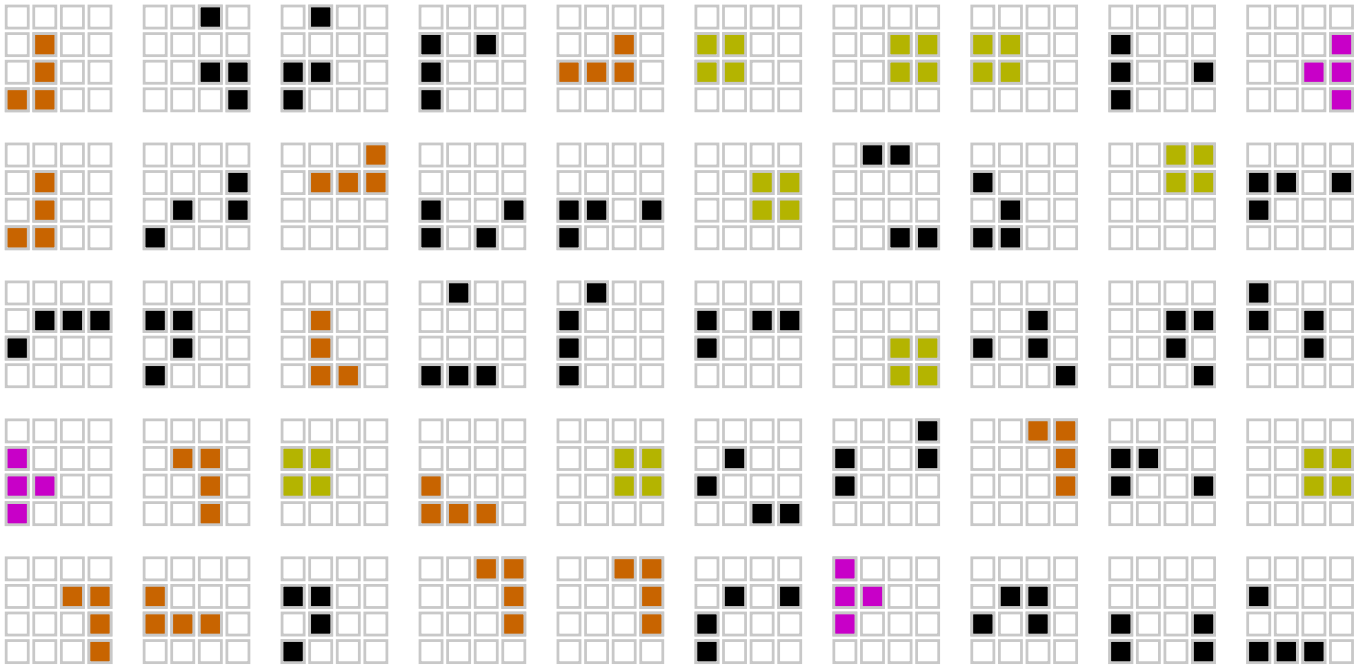
Random grids



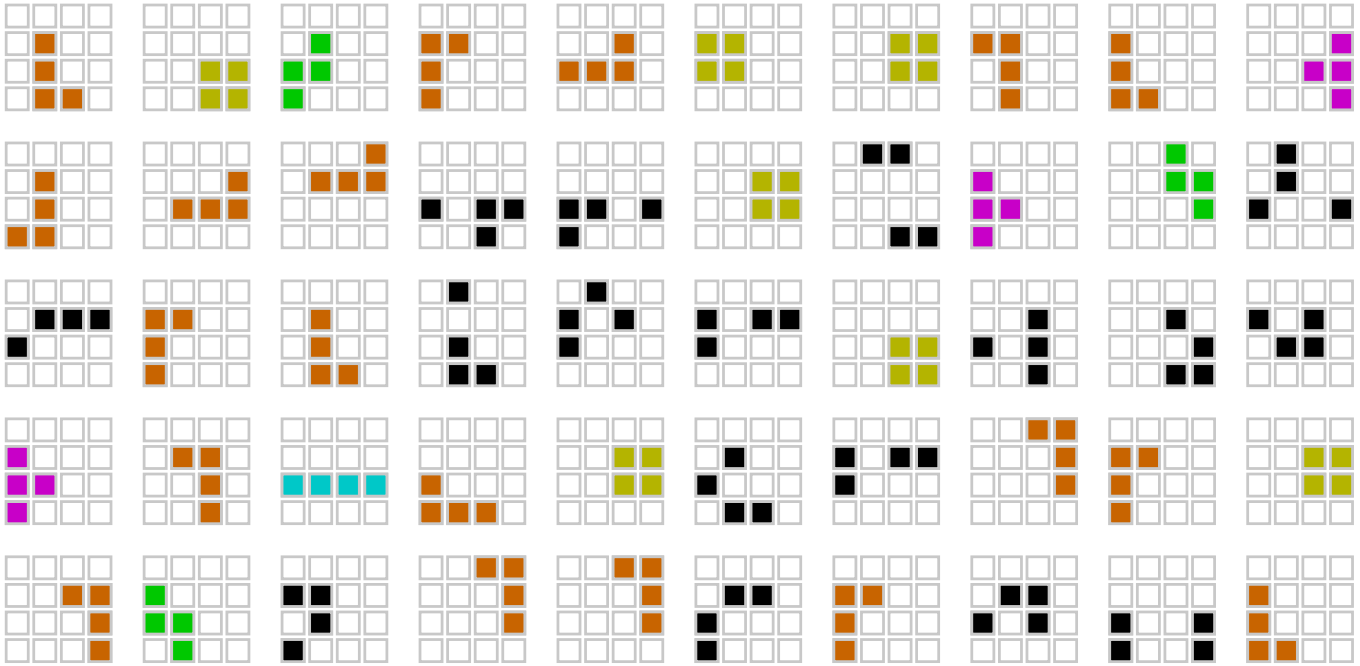
Generation 1



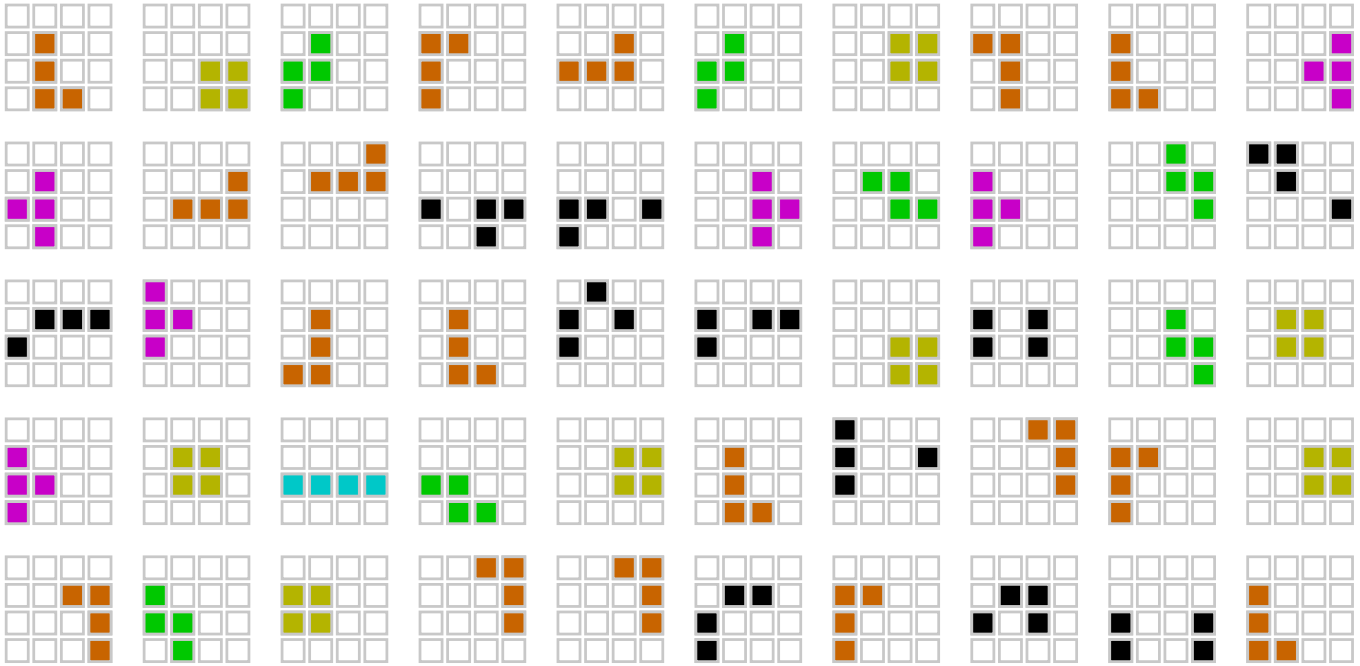
Generation 2



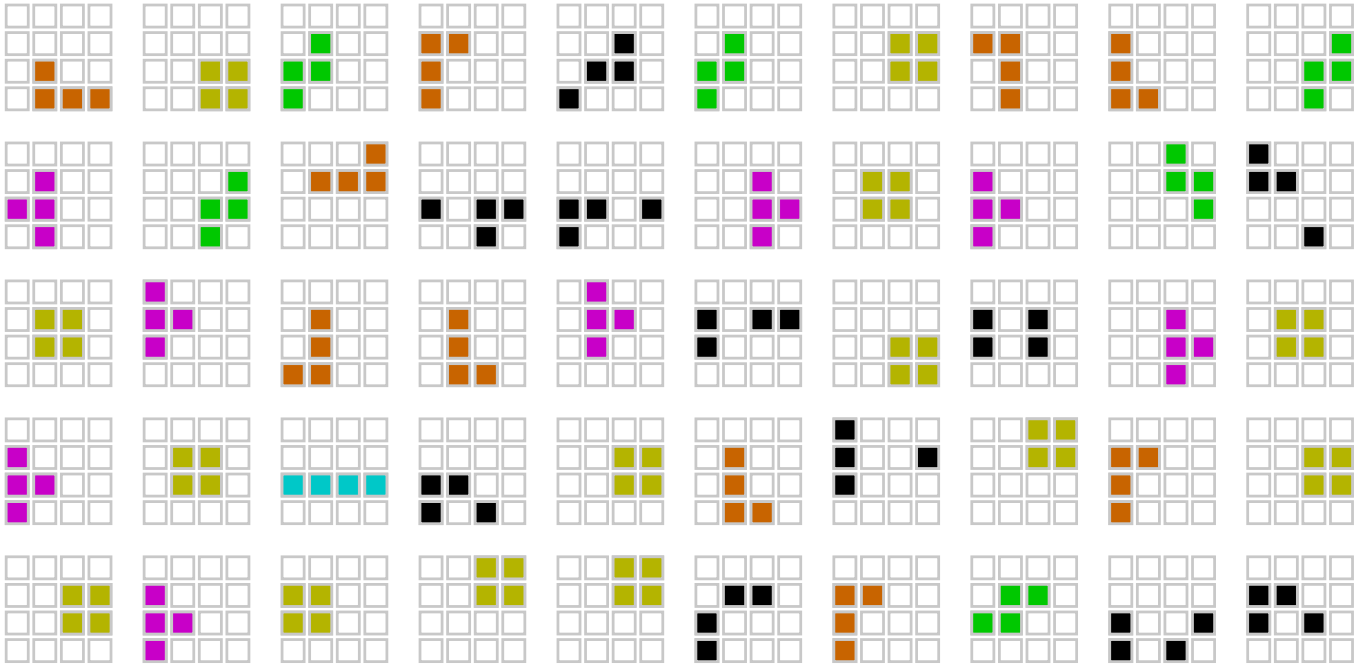
Generation 3



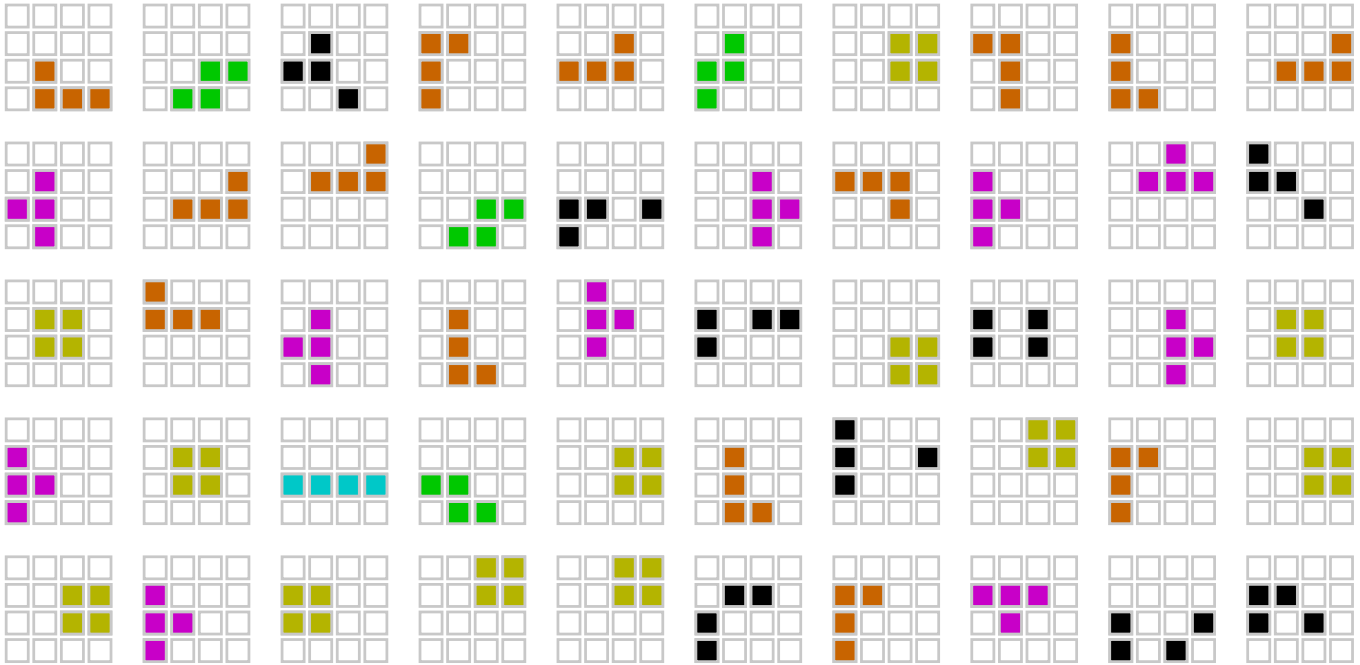
Generation 4



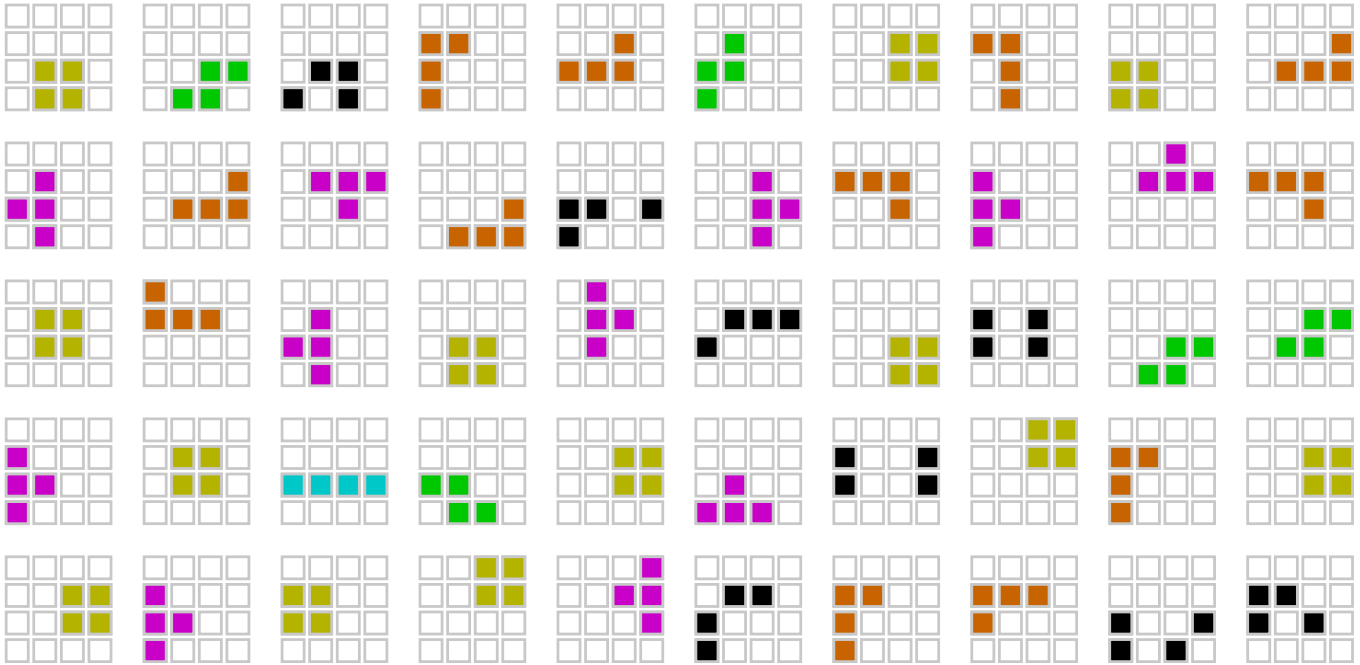
Generation 5



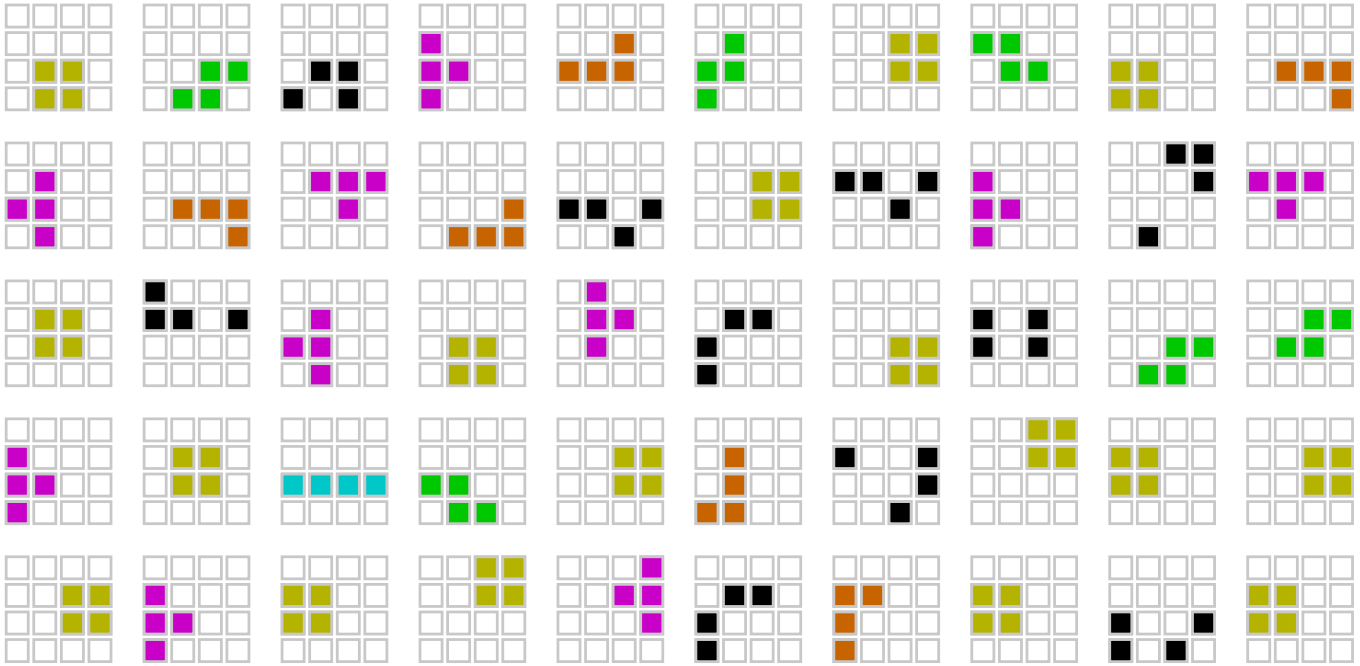
Generation 6



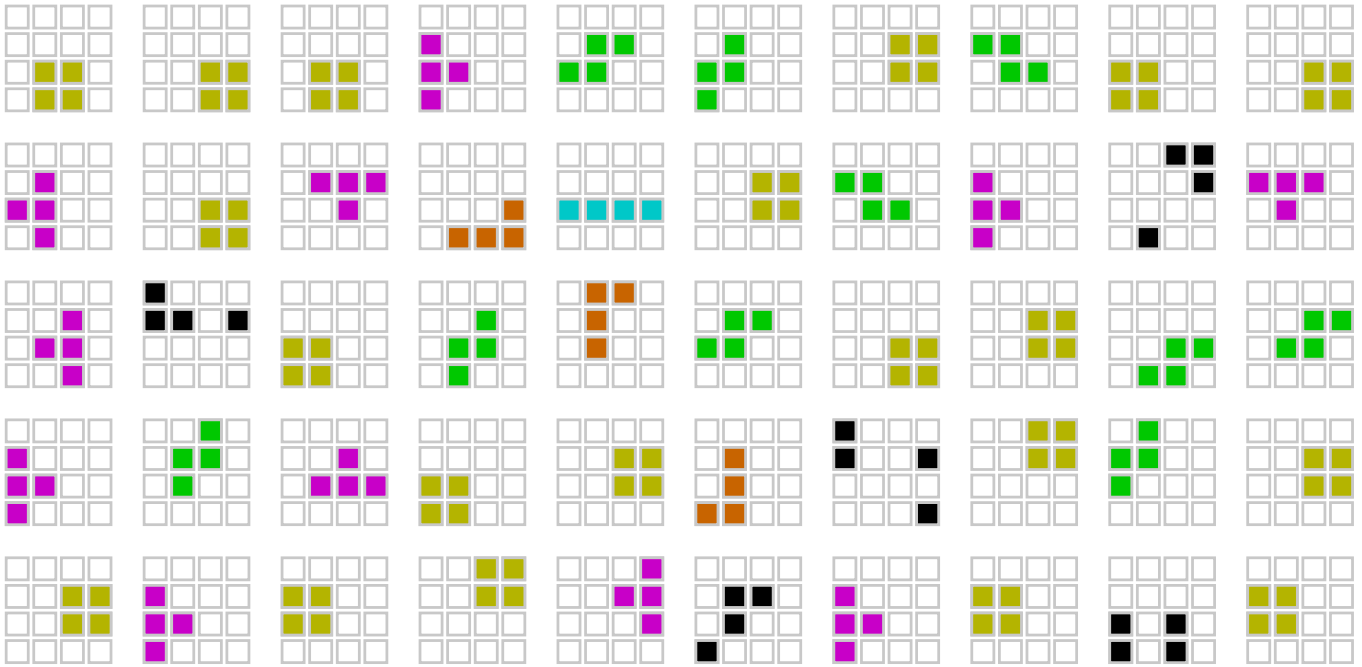
Generation 7



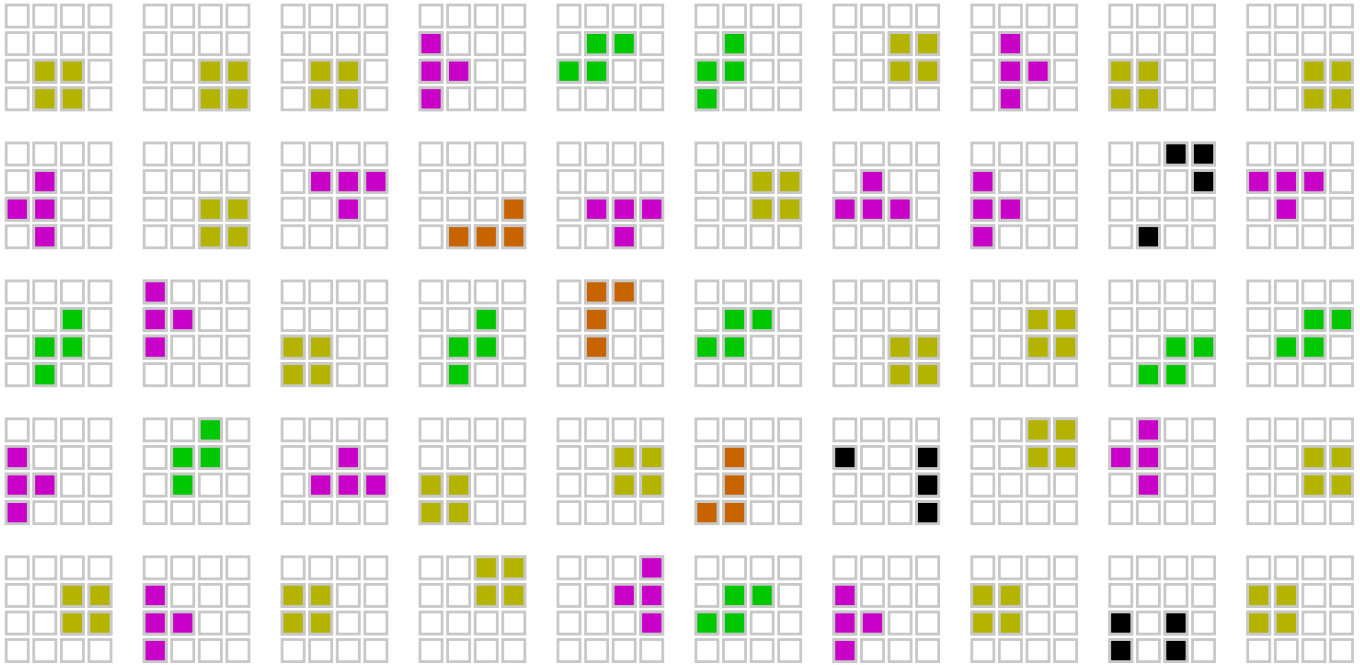
Generation 8



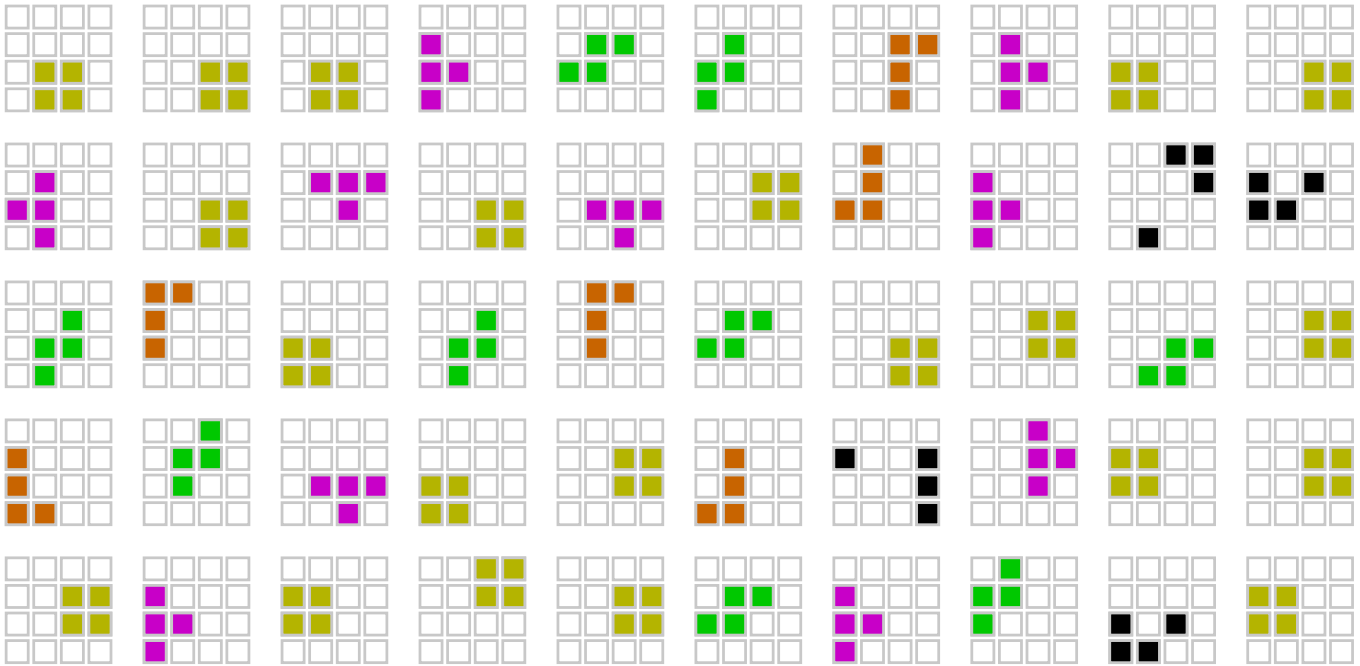
Generation 9



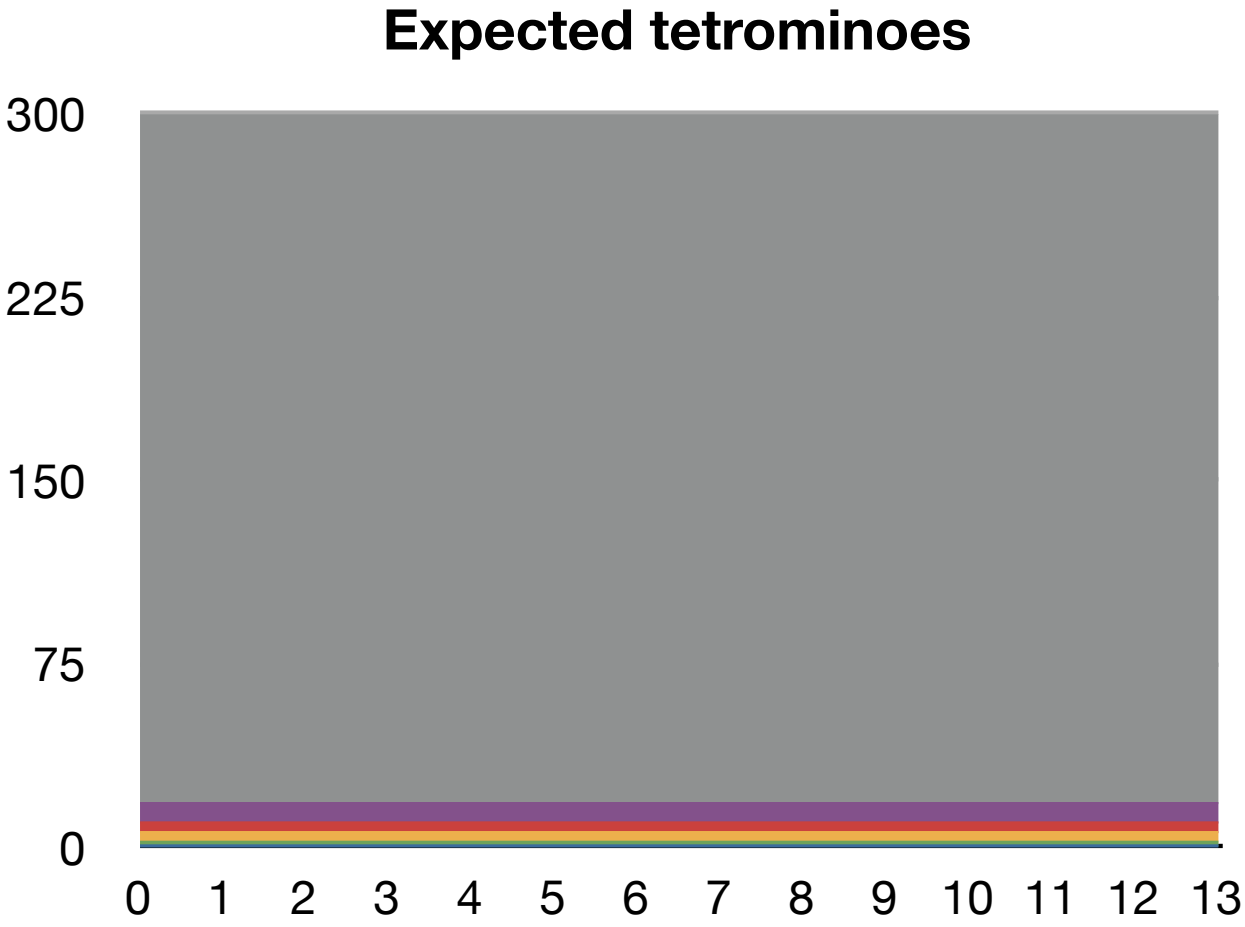
Generation 10



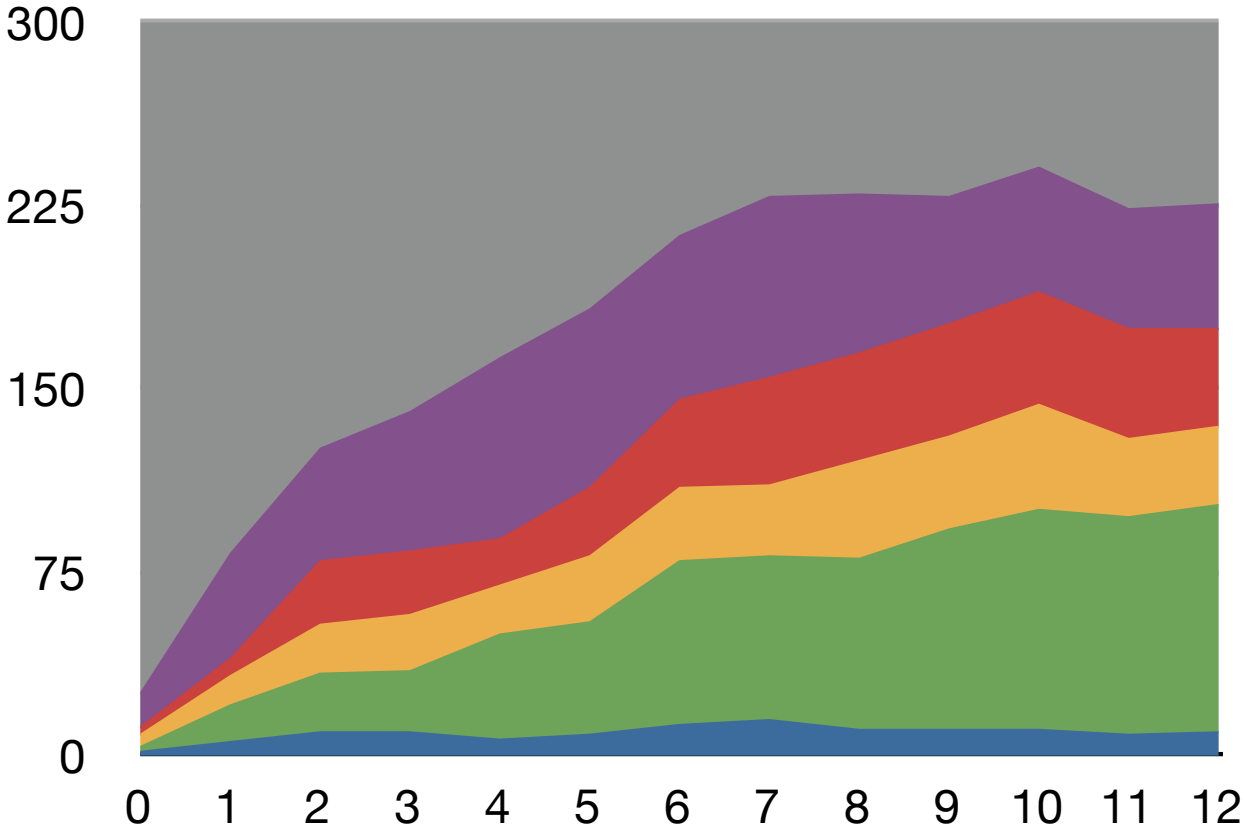
Generation 11

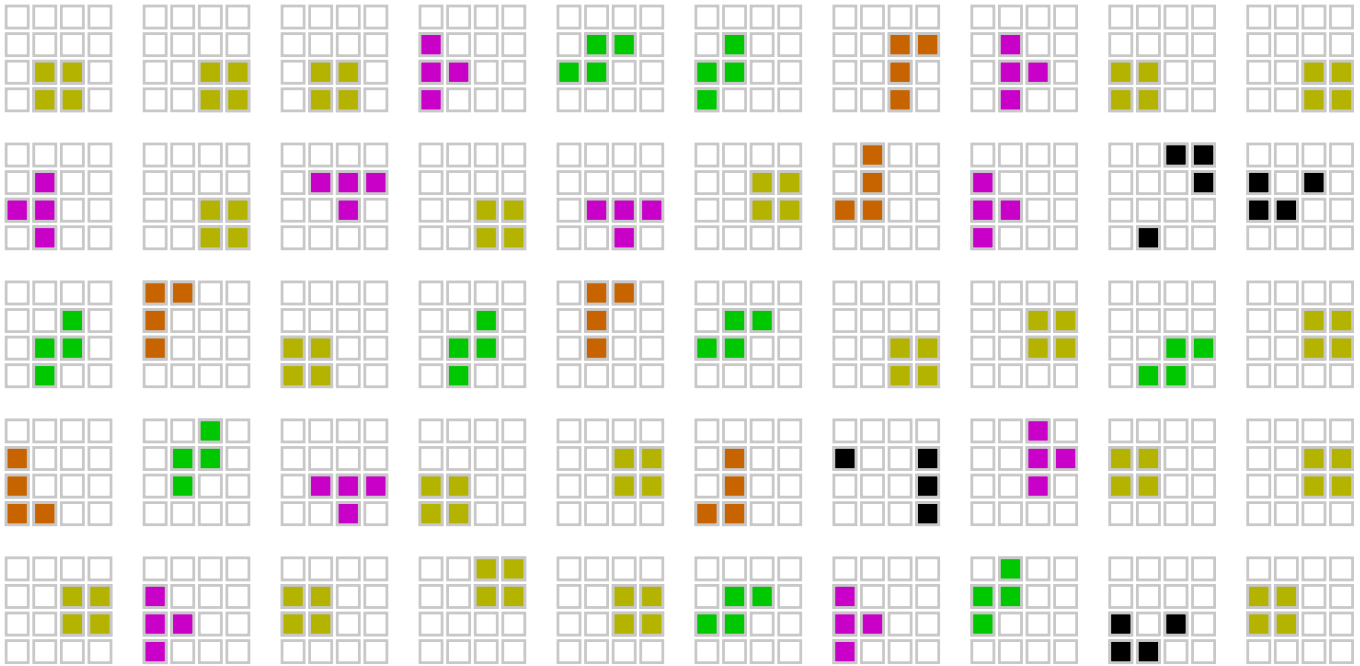


Generation 12


Expected tetrominoes
300
225
150
75
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13

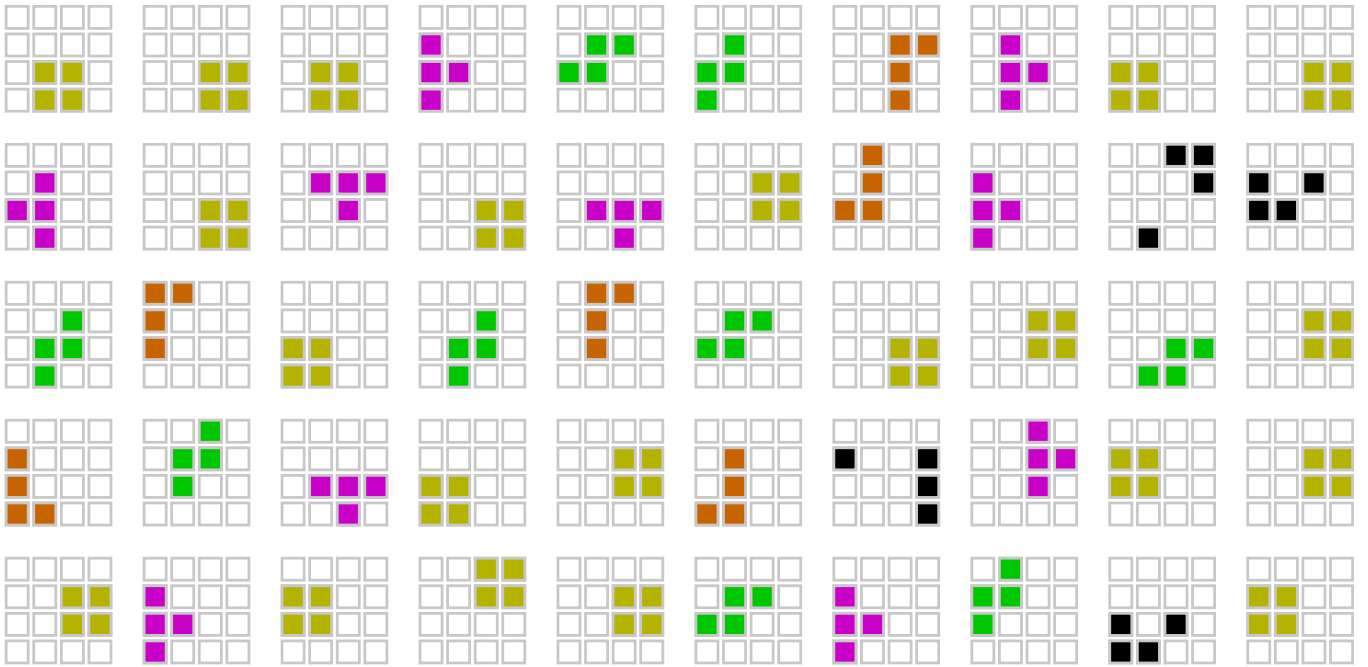
Actual tetrominoes





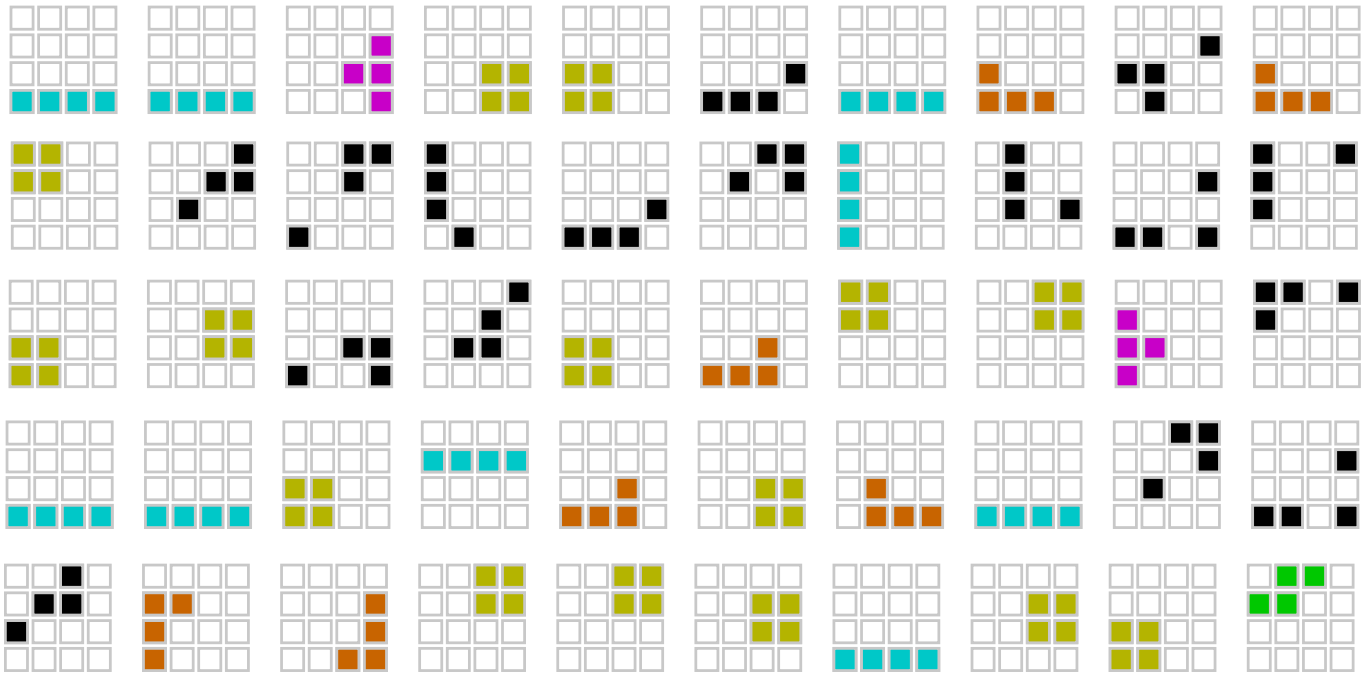
Generation 12

Emergence of a **system**



Chain 4, Generation 12

Emergence of a **system**



Chain 1, Generation 12

Systematic structure develops even in baboons (if you scaffold their environment in the right way)

The idea

- Humans ended up with an unusual combination of traits: ubiquitous social learning (including of vocal signalling) and mental interpenetration
- This set in place a cultural evolutionary process that shaped how language works

Schedule (assuming strikes)

Week	Topic
1	Introduction
2	*No class – strike (TBC)*
3	Natural selection, adaptation and language
4	Intention and structure in animal communication
5	*No class*
6	Social learning and cumulative culture
7	Speech, vocal learning, grammar learning
8	Evolution of social cognition
9	Cultural evolution of language
10	Sign language and language origins
	~~Gene-culture co-evolution~~

Next lecture

- What is evolution? What is adaptation? How can we learn about humans by studying other animals?
- Language as a biological adaptation, evolved through natural selection under pressure for communication