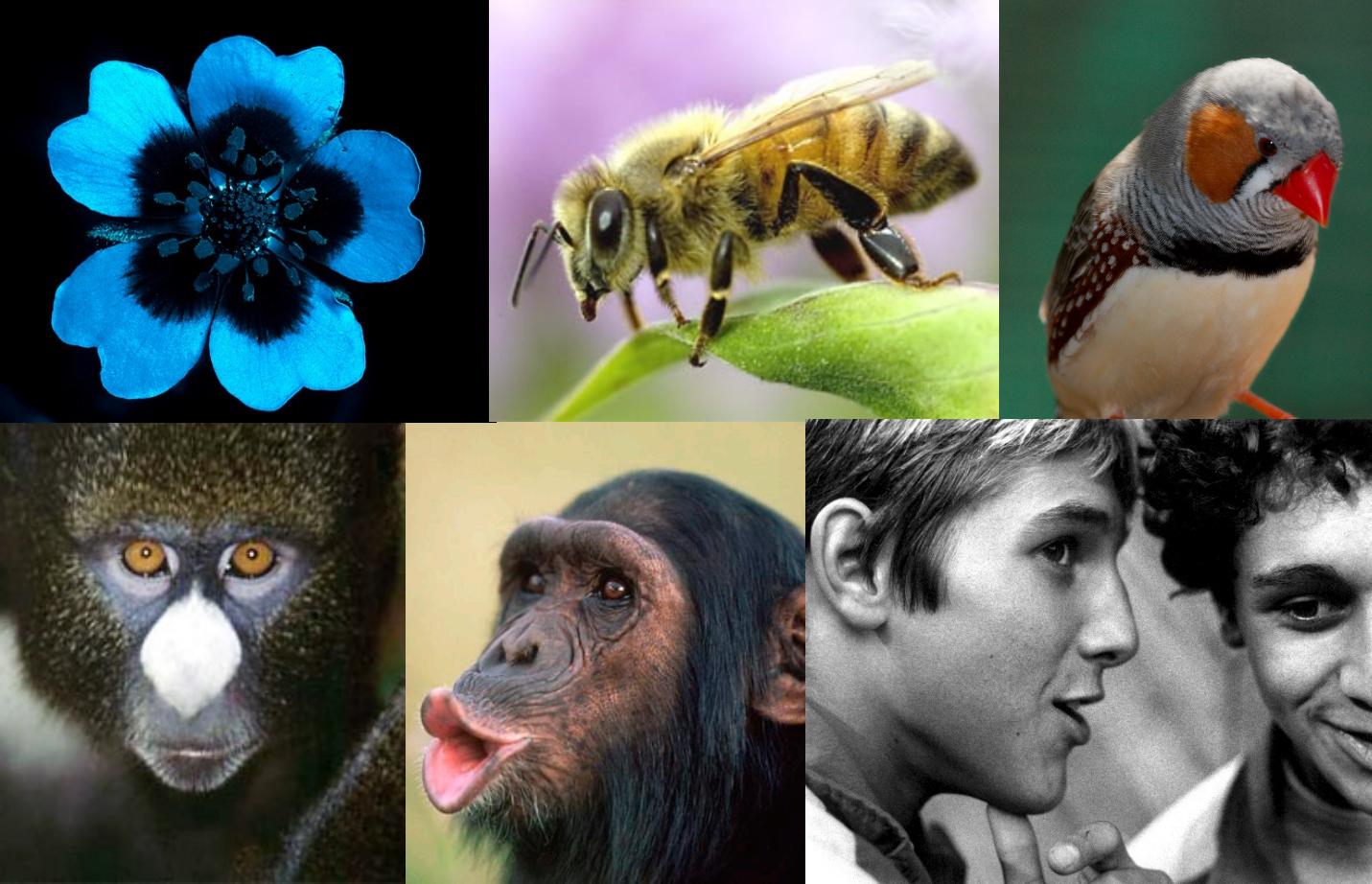


# Origins and Evolution of Language

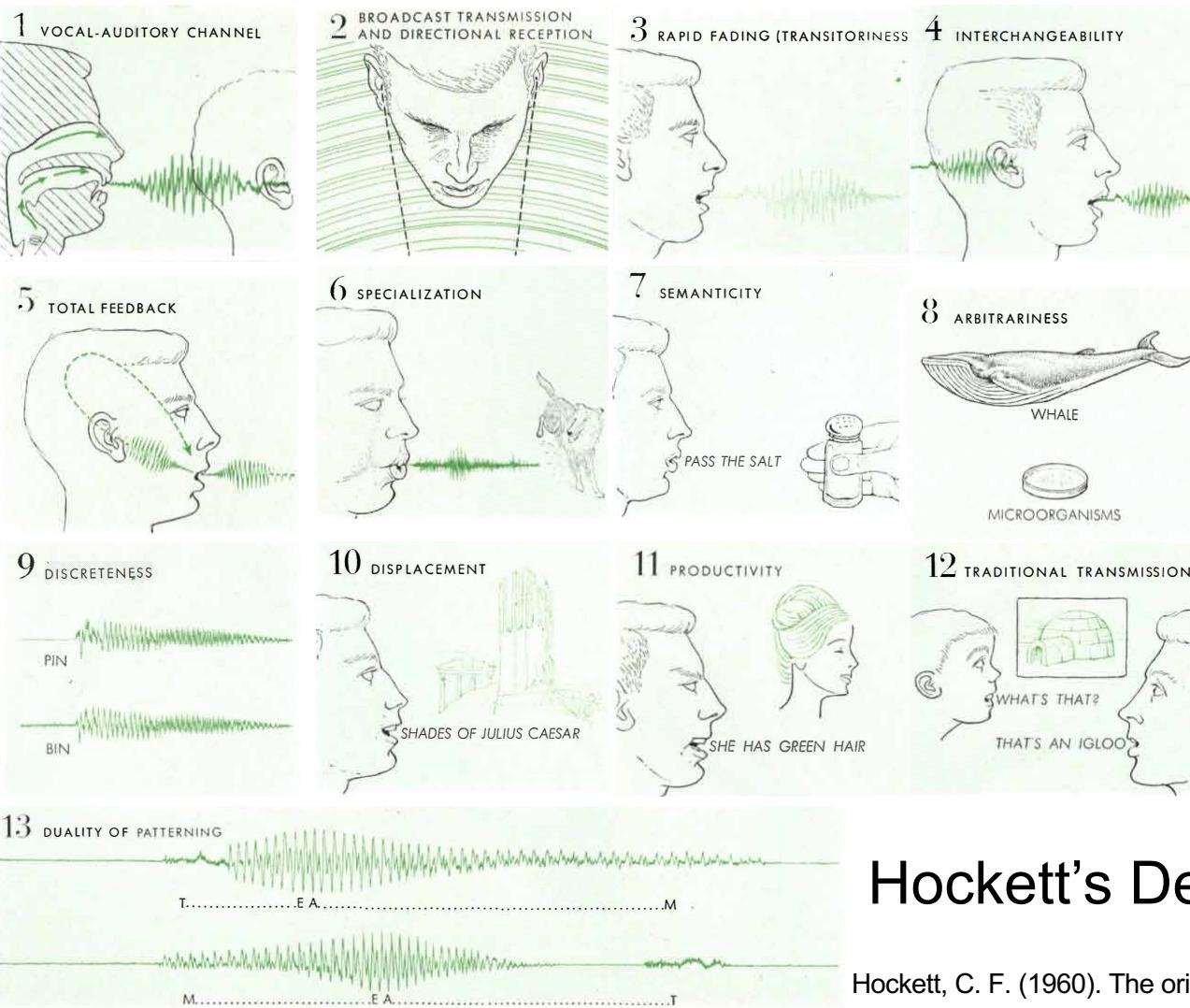
## Week 1: Introduction

**Kenny Smith**

[kenny.smith@ed.ac.uk](mailto:kenny.smith@ed.ac.uk)



Communication is widespread, but language is unique



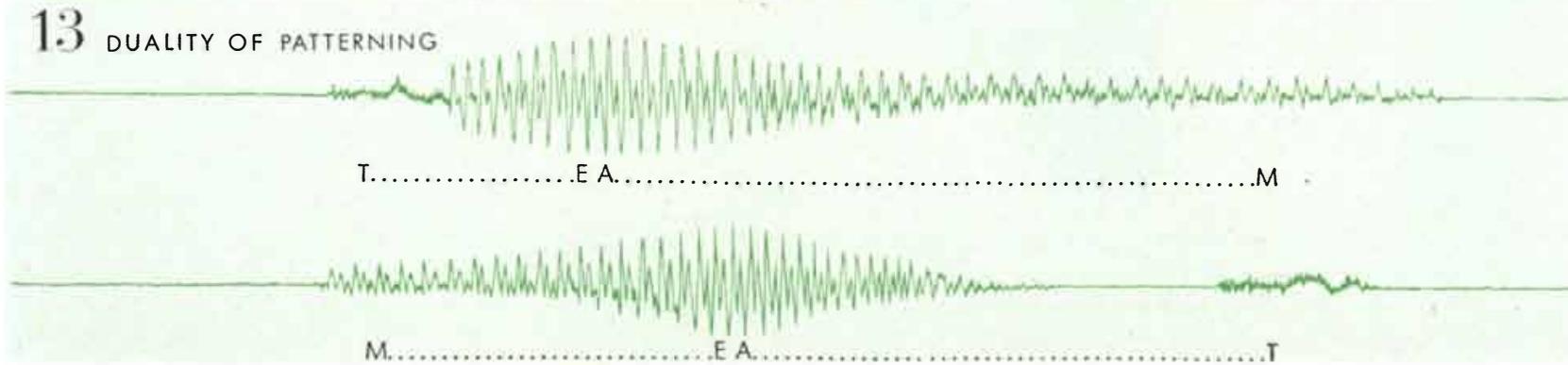
## Hockett's Design features

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



# Language's communicative power comes from its structure

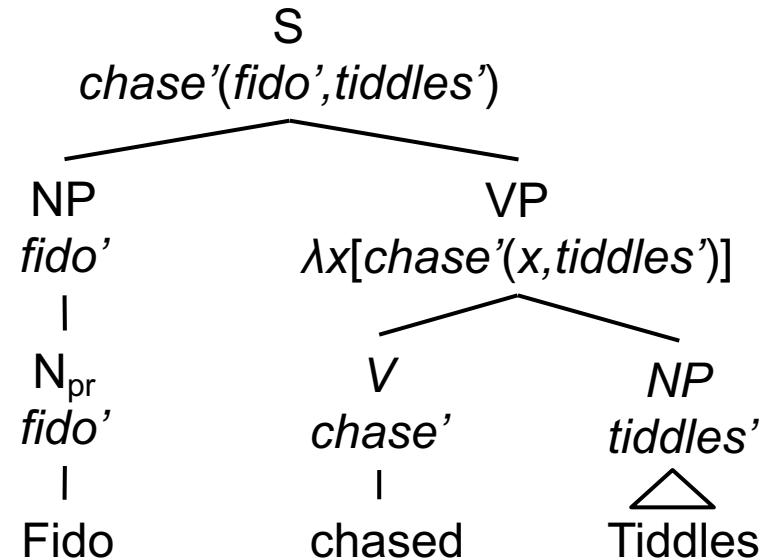
**Duality of patterning:** meaning-bearing units composed of (re)combinations of meaningless differentiating units

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

# 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

$S \rightarrow NP VP$	$VP'(NP')$
$NP \rightarrow N_{pr}$	$N'_{pr}$
$N_{pr} \rightarrow Fido$	$fido'$
$N_{pr} \rightarrow Tiddles$	$tiddles'$
$VP \rightarrow V NP$	$V'(NP')$
$V \rightarrow \text{chased}$	$\lambda x [\lambda y [(\text{chase}'(x,y))]]$



# 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 dɒg kat ðat spot ...  
(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



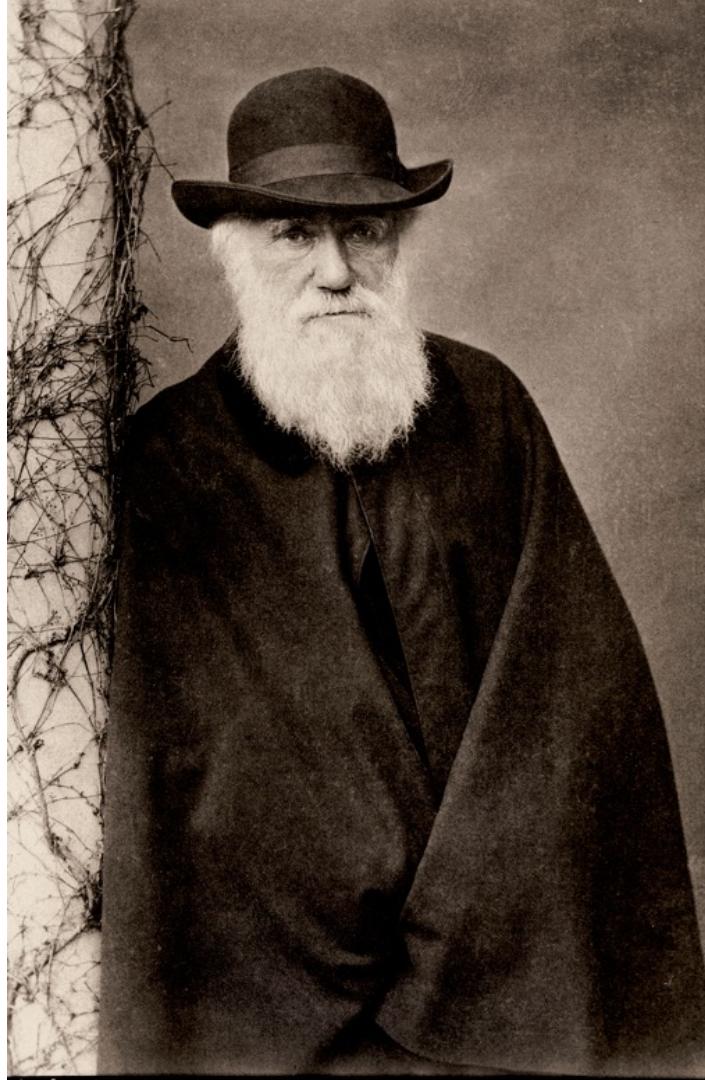
# A tool for the communication of knowledge and internal states



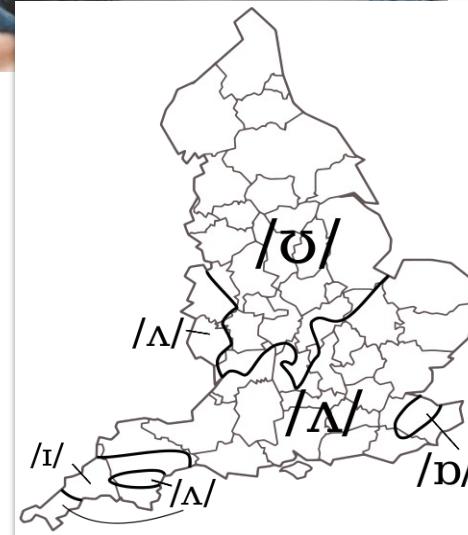
# One possible explanation

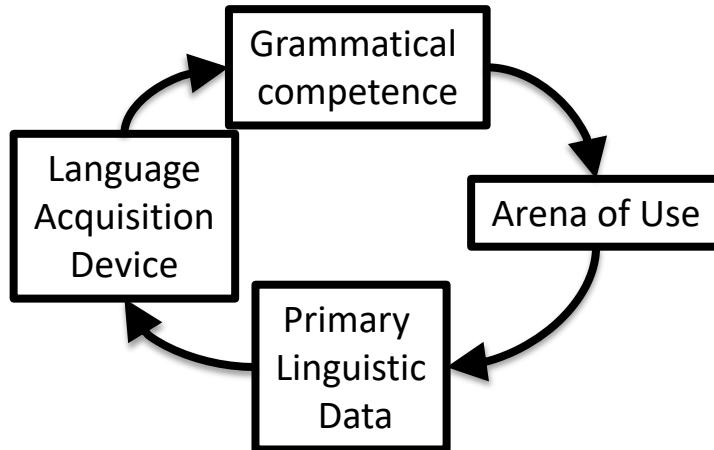
- Language is just like any other adaptive feature of an organism's biology
- It's an **innate** feature of the human mind
- It evolved by natural selection under pressure for communication

More on this in week 2



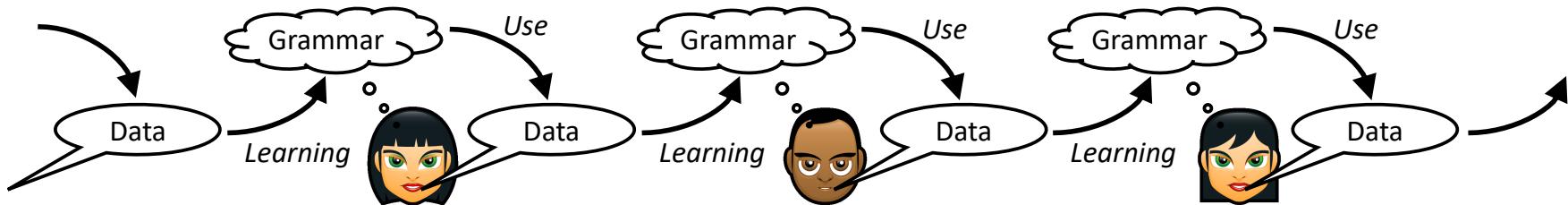
# Social learning is ubiquitous in humans





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

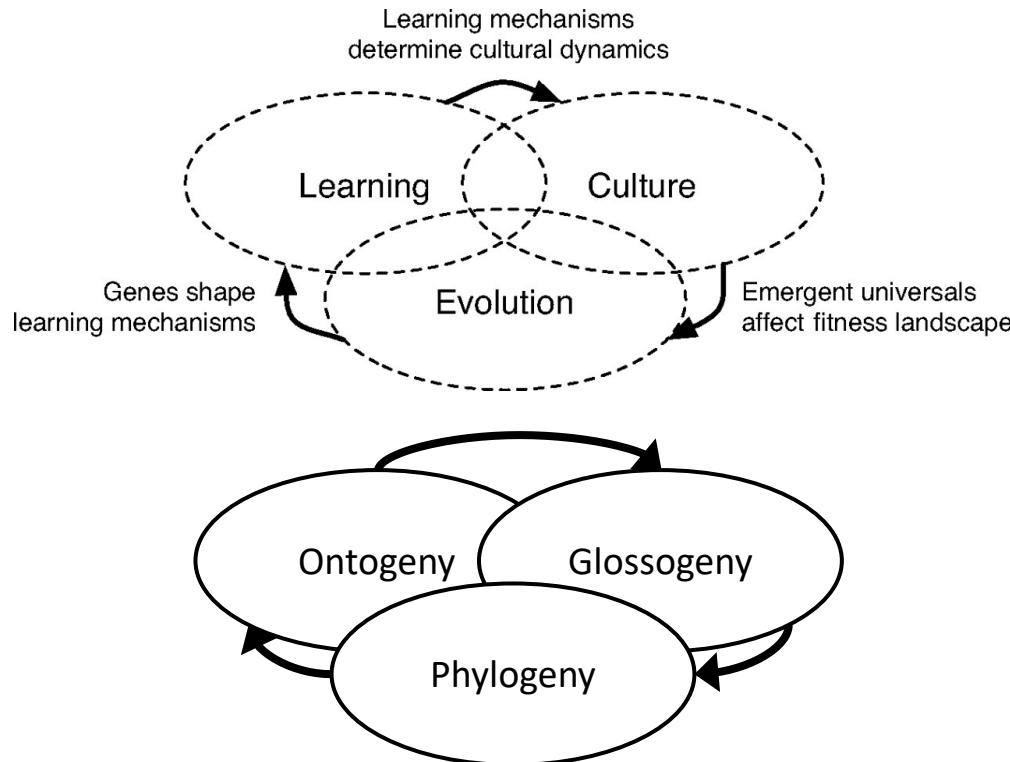
Language is shaped as a consequence of these processes



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

# Schedule

Week	Topic
1	Introduction
2	Natural selection, adaptation and language
3	Intention and structure in animal communication
4	Social learning and cumulative culture
5	Evolution of speech, vocal learning
<i>Flexible learning week</i>	
6	<i>No class (essay 1 due this week)</i>
7	Evolution of social cognition
8	Cultural evolution of language
9	Sign language and language origins
10	Gene-culture co-evolution

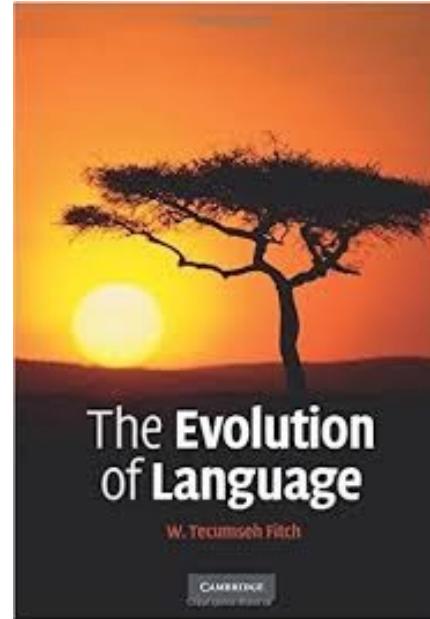
<https://kennysmithed.github.io/origins2223/>

# Pre-lecture preparation

- **Readings must be done in advance**
- Do the reading, answer the quiz questions on Top Hat
  - 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

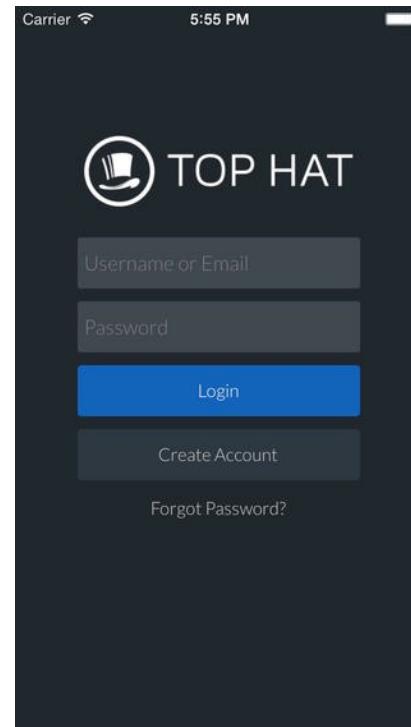
# Tecumseh Fitch

## *The Evolution of Language*



# Top Hat for reading quizzes and in-class voting

- Instructions for registering on Learn/github
- <https://app-ca.tophat.com/>
- Origins class code: 285083



# Tutorials

- Tutorials will start in week 2
- Weeks 2-3: an easy start
- Later weeks: **debates**



**Maisy Hallam**  
Friday 10-11  
Friday 12-1



**Aislinn Keogh**  
Wednesday 2-3  
Thursday 2-3



**Lauren Fletcher**  
Wednesday 10-11  
Wednesday 2-3

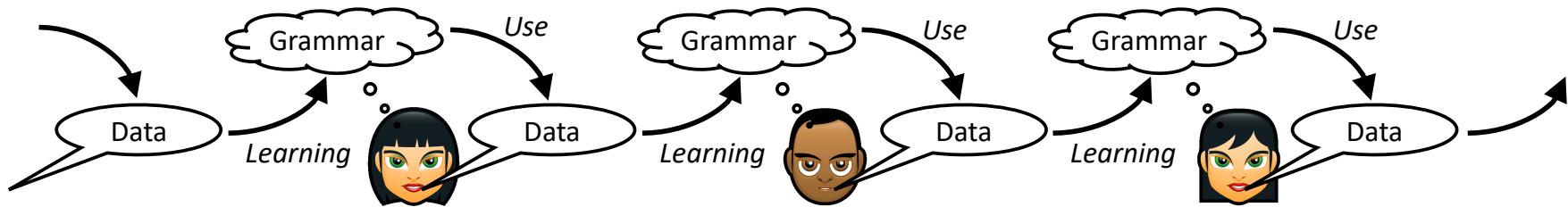
# Assessment

- 1.5k word essay (50% for undergrads, 40% for postgrads)
  - List of topics to be provided (end of week 3 at the latest)
  - **Due 2<sup>nd</sup> March**
- 1.5k word essay (50% for undergrads, 60% for postgrads)
  - Same list of topics
  - **Due 13<sup>th</sup> April**

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 be learnable yet communicatively powerful

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

# What's required for this to happen?

Social learning,  
vocal learning



Mitteilungsbedürfnis  
and mindreading



# What's required for this to happen?

Social learning,  
vocal 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

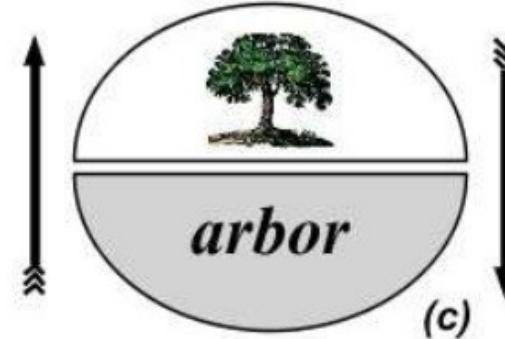
# What's the evidence?

- 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)

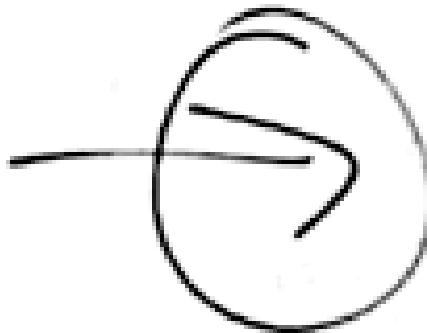
# Where do symbols come from?

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



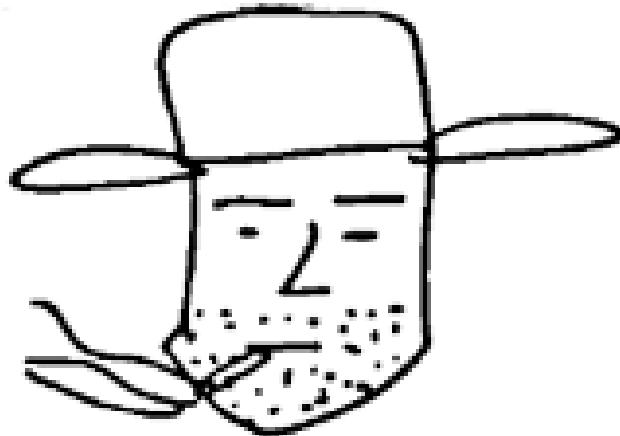
# Ritualization in the lab, with humans

Repeated interaction in a Pictionary-like communication task

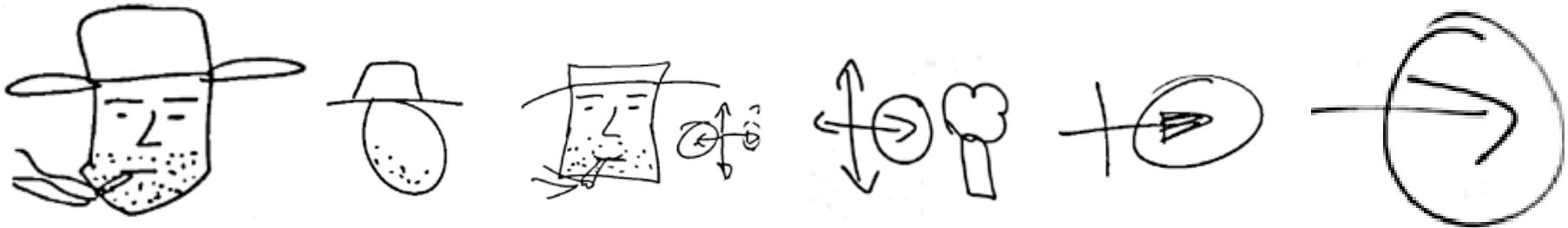


# Ritualization in the lab, with humans

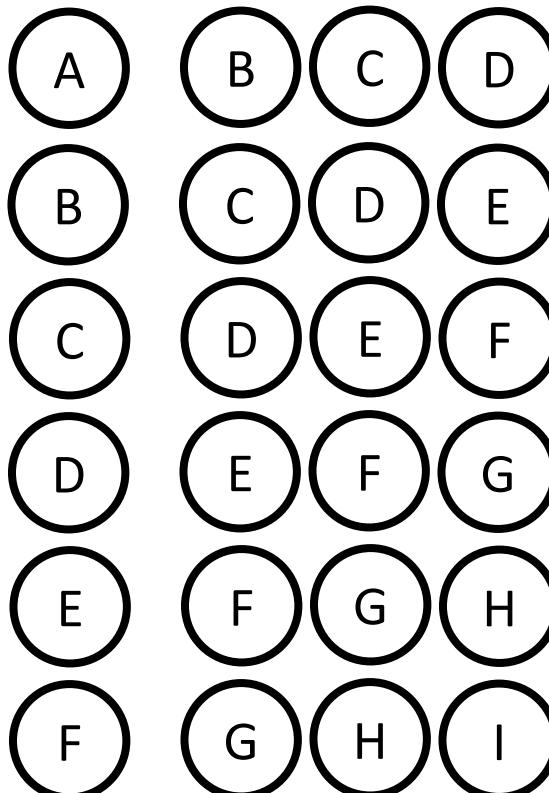
Repeated interaction in a Pictionary-like communication task



# Ritualization in the lab



# Transmission in laboratory ‘societies’



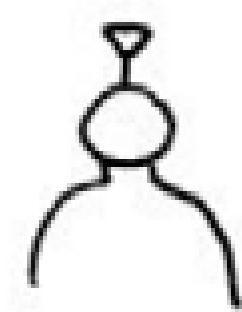
Caldwell, C. A., & Smith, K. (2012). Cultural evolution and the perpetuation of arbitrary communicative conventions in experimental microsocieties. *PLoS ONE*, 7, e43807.

# Transmission in laboratory ‘societies’



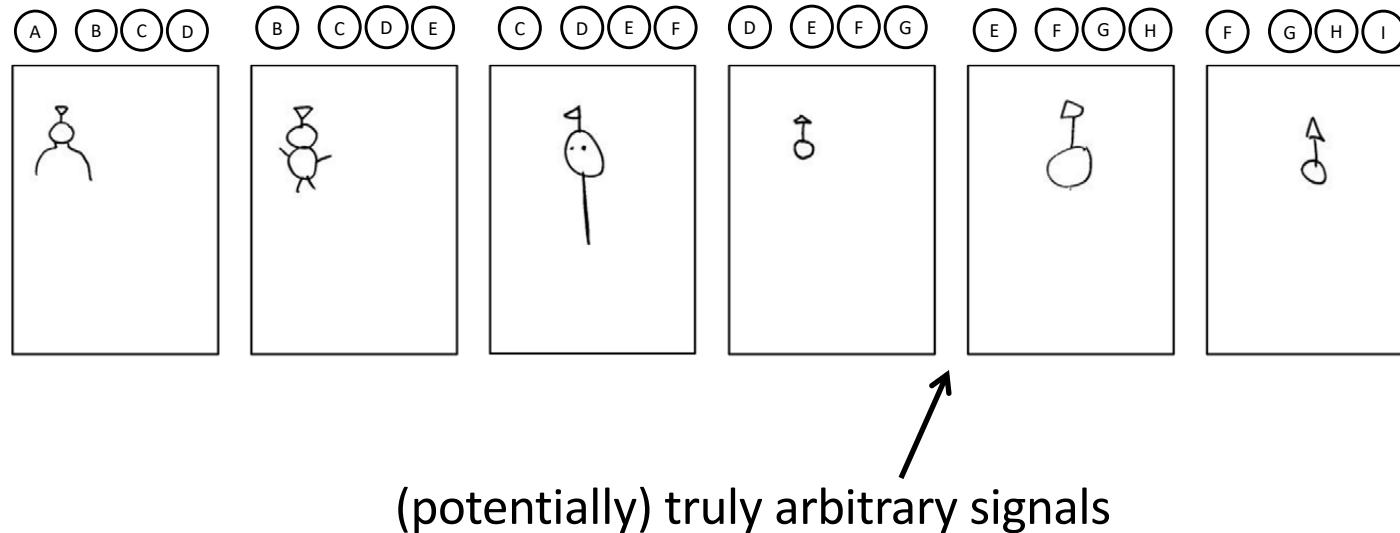
Caldwell, C. A., & Smith, K. (2012). Cultural evolution and the perpetuation of arbitrary communicative conventions in experimental microsocieties. *PLoS ONE*, 7, e43807.

# 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.

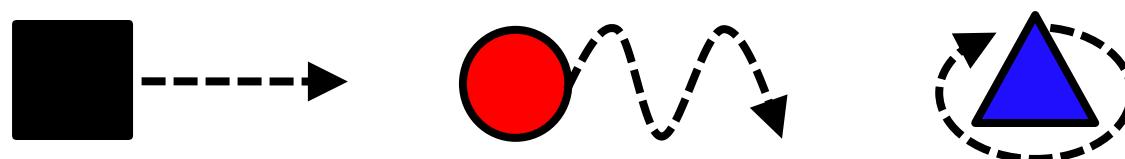
# Transmission in laboratory ‘societies’



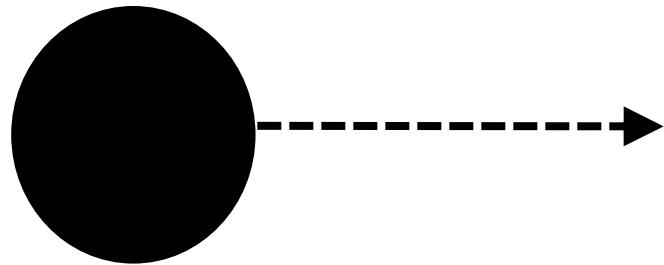
So much for symbols – how about structure?

# Artificial language learning in the lab

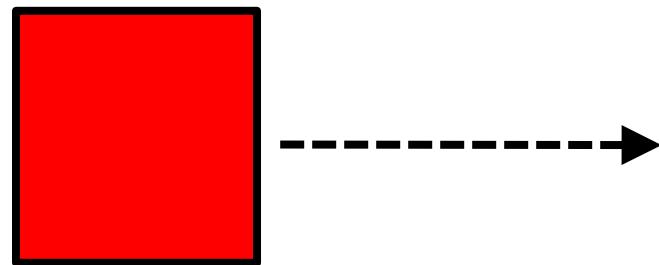
- Adult participants repeatedly trained on set of picture-label pairs
  - An ‘alien language’
- Tested repeatedly
  - Presented with picture, enter label



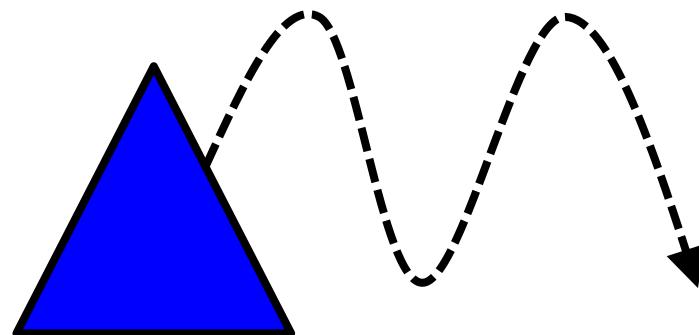
nihepi

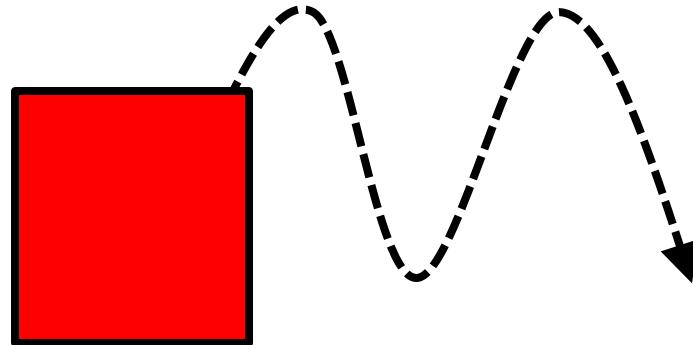


gepini



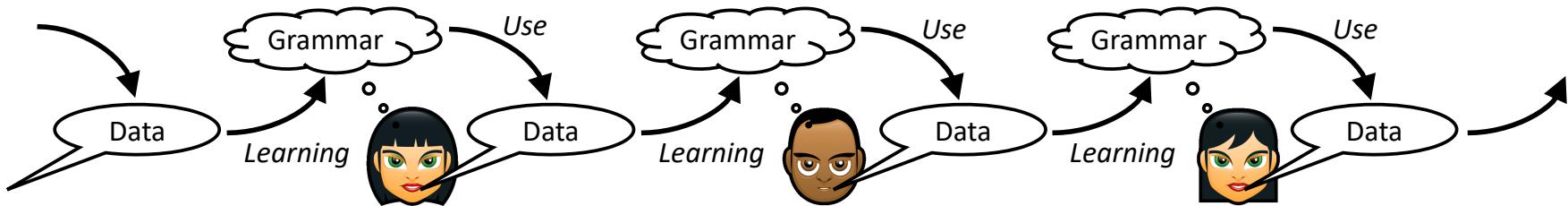
wige





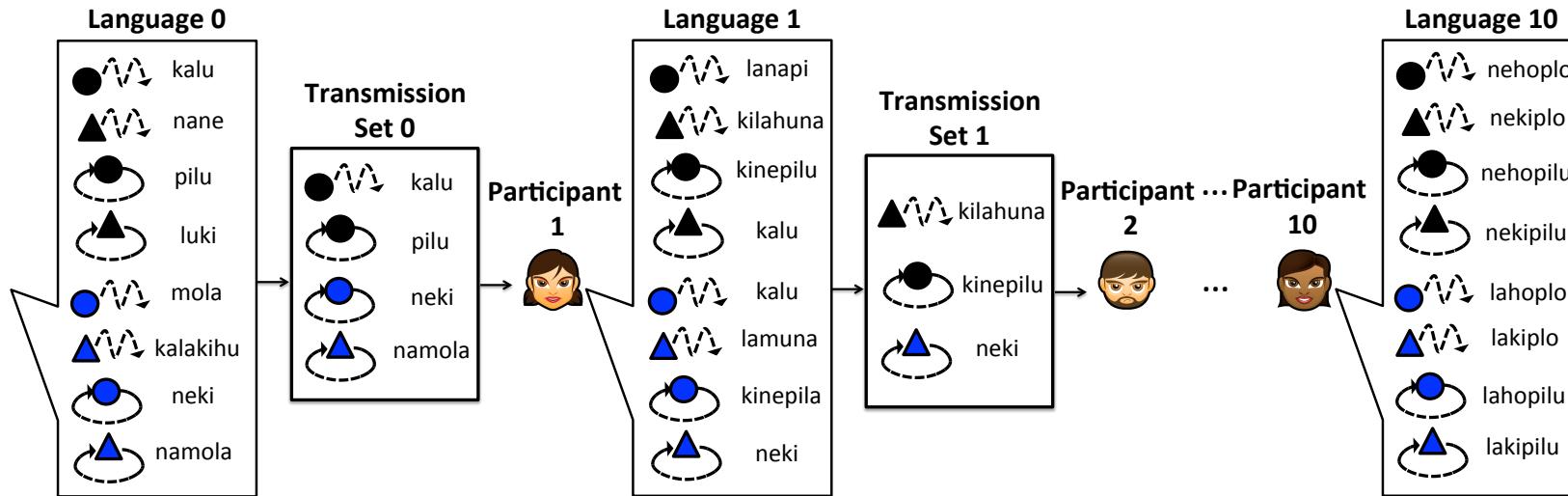
wimaku

# 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.

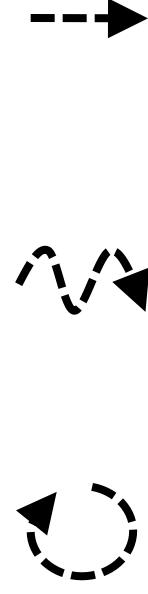
# Transmission in laboratory ‘societies’



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

wimaku	miniki	gepinini	□
nihepi	wigemi	mahekuki	○
wikima	nipikuge	hema	△
miwiniku	pinipi	kihemiwi	□
kinimapi	wikuki	kikumi	○
miwimi	nipi	wige	△
gepihemi	kunige	miki	□
pikuhemi	kimaki	pimikihe	○
mihe	winige	kinimage	△



# 10 generations later...

ne-re-ki	le-re-ki	renana	□
ne-he-ki	la-ho-ki	re-ne-ki	○
ne-ke-ki	la-ke-ki	ra-he-ki	△
ne-ro-plo	la-ne-plo	re--plo	□
ne-ho-plo	la-ho-plo	re-ho-plo	○
ne-ki-plo	la-ki-plo	ra-ho-plo	△
ne--pilu	la-ne-pilu	re--pilu	□
ne-ho-pilu	la-ho-pilu	re-he-pilu	○
ne-ki-pilu	la-ki-pilu	ra-ho-pilu	△

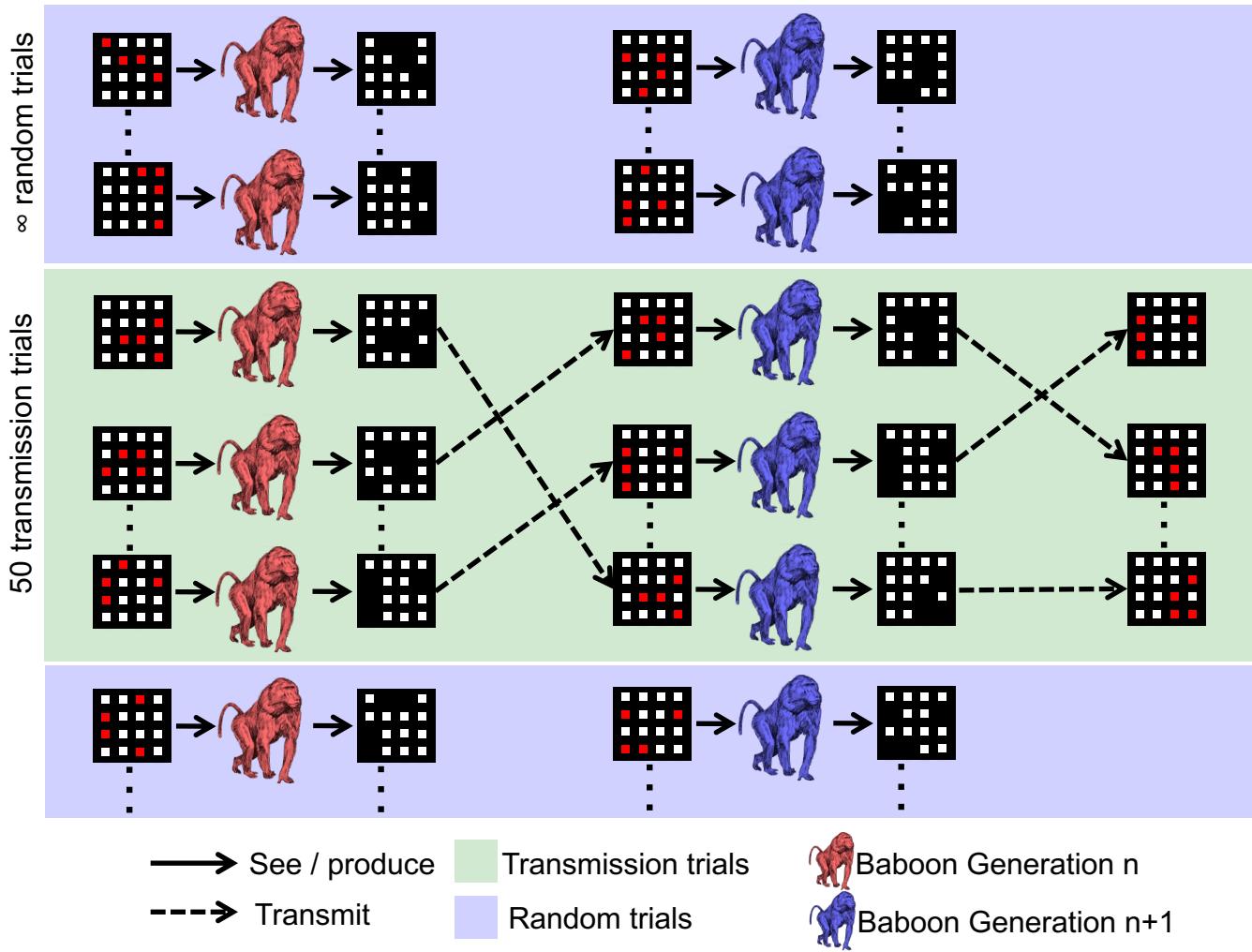


If structure arises from social learning,  
why isn't it more common?

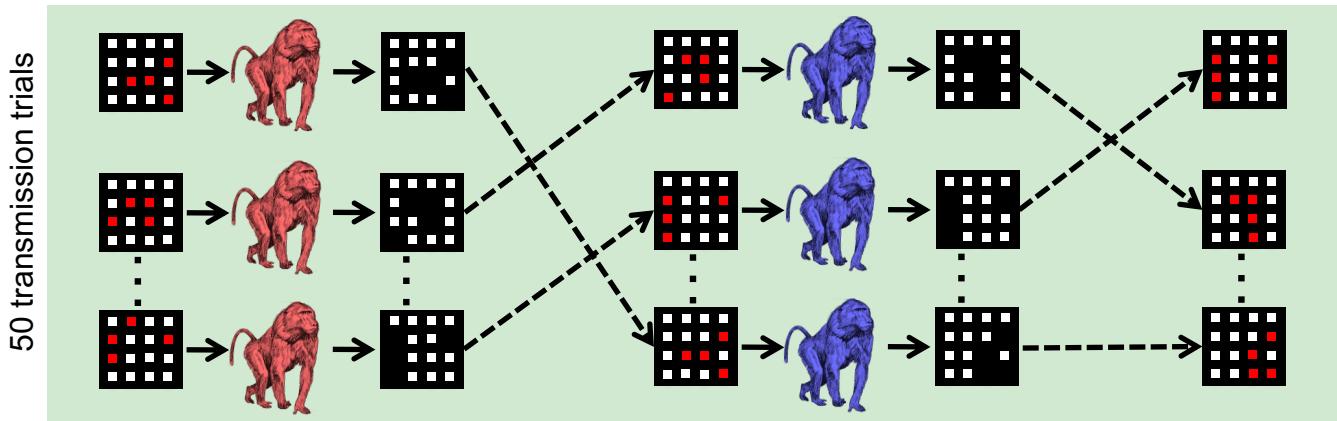


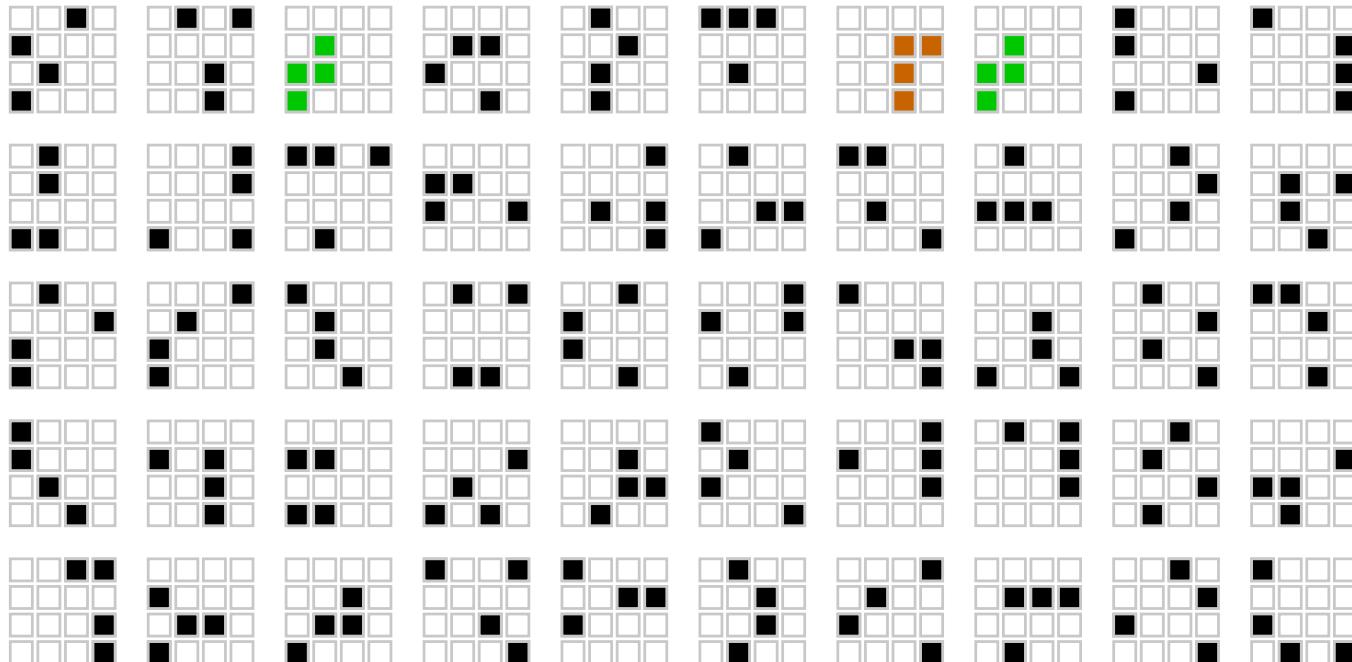
Claidière, N., Smith, K., Kirby, S., & Fagot, J. (2014). Cultural evolution of a systematically structured behaviour in a non-human primate. *Proceedings of the Royal Society B*, 281, 20141541.



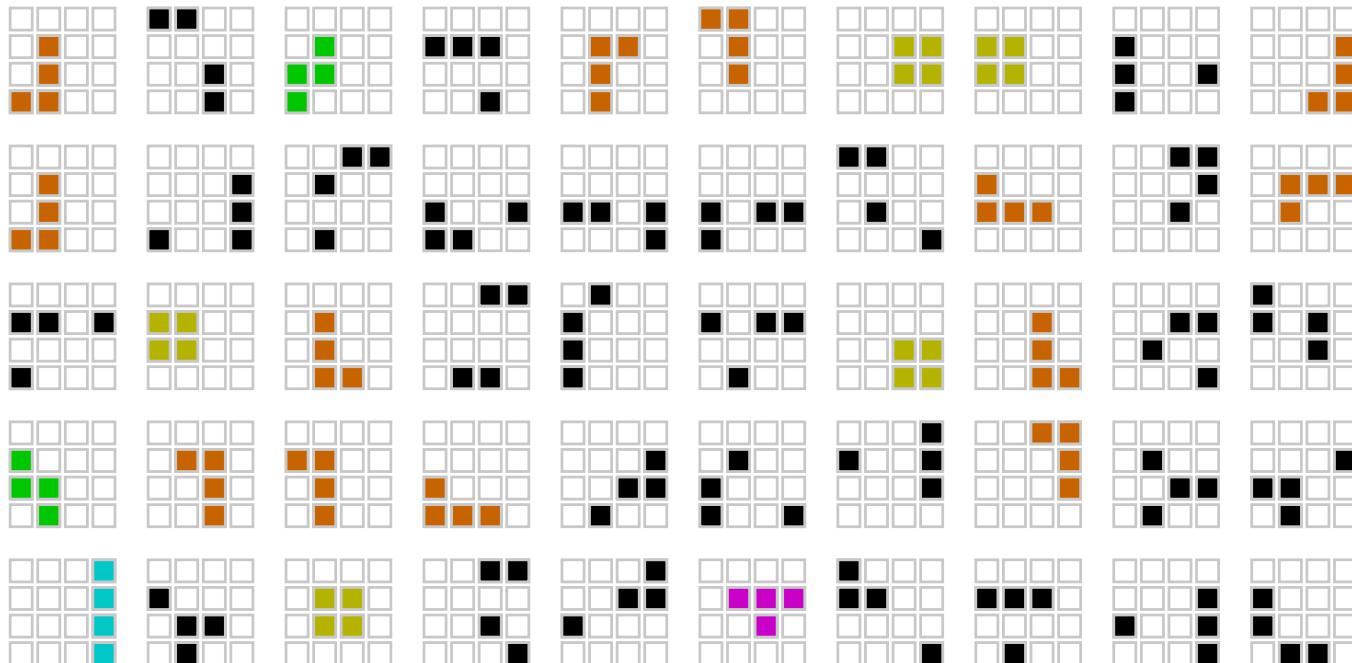


# What do you think will happen?

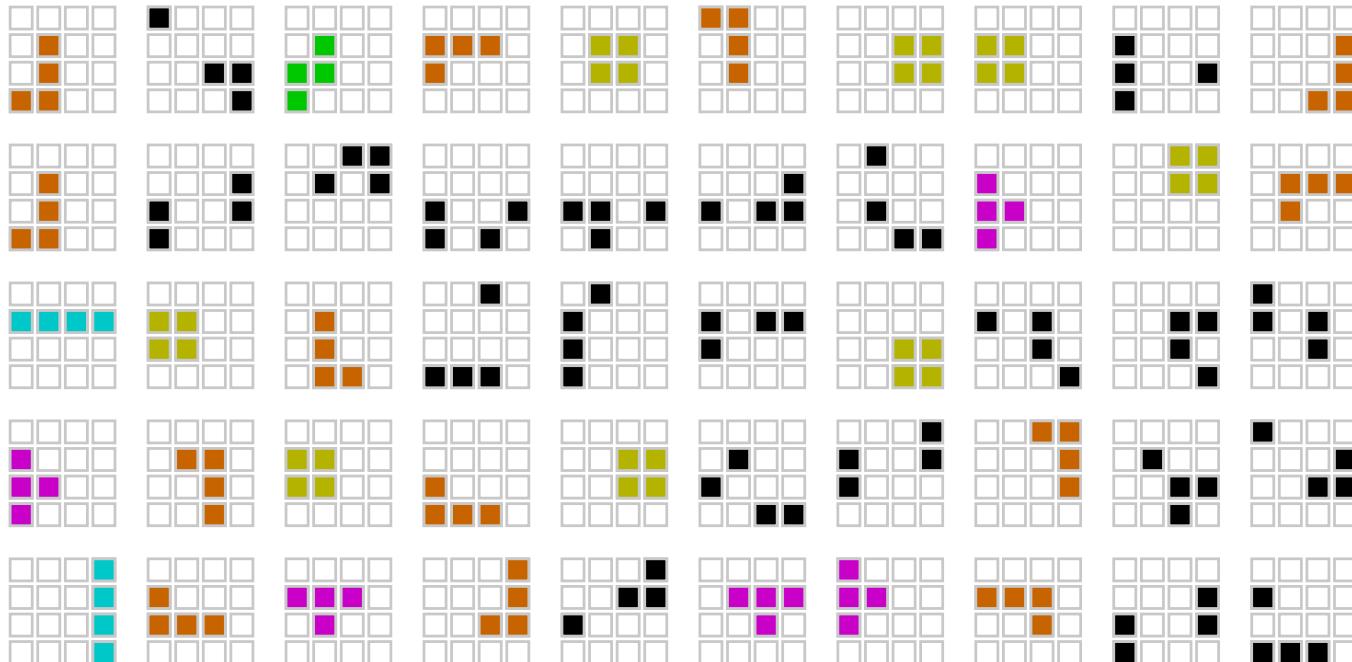




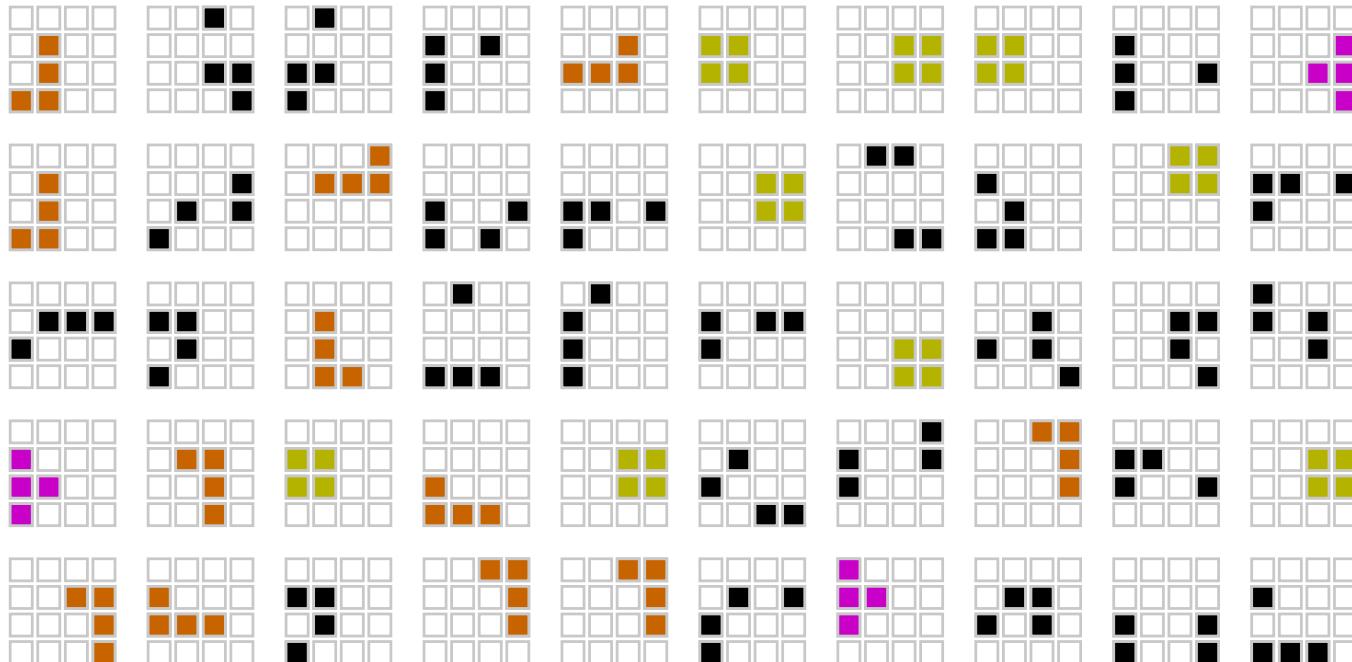
Random grids



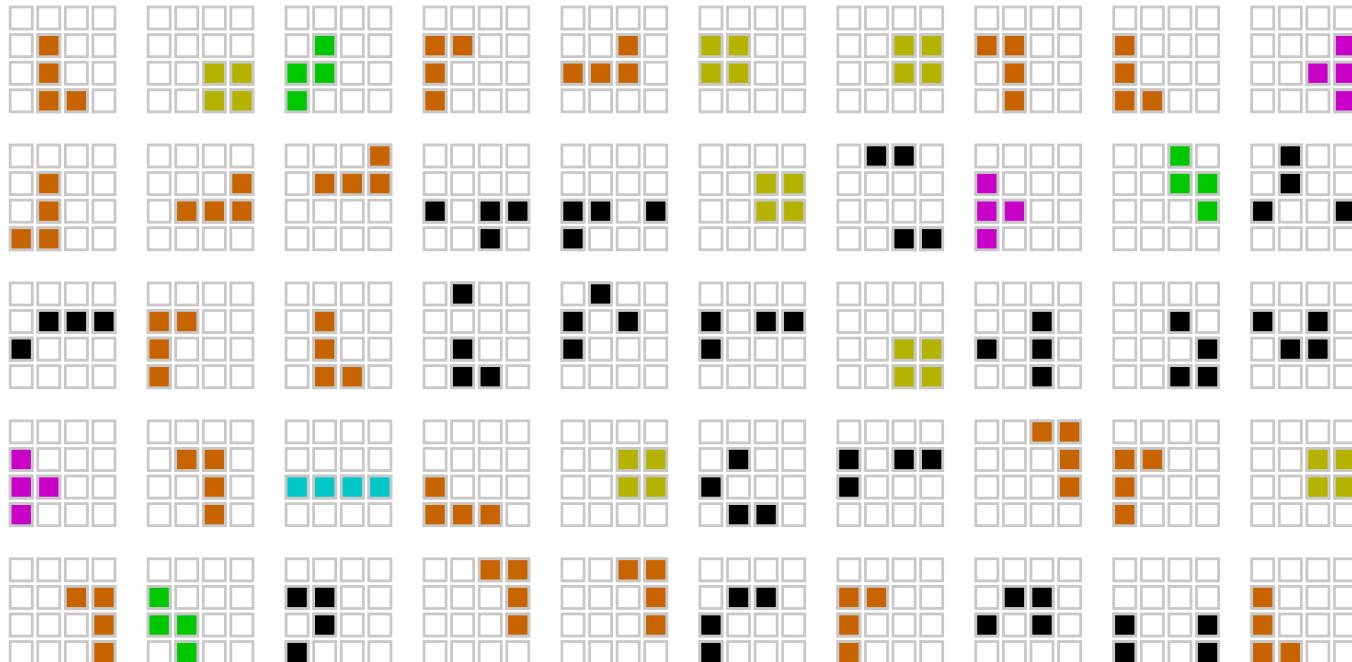
Generation 1



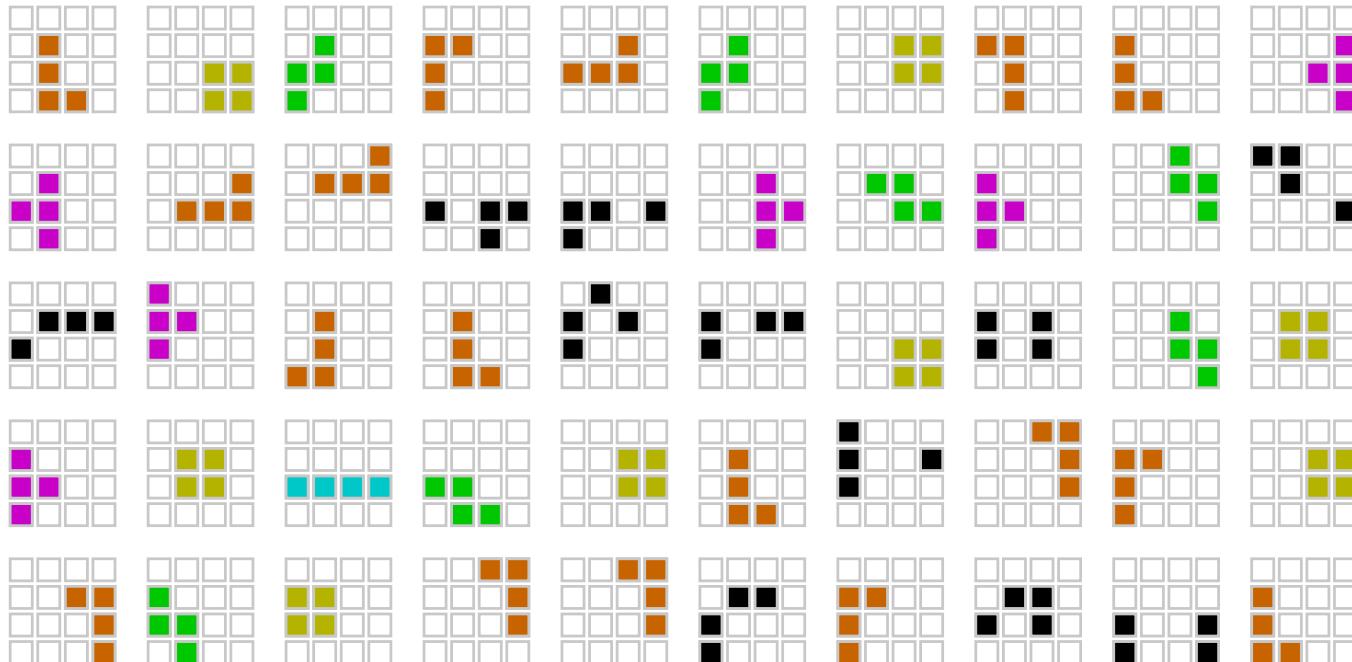
Generation 2



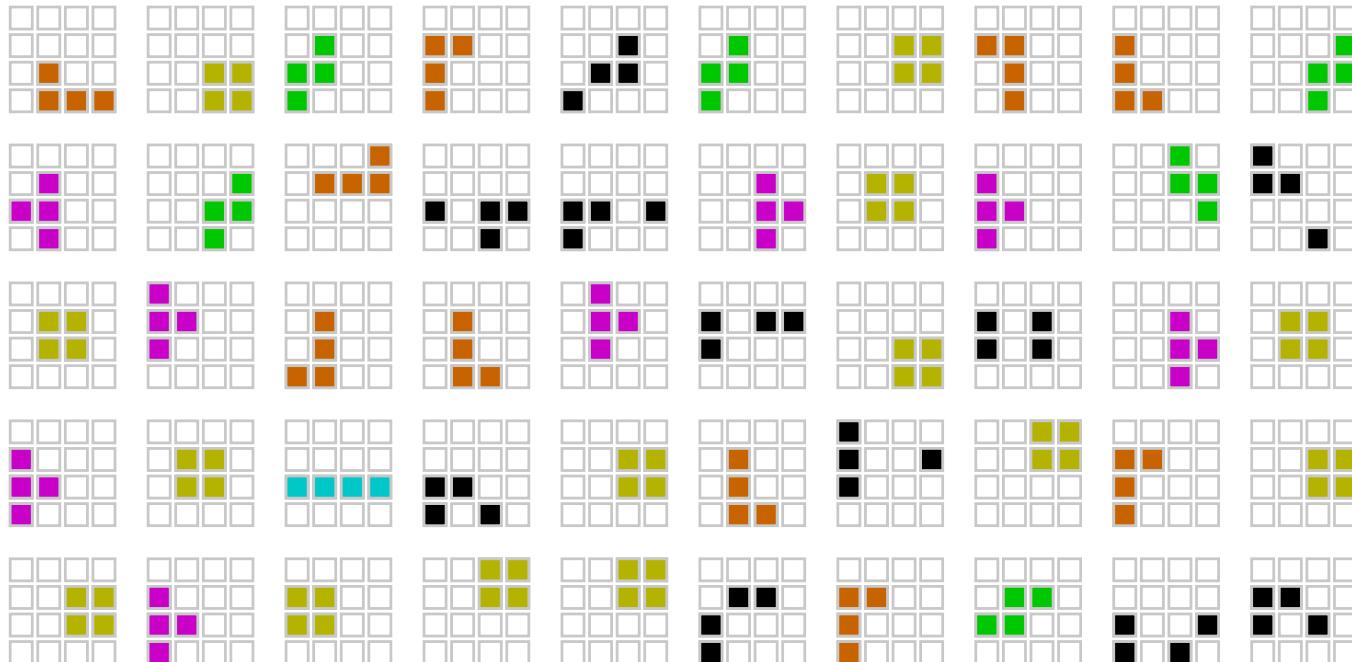
Generation 3



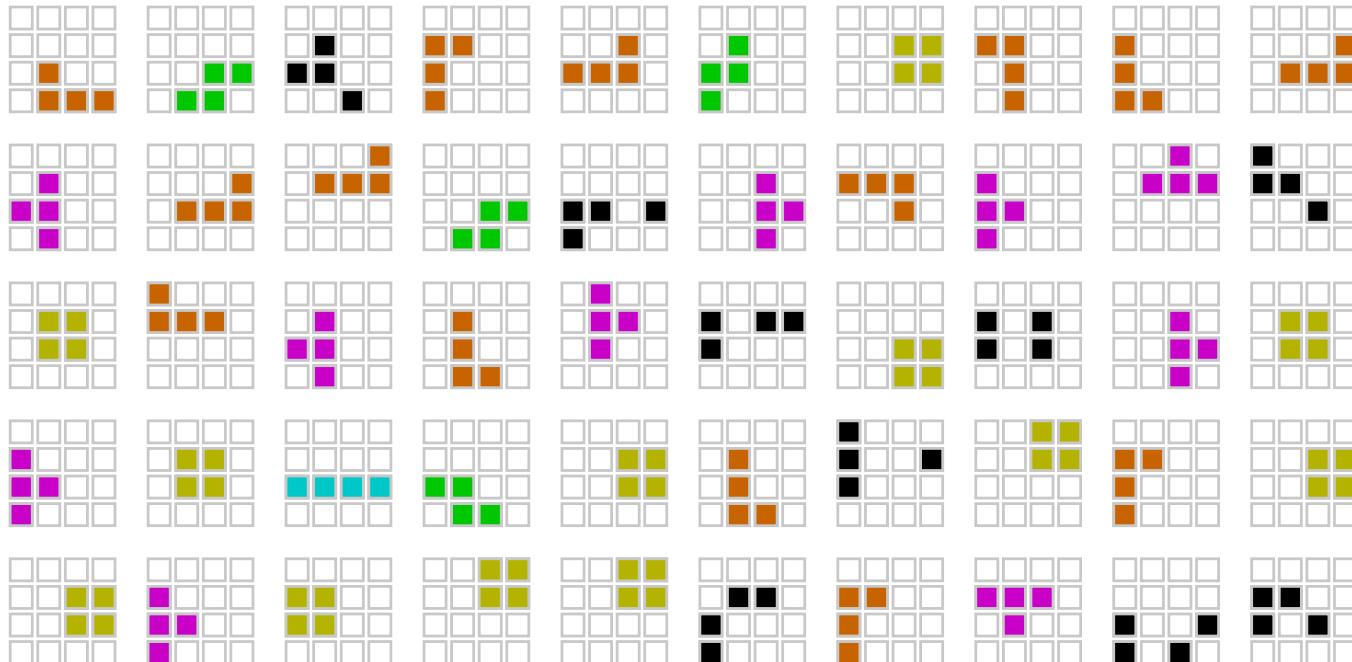
Generation 4



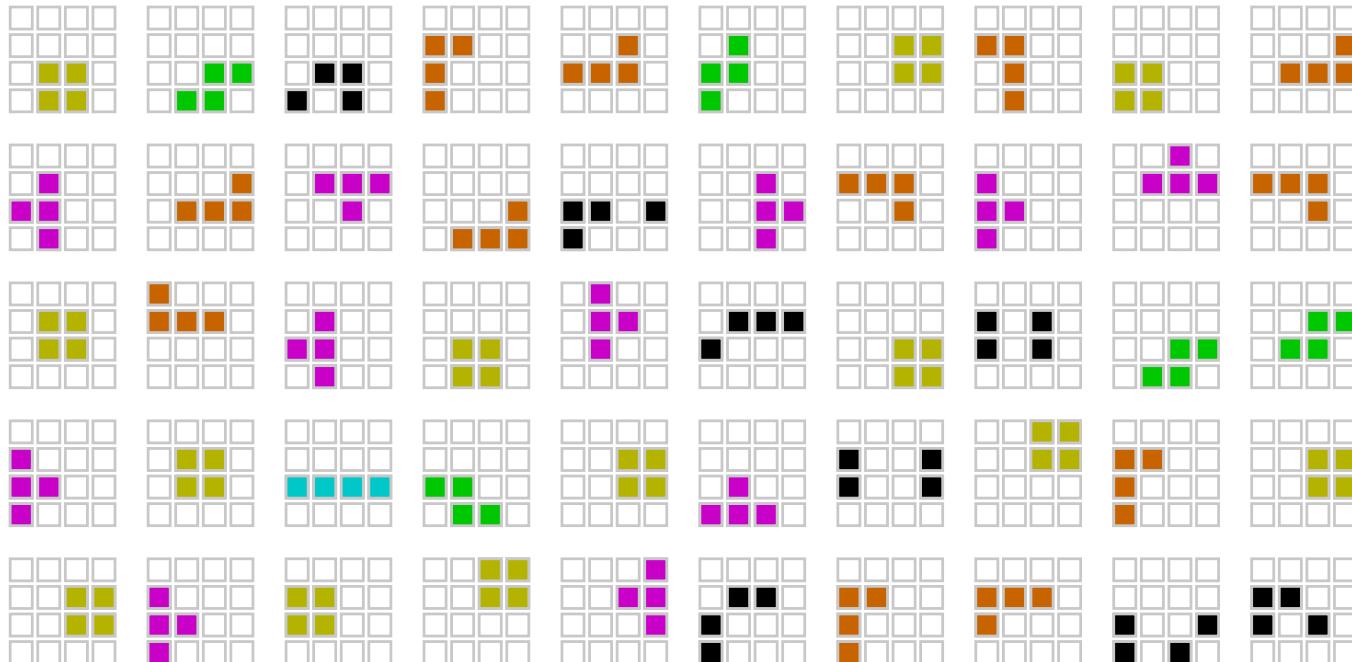
Generation 5



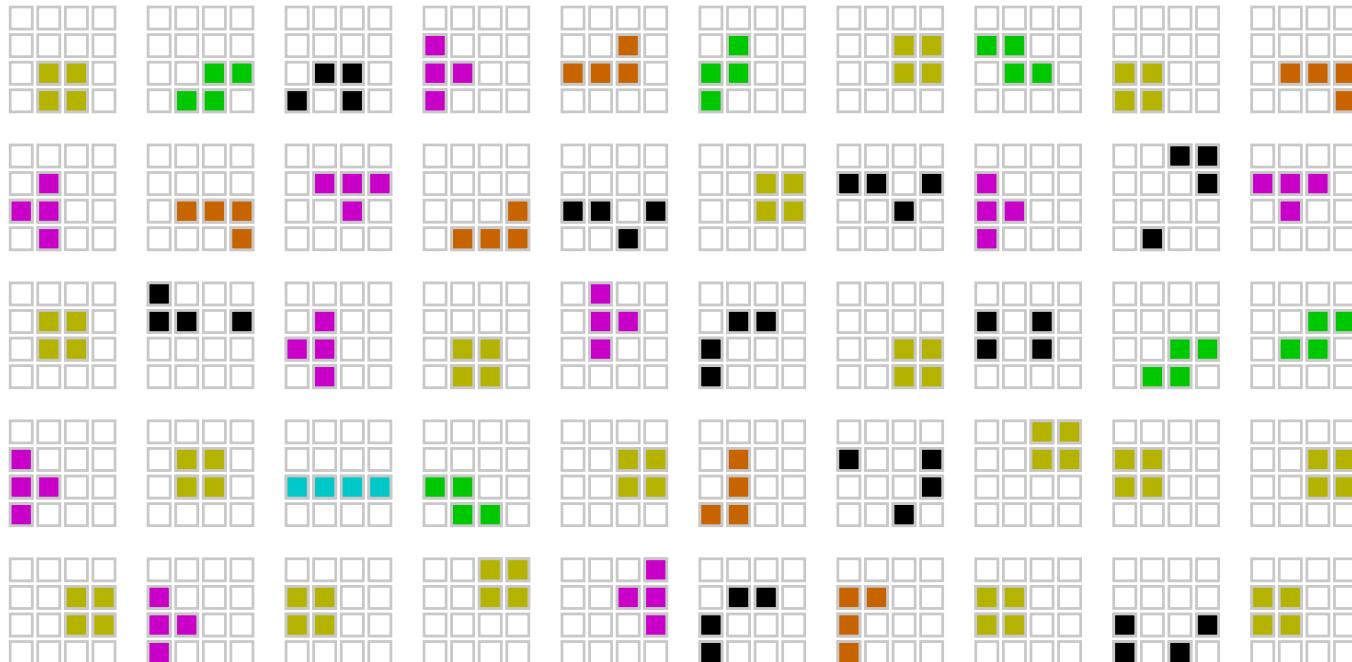
Generation 6



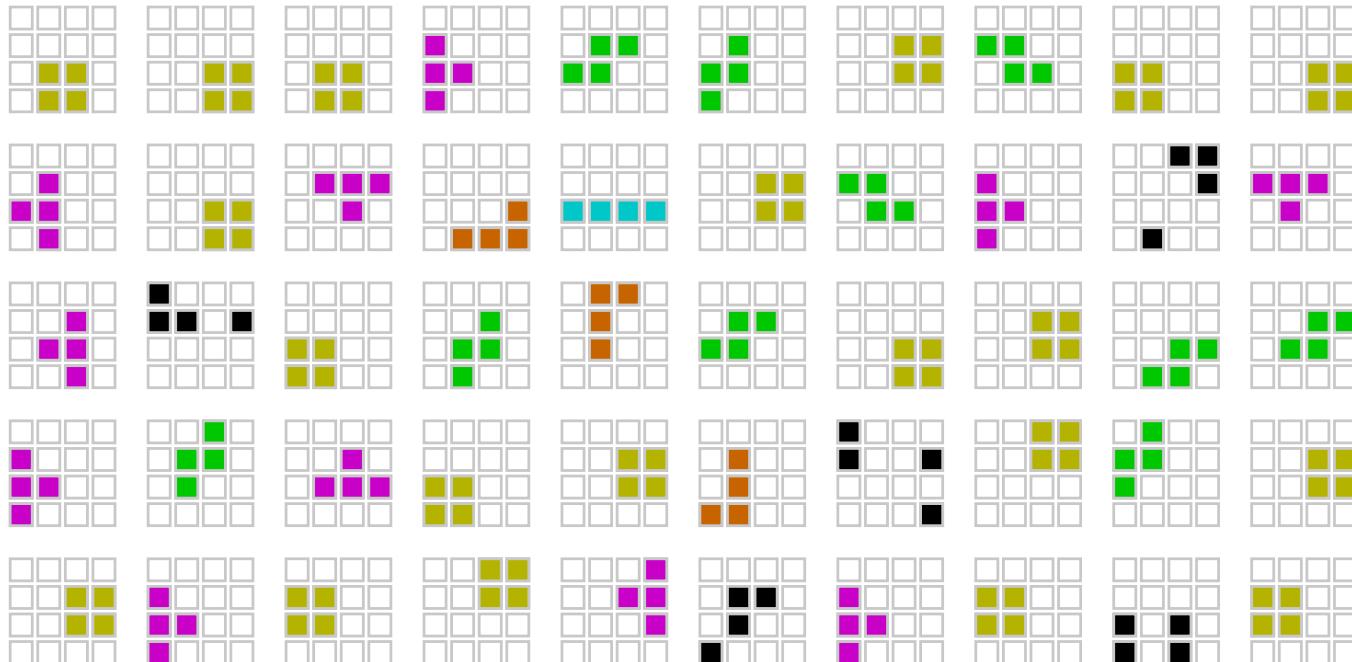
Generation 7



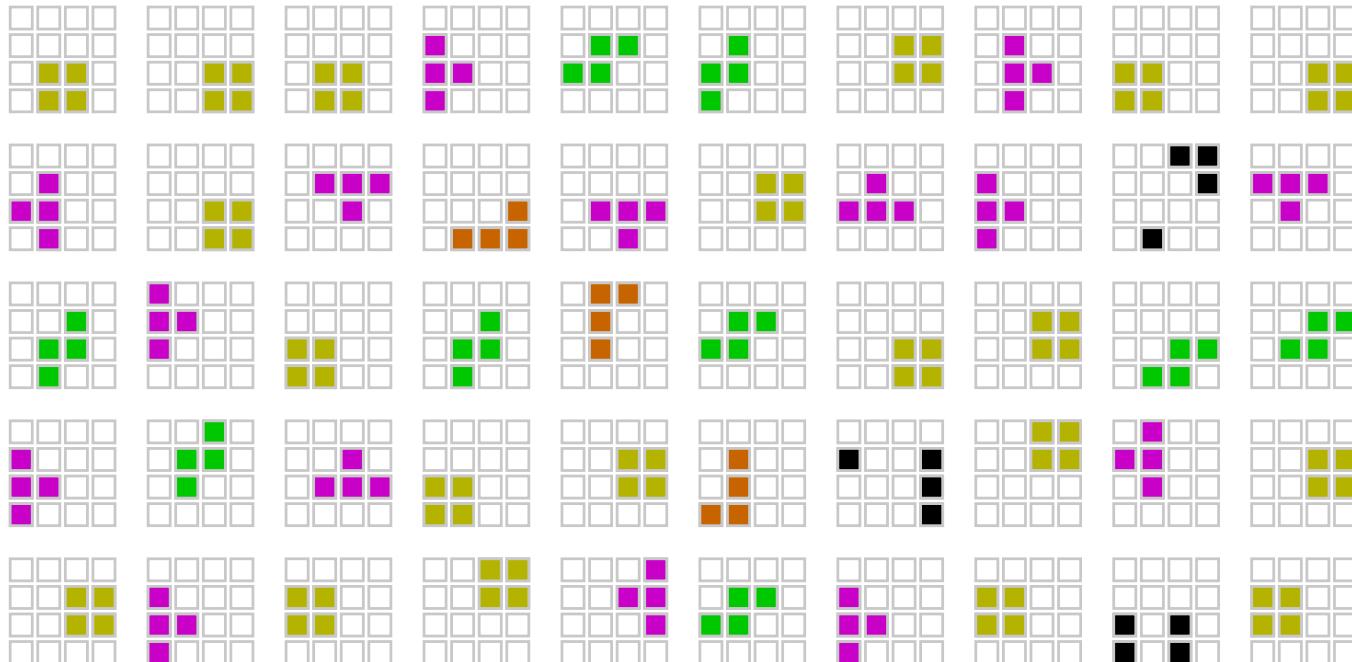
Generation 8



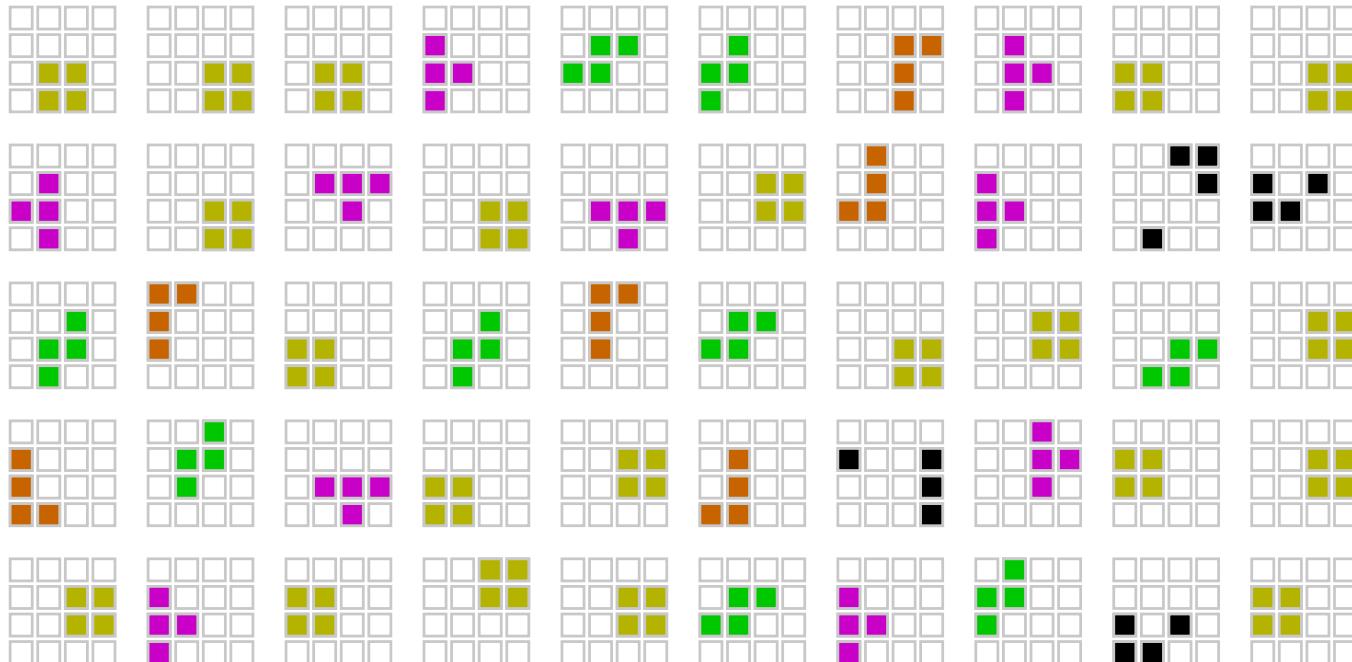
Generation 9



Generation 10

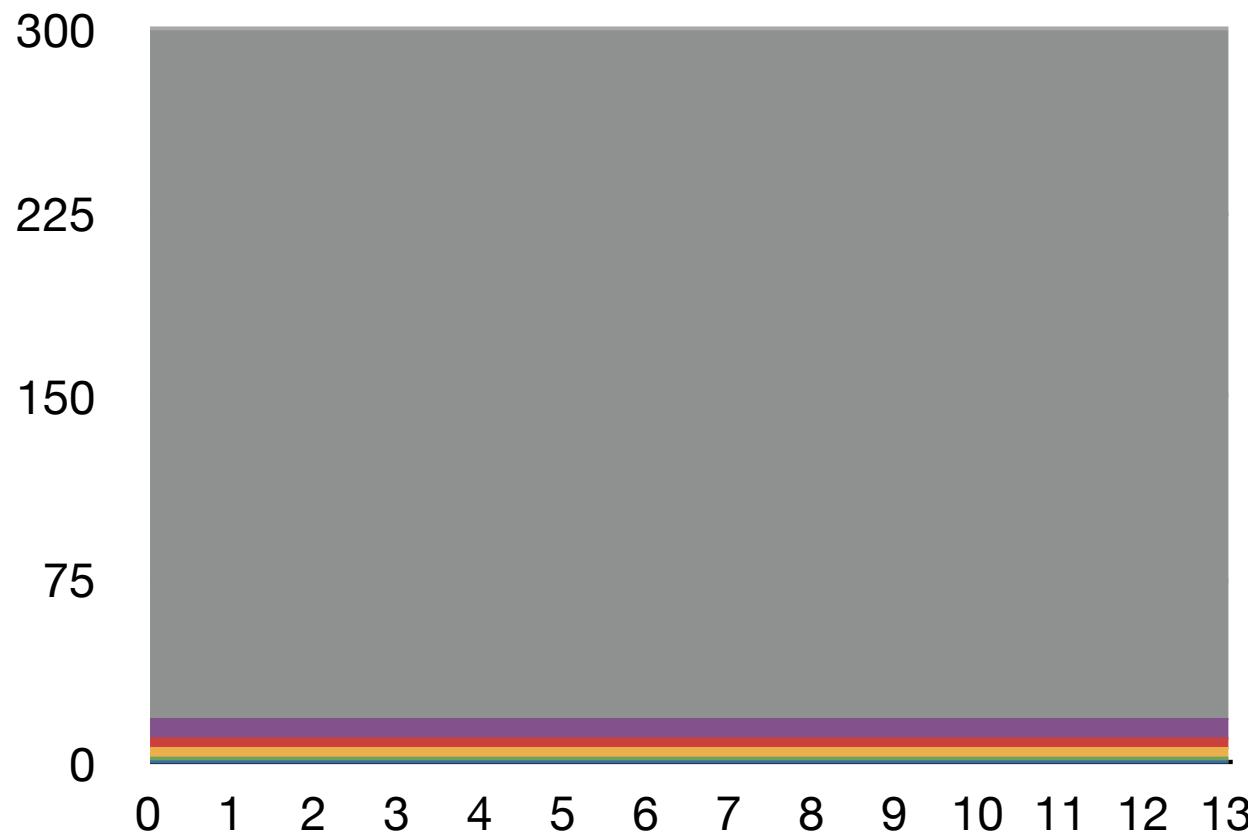


Generation 11

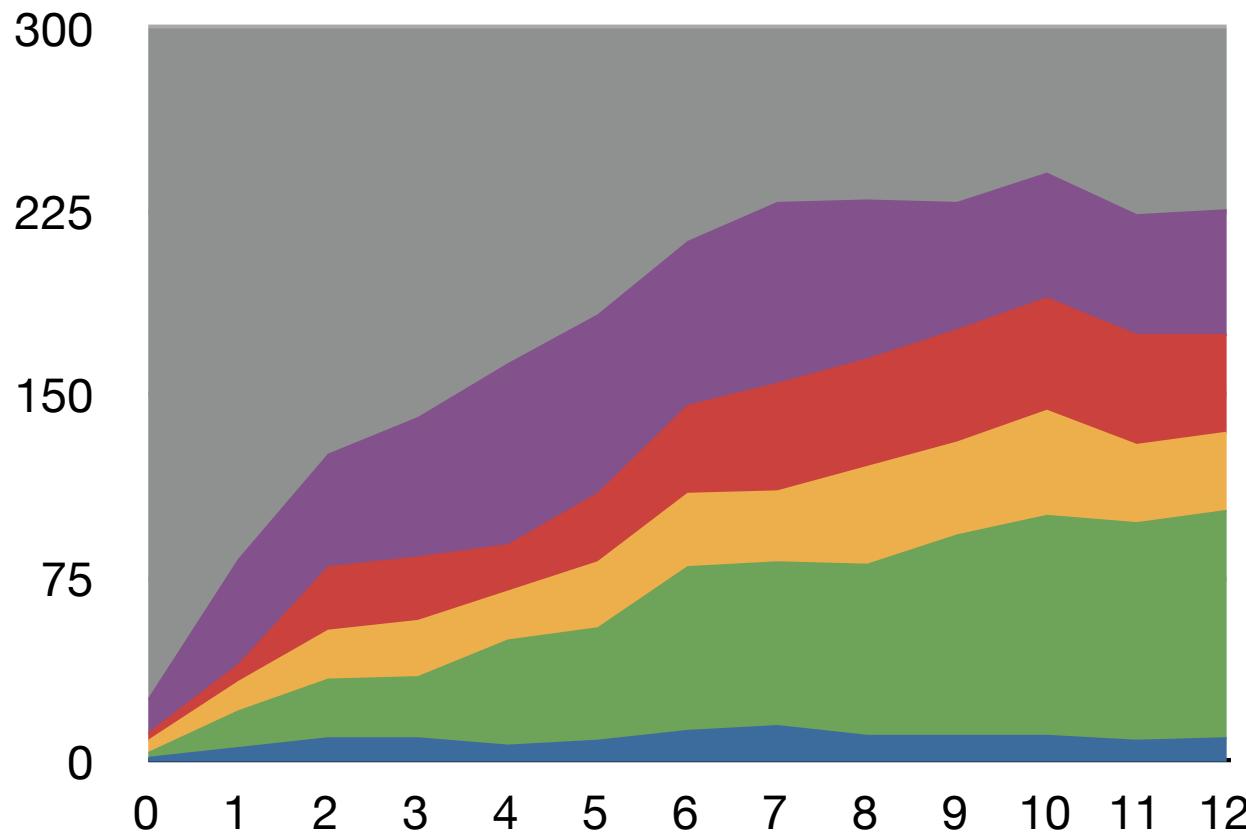


Generation 12

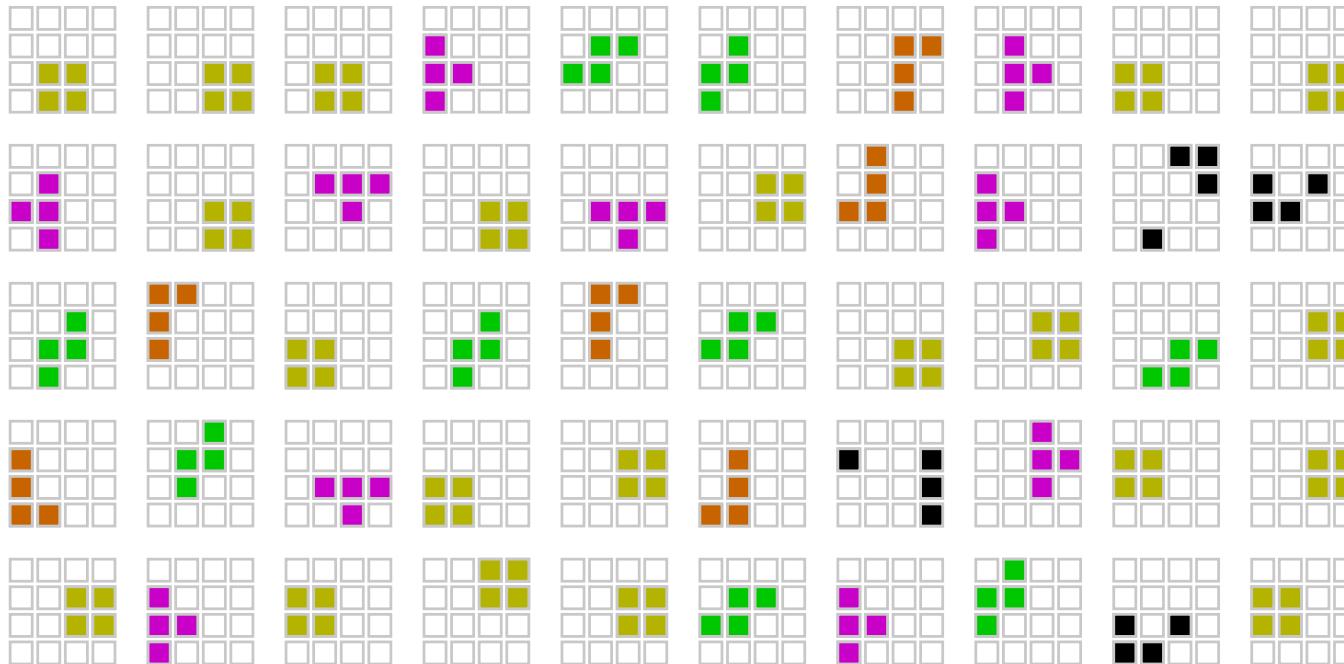
# Expected tetrominoes



## Actual tetrominoes

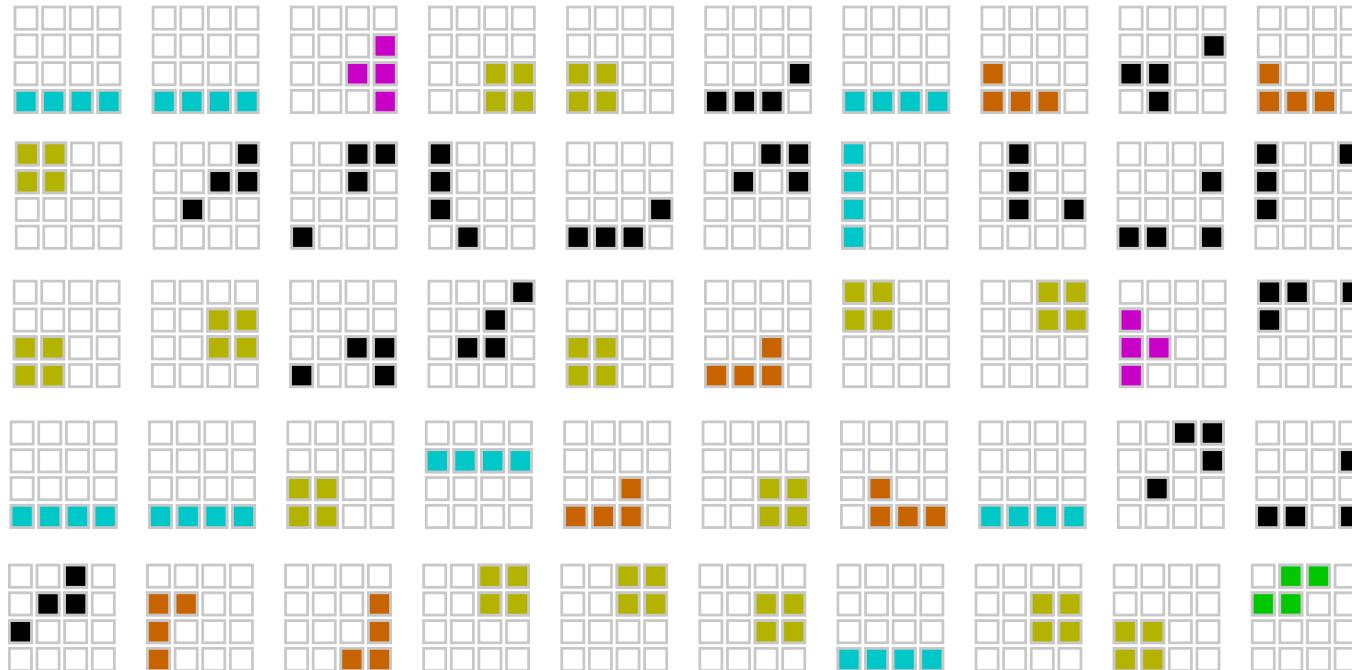


# Emergence of a **system**



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

Week	Topic
1	Introduction
2	Natural selection, adaptation and language
3	Intention and structure in animal communication
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<i>Flexible learning week</i>	
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7	Evolution of social cognition
8	Cultural evolution of language
9	Sign language and language origins
10	Gene-culture co-evolution

# Next week

- 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

