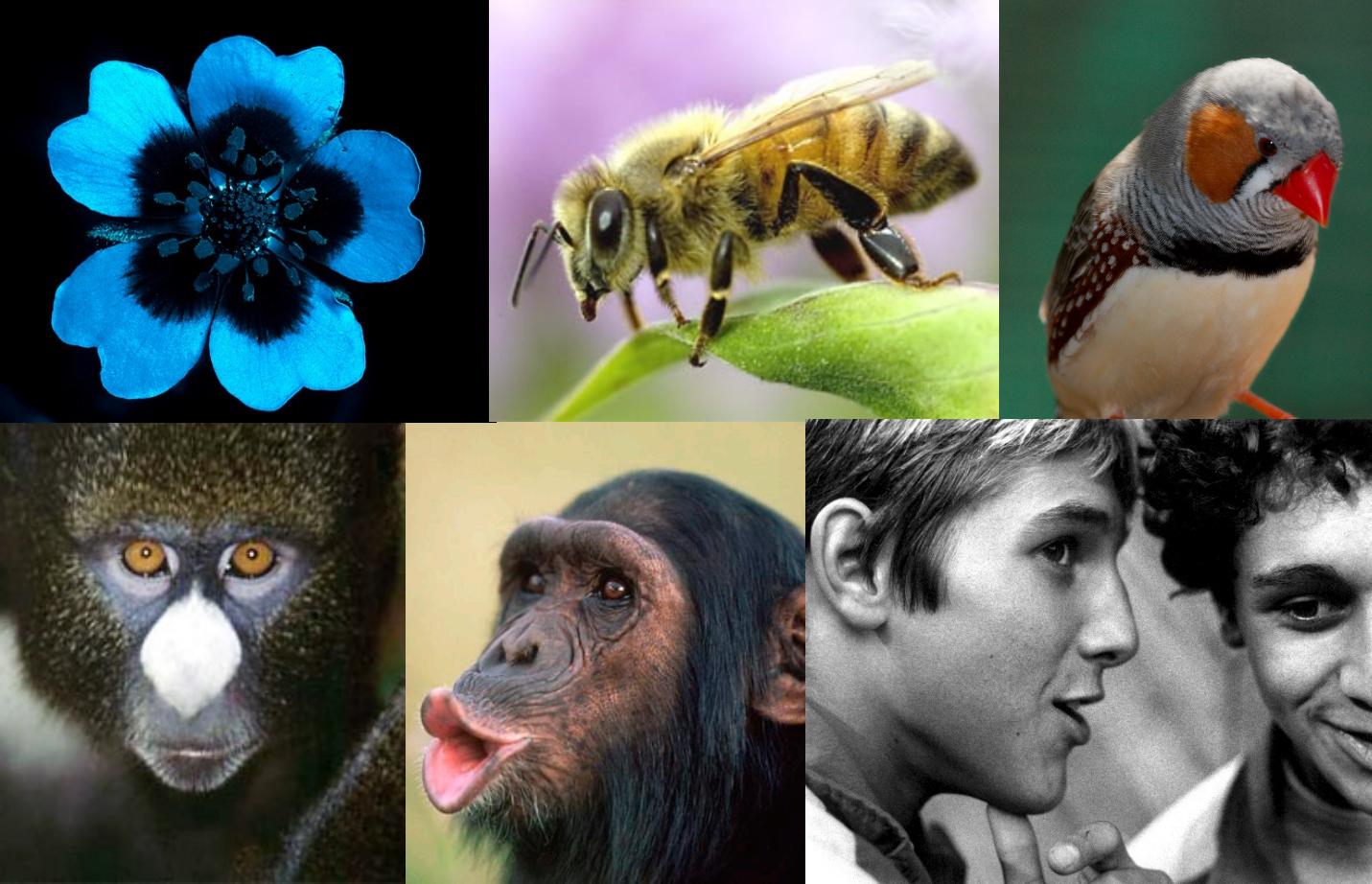


Origins and Evolution of Language

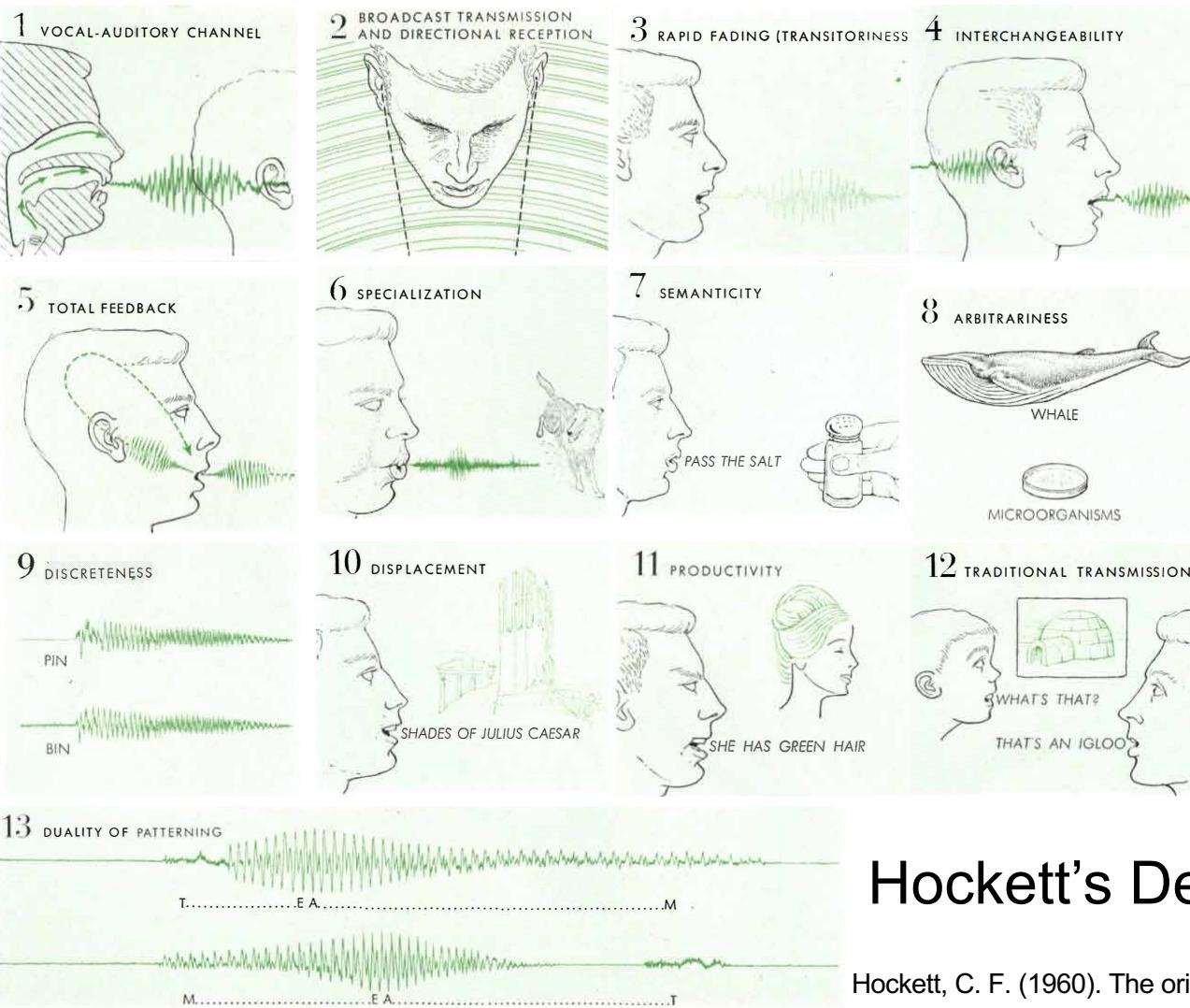
Week 1: Introduction

Kenny Smith

kenny.smith@ed.ac.uk



Communication is widespread, but language is unique



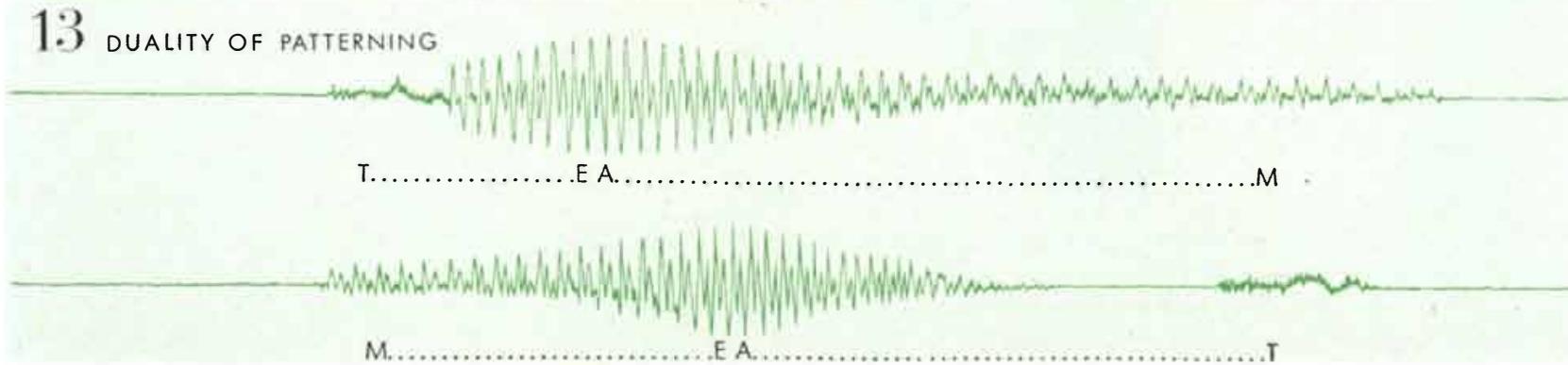
Hockett's Design features

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



Language's communicative power comes from its structure

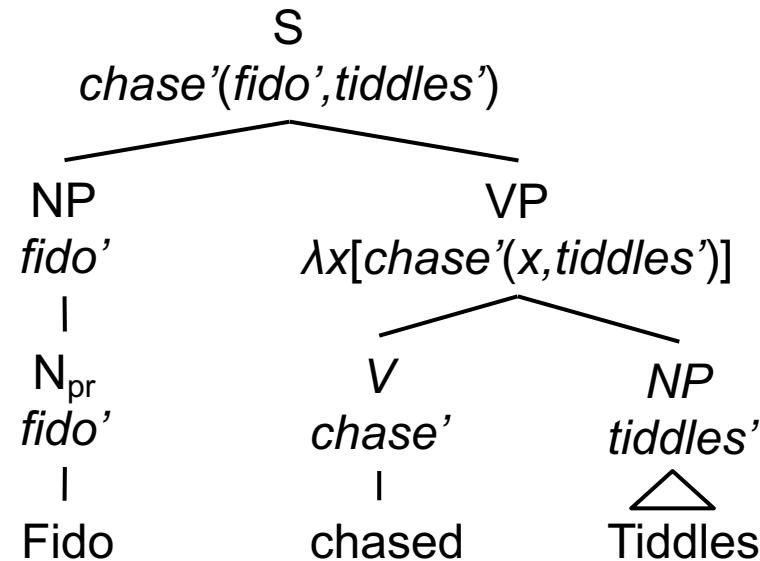
Duality of patterning: meaning-bearing units composed of (re)combinations of meaningless differentiating units

| 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



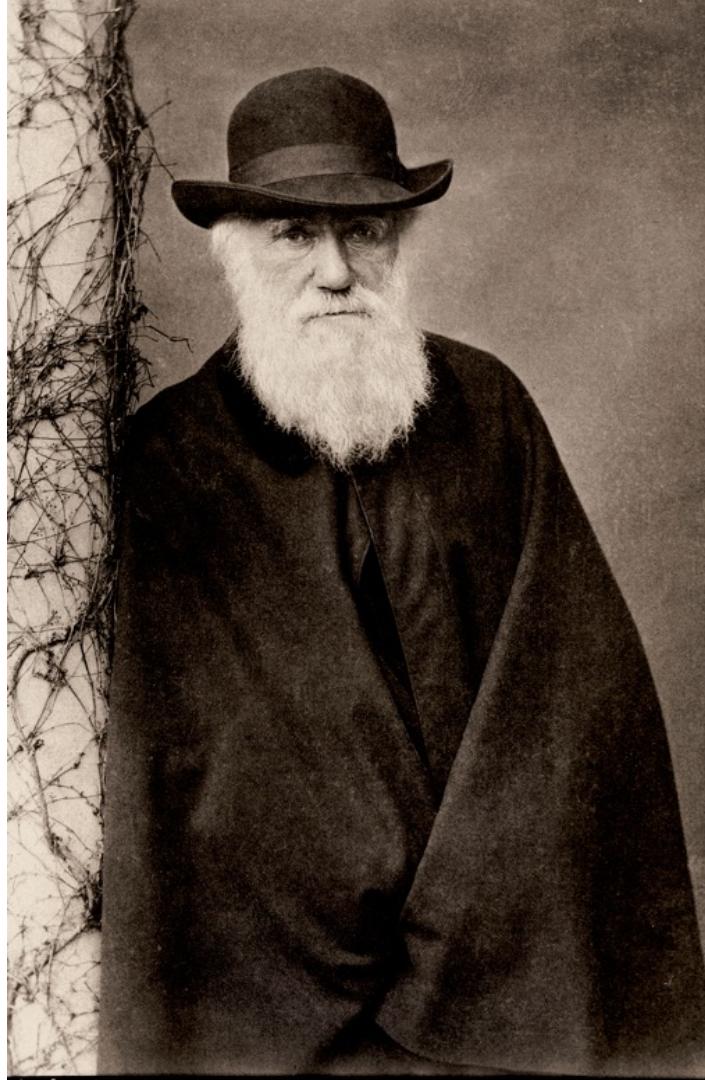
A tool for the communication of knowledge and internal states



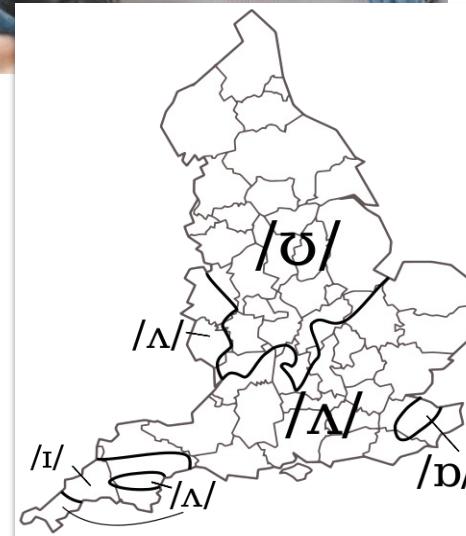
One possible explanation

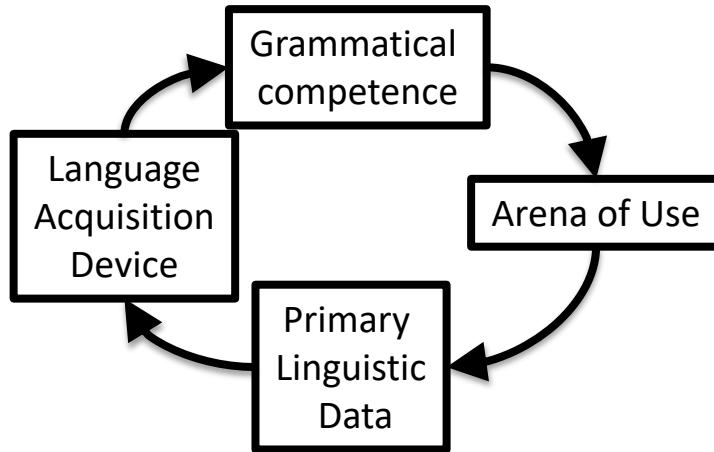
- Language is just like any other adaptive feature of an organism's biology
- It's an **innate** feature of the human mind
- It evolved by natural selection under pressure for communication

More on this in week 2



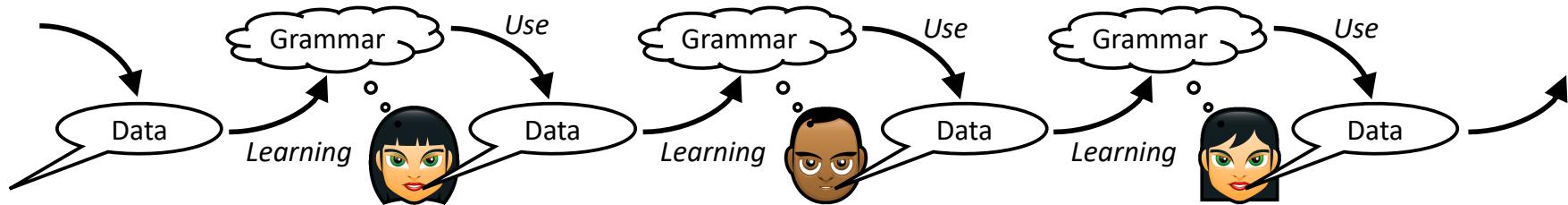
Social learning is ubiquitous in humans





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

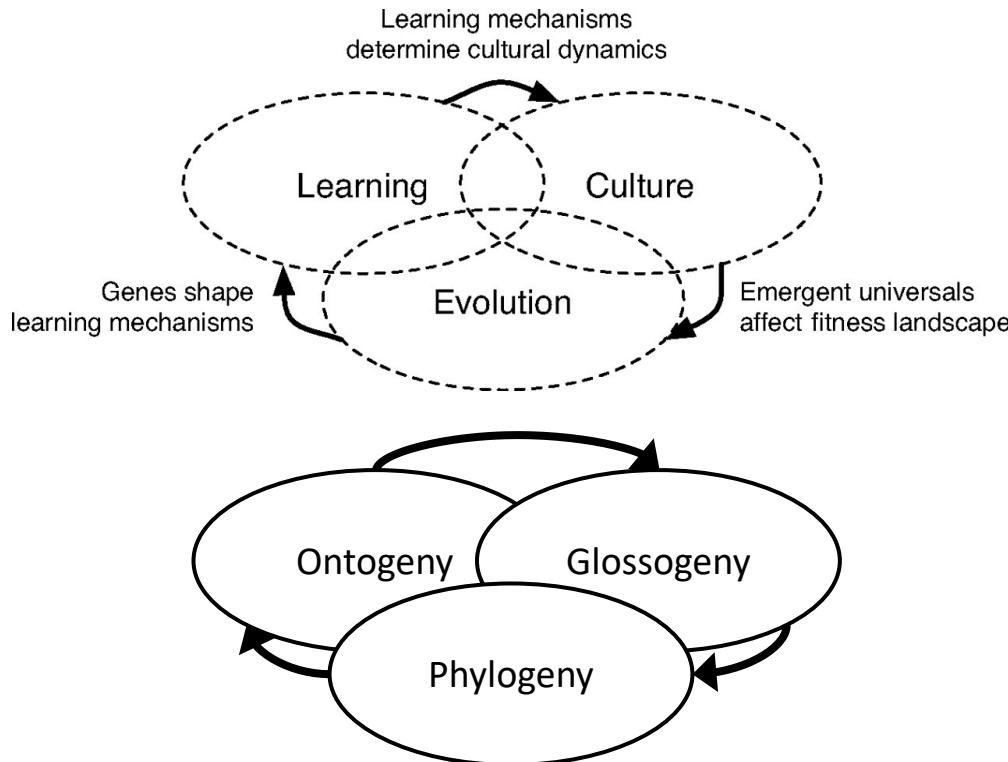
Language is shaped as a consequence of these processes



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 |

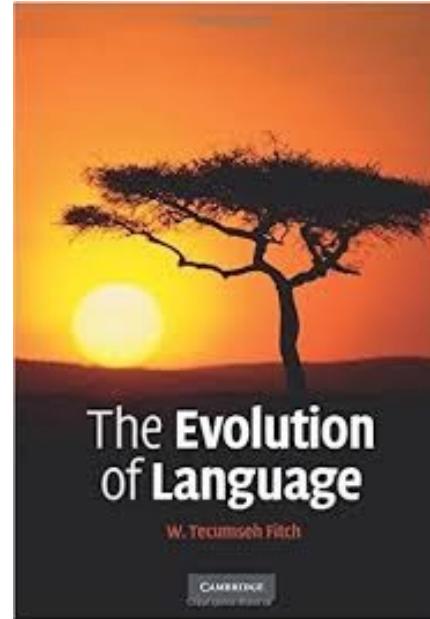
<https://kennysmithed.github.io/origins2223/>

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

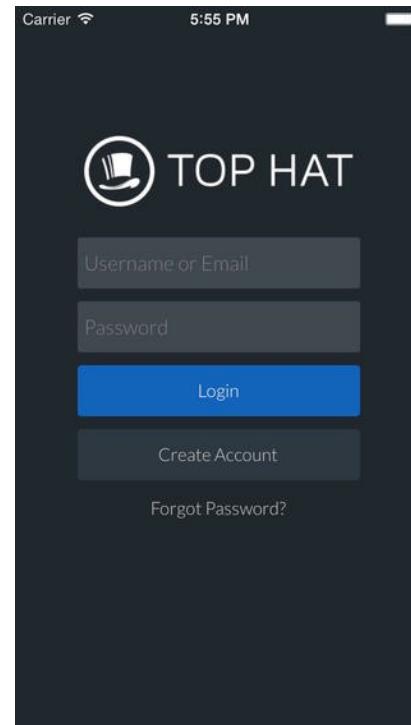
Tecumseh Fitch

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

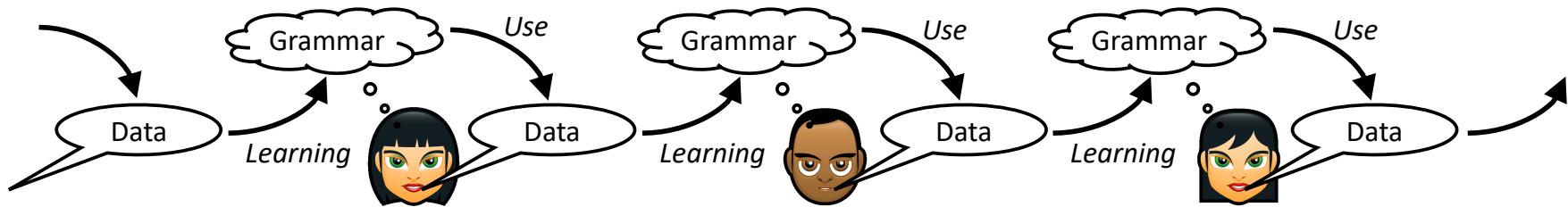
Assessment

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

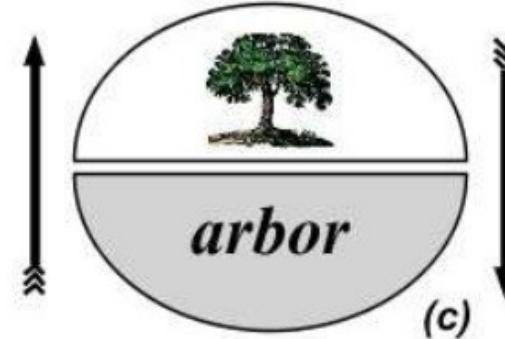
What's the evidence?

- 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)

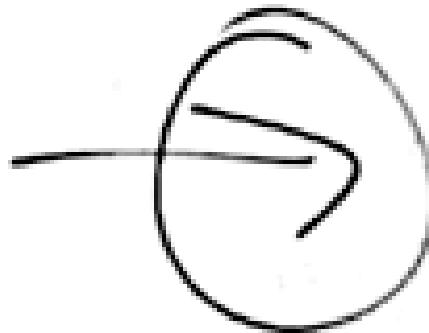
Where do symbols come from?

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



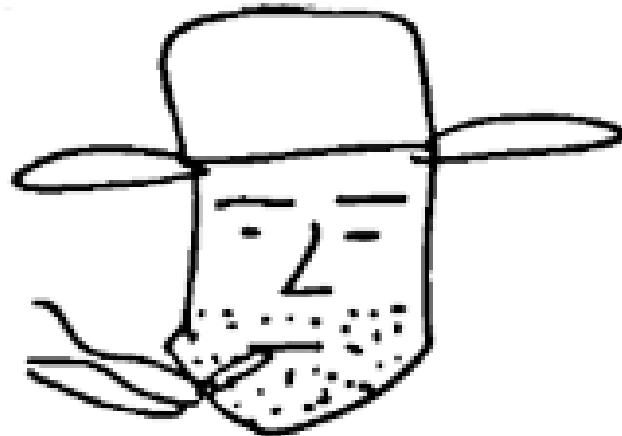
Ritualization in the lab, with humans

Repeated interaction in a Pictionary-like communication task

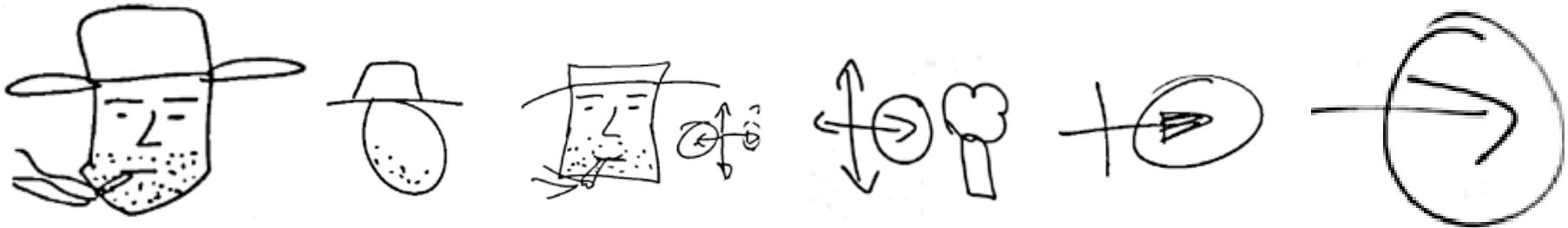


Ritualization in the lab, with humans

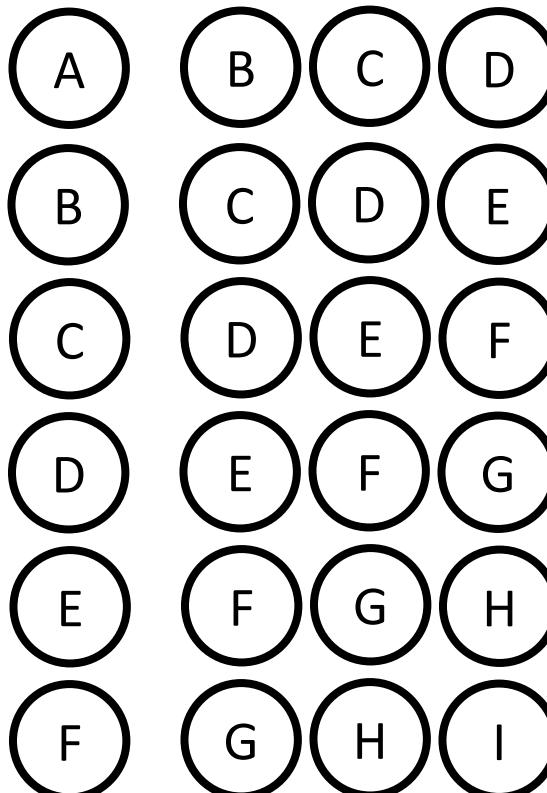
Repeated interaction in a Pictionary-like communication task



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’



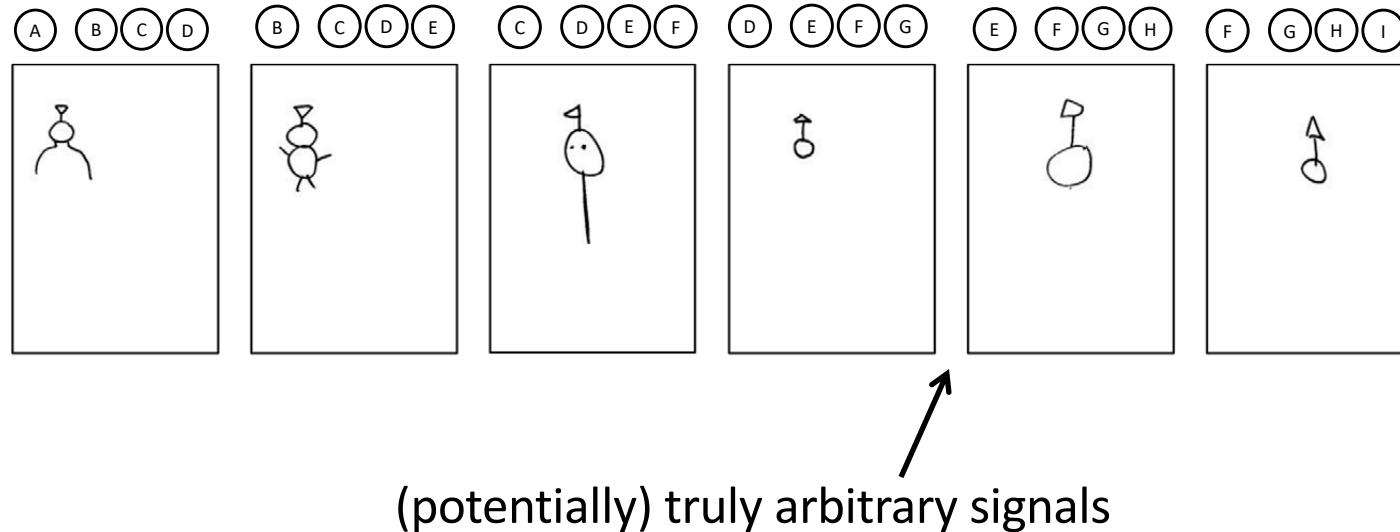
Caldwell, C. A., & Smith, K. (2012). Cultural evolution and the perpetuation of arbitrary communicative conventions in experimental microsocieties. *PLoS ONE*, 7, e43807.

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.

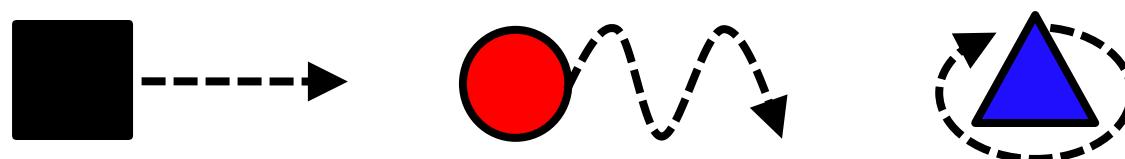
Transmission in laboratory ‘societies’



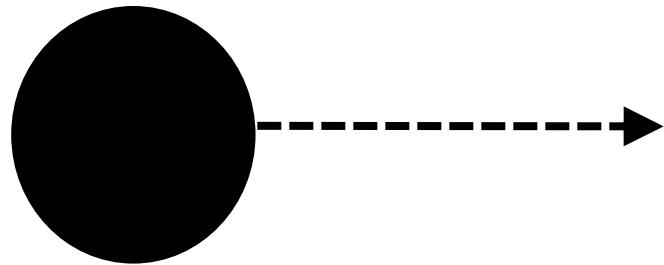
So much for symbols – how about structure?

Artificial language learning in the lab

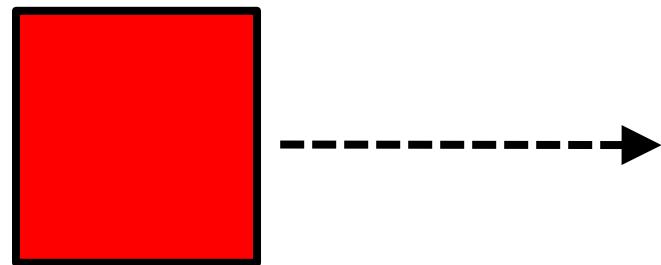
- Adult participants repeatedly trained on set of picture-label pairs
 - An ‘alien language’
- Tested repeatedly
 - Presented with picture, enter label



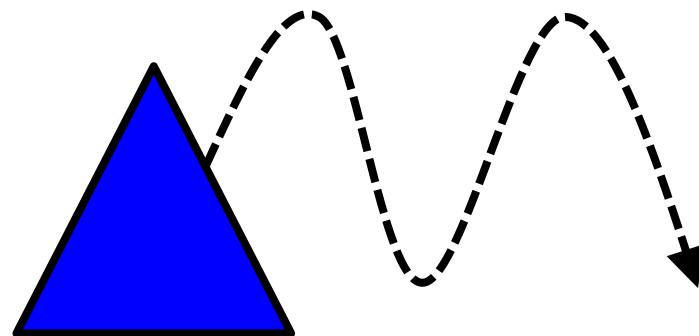
nihepi

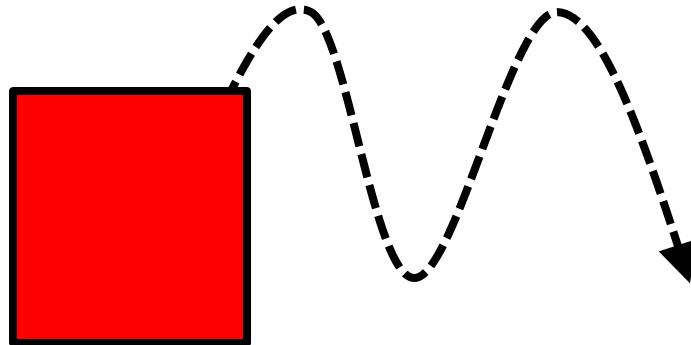


gepini



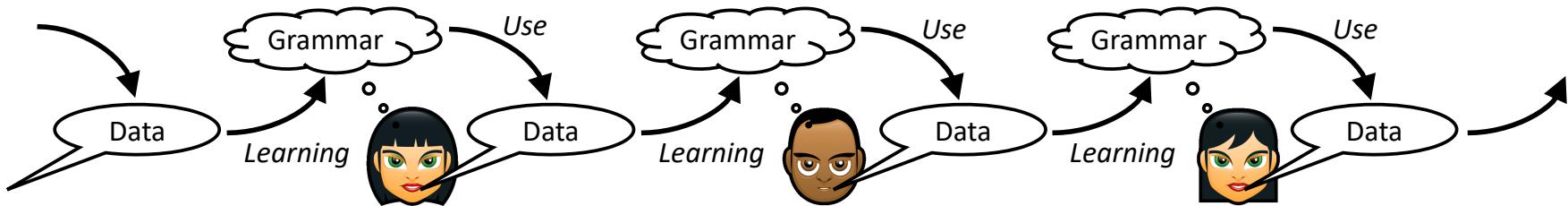
wige





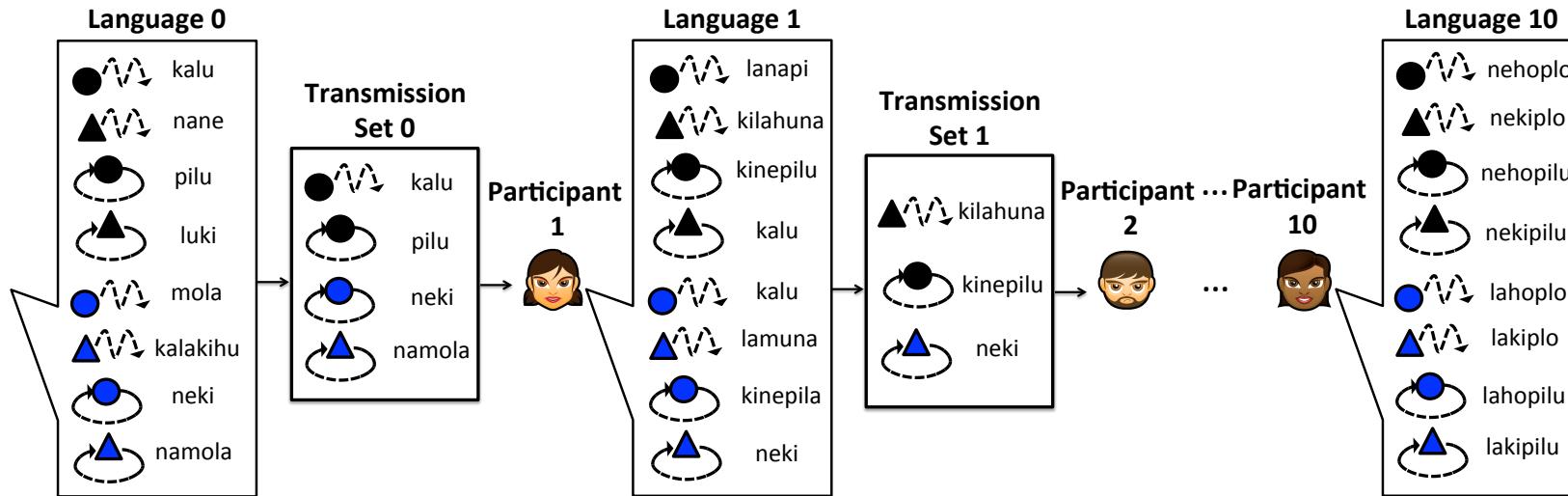
wimaku

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.

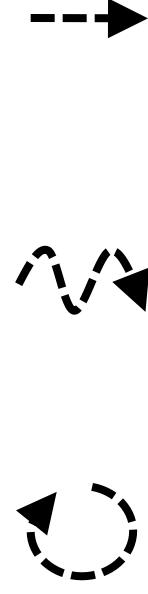
Transmission in laboratory ‘societies’



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 | △ |

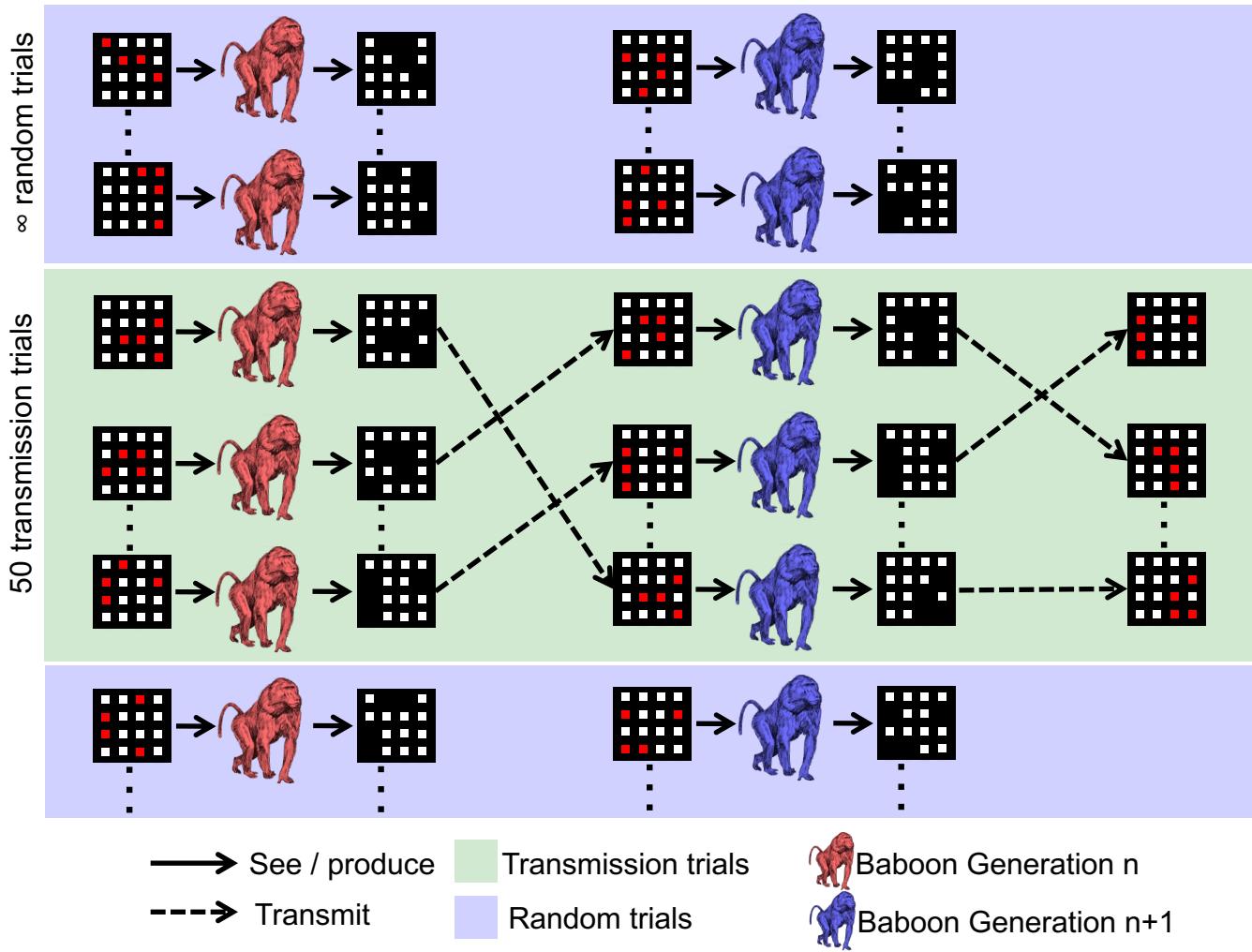


If structure arises from social learning,
why isn't it more common?

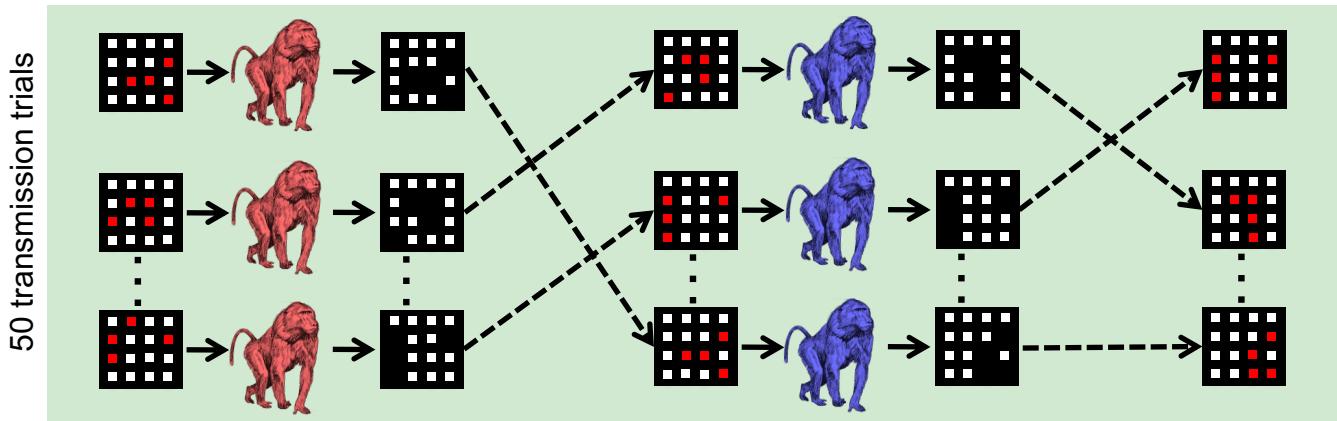


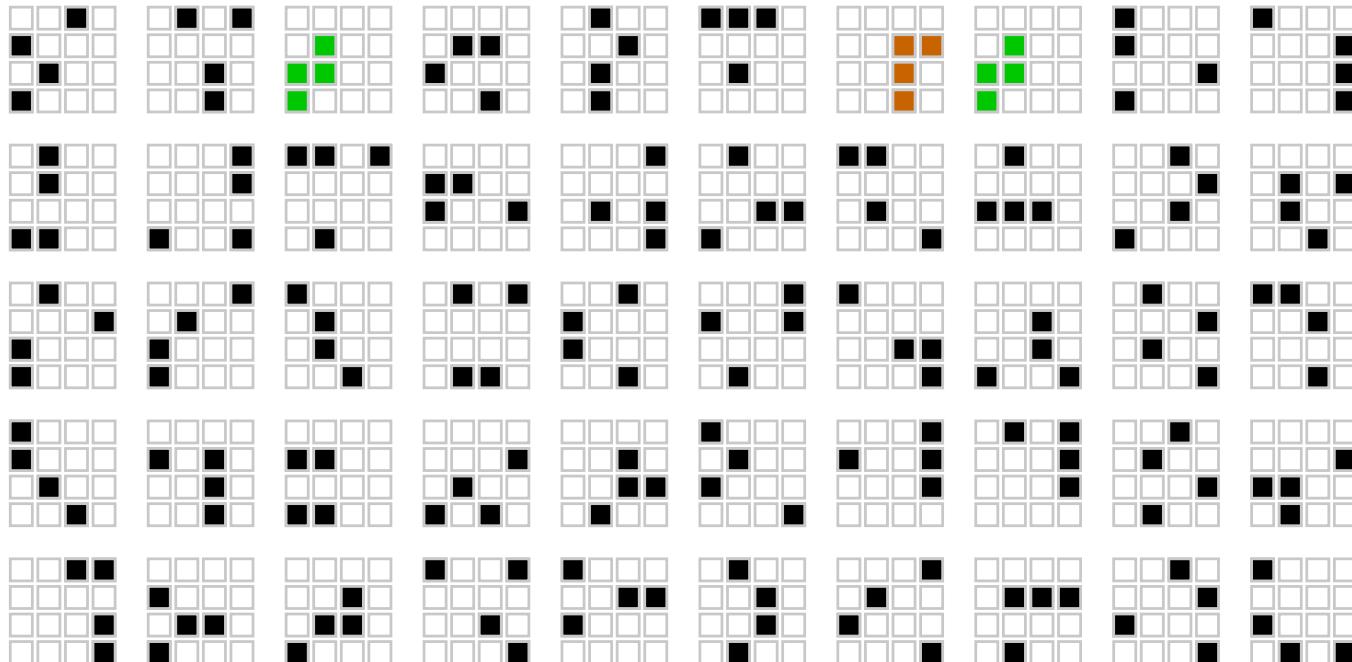
Claidière, N., Smith, K., Kirby, S., & Fagot, J. (2014). Cultural evolution of a systematically structured behaviour in a non-human primate. *Proceedings of the Royal Society B*, 281, 20141541.



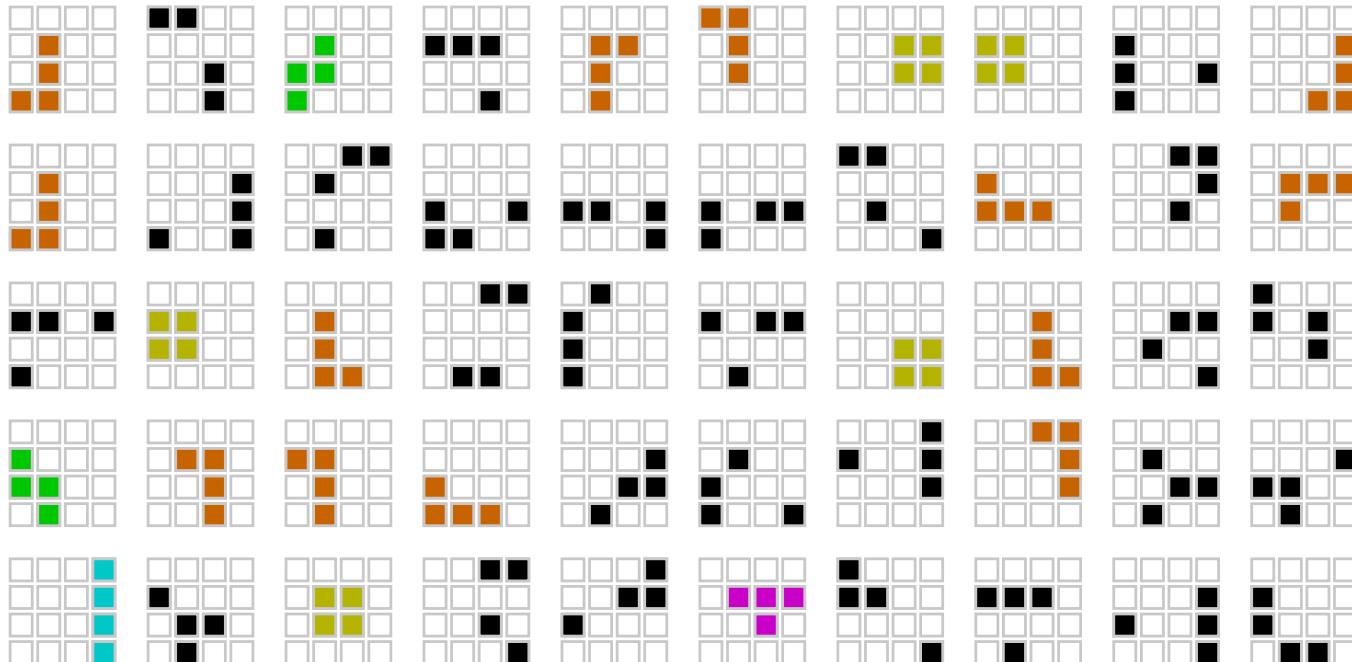


What do you think will happen?

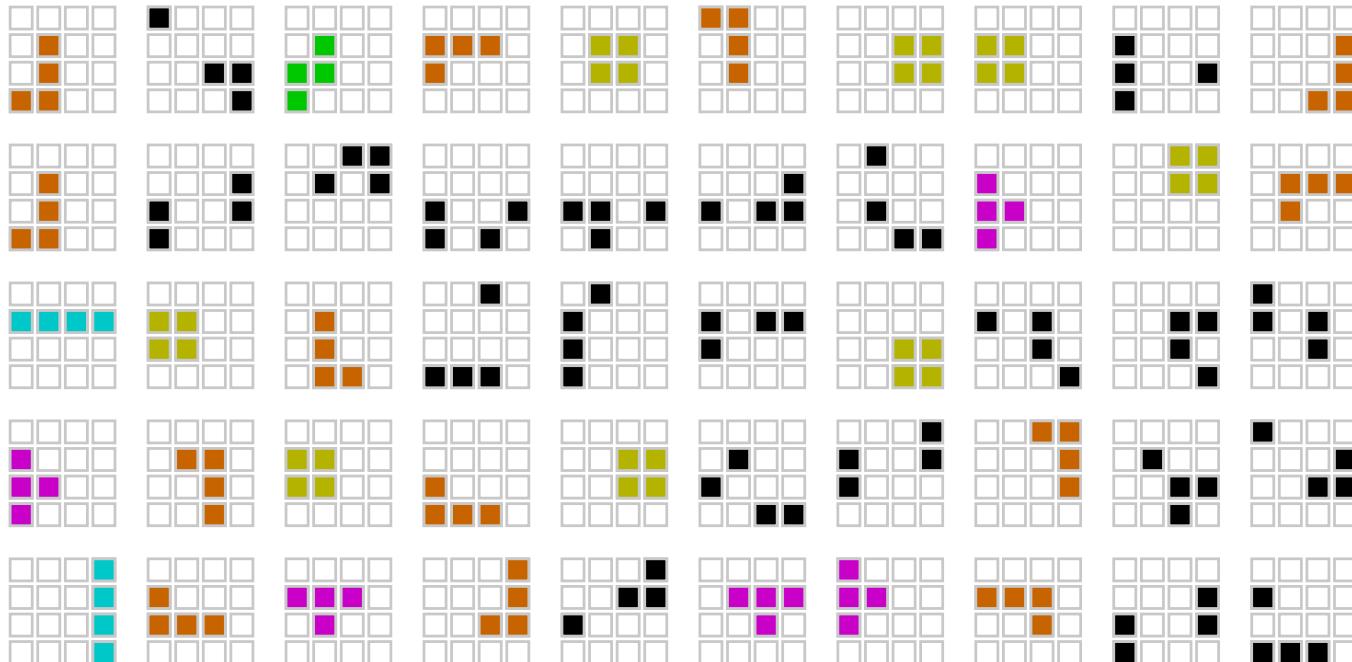




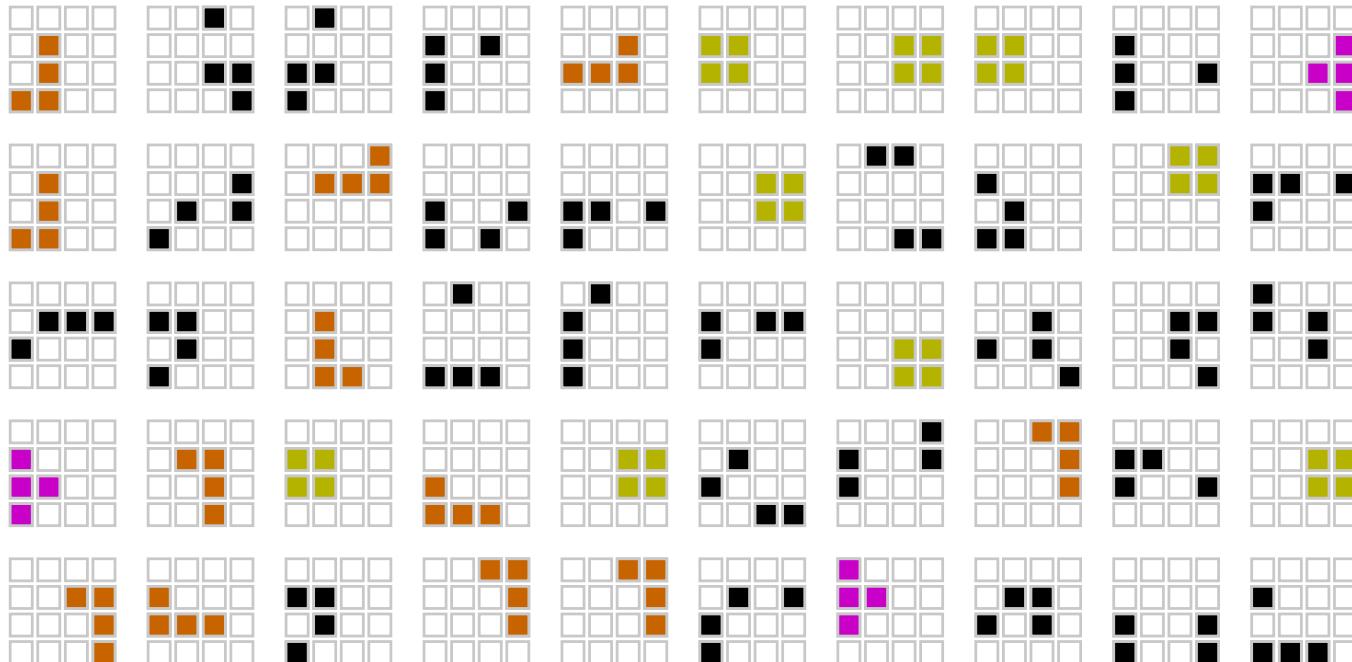
Random grids



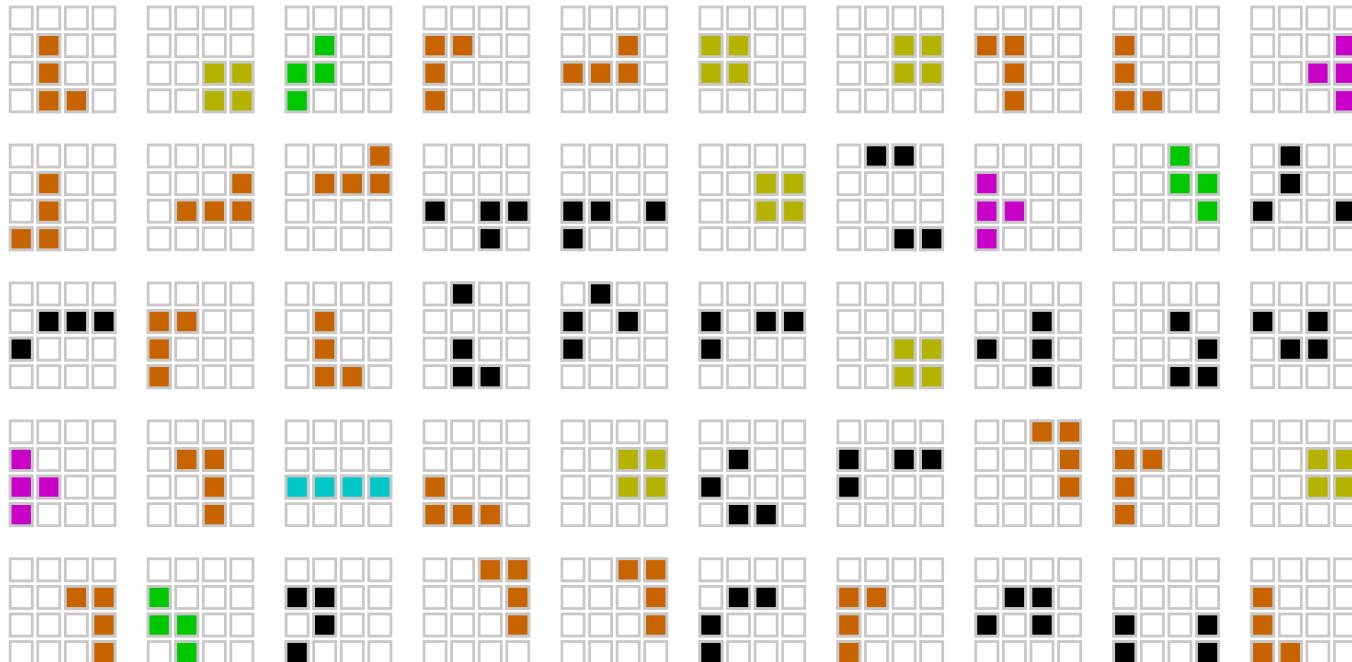
Generation 1



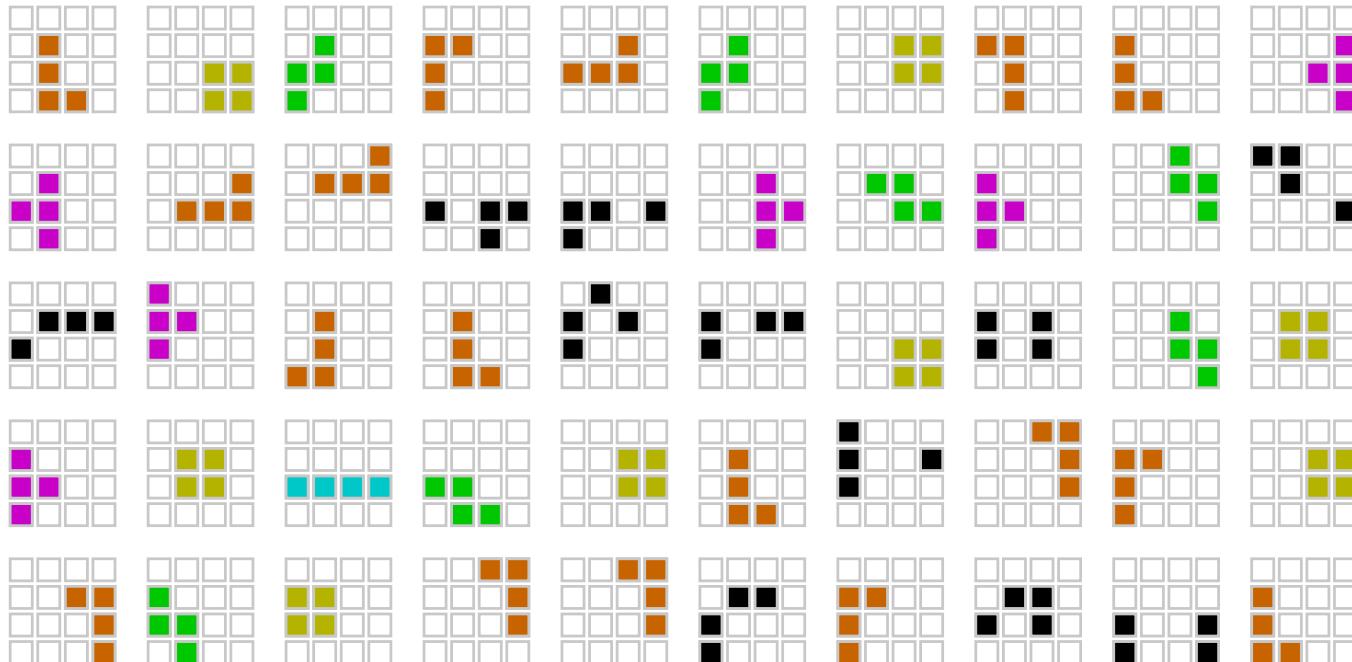
Generation 2



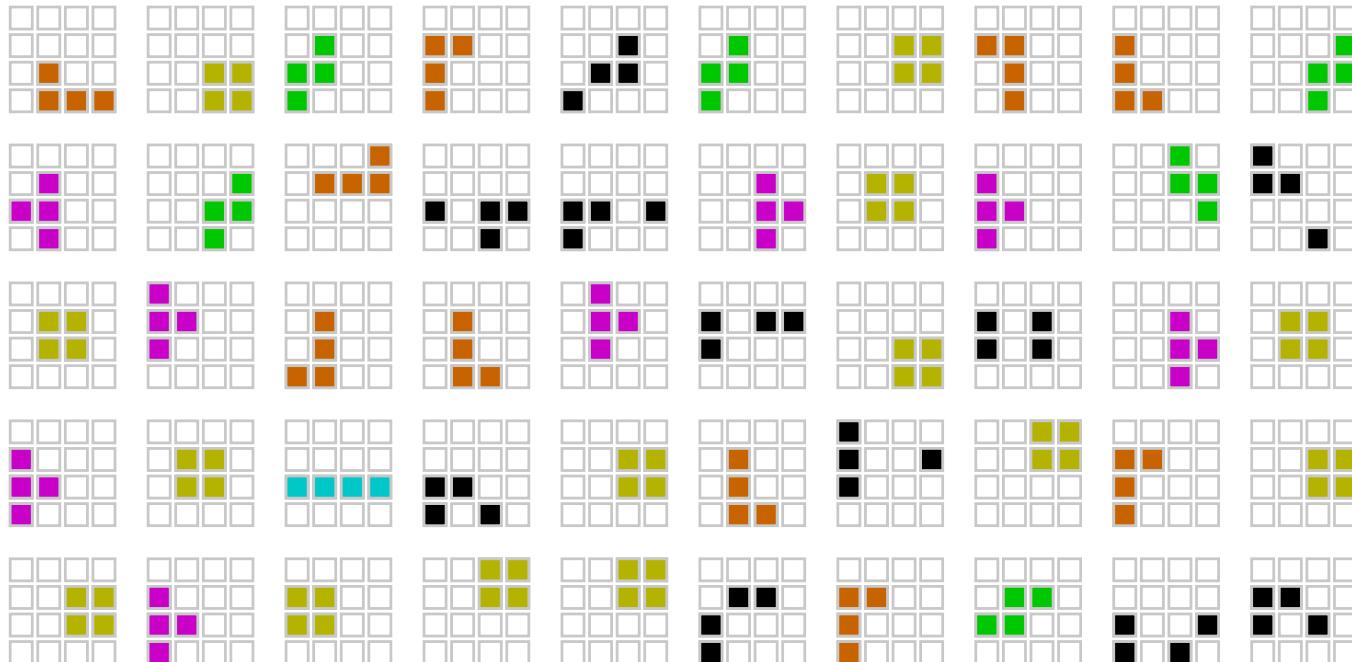
Generation 3



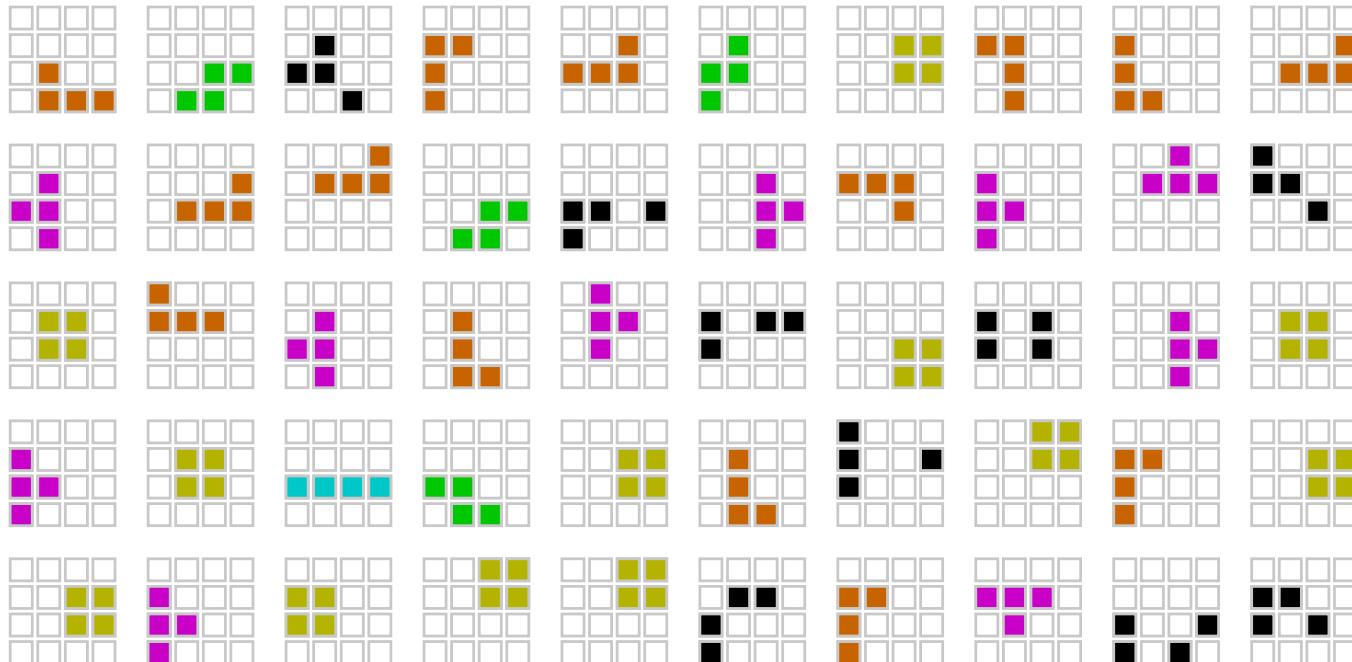
Generation 4



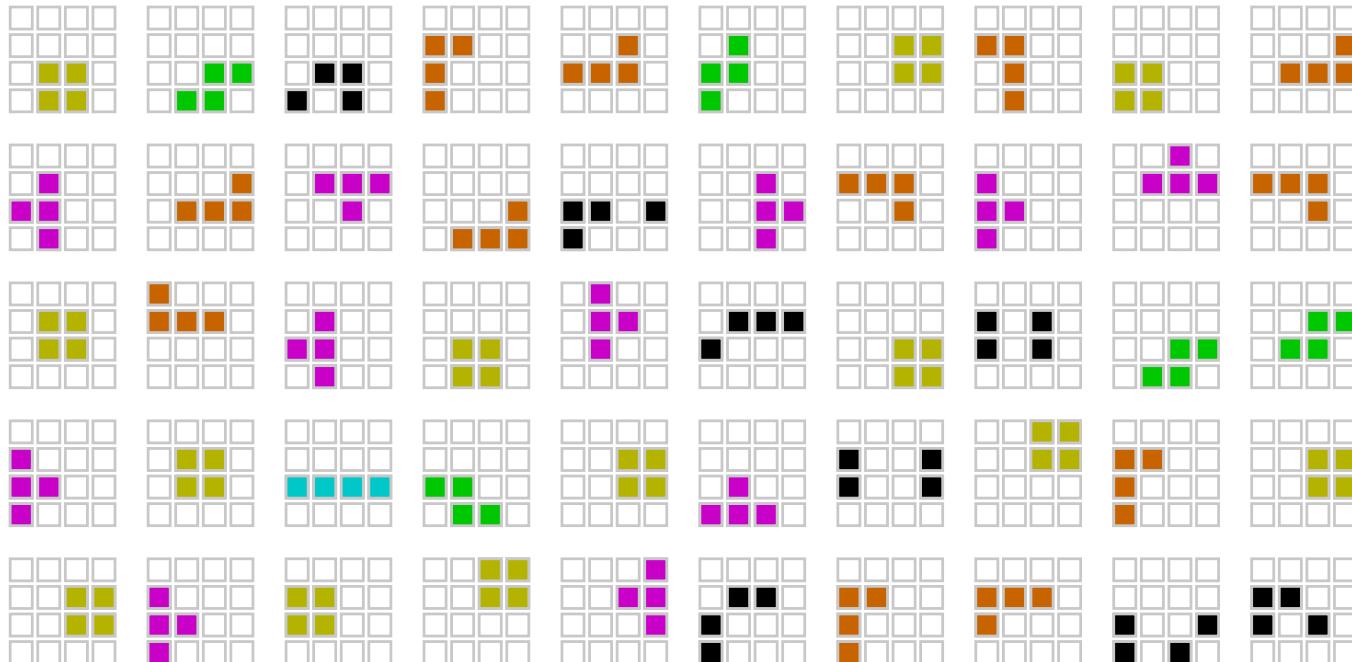
Generation 5



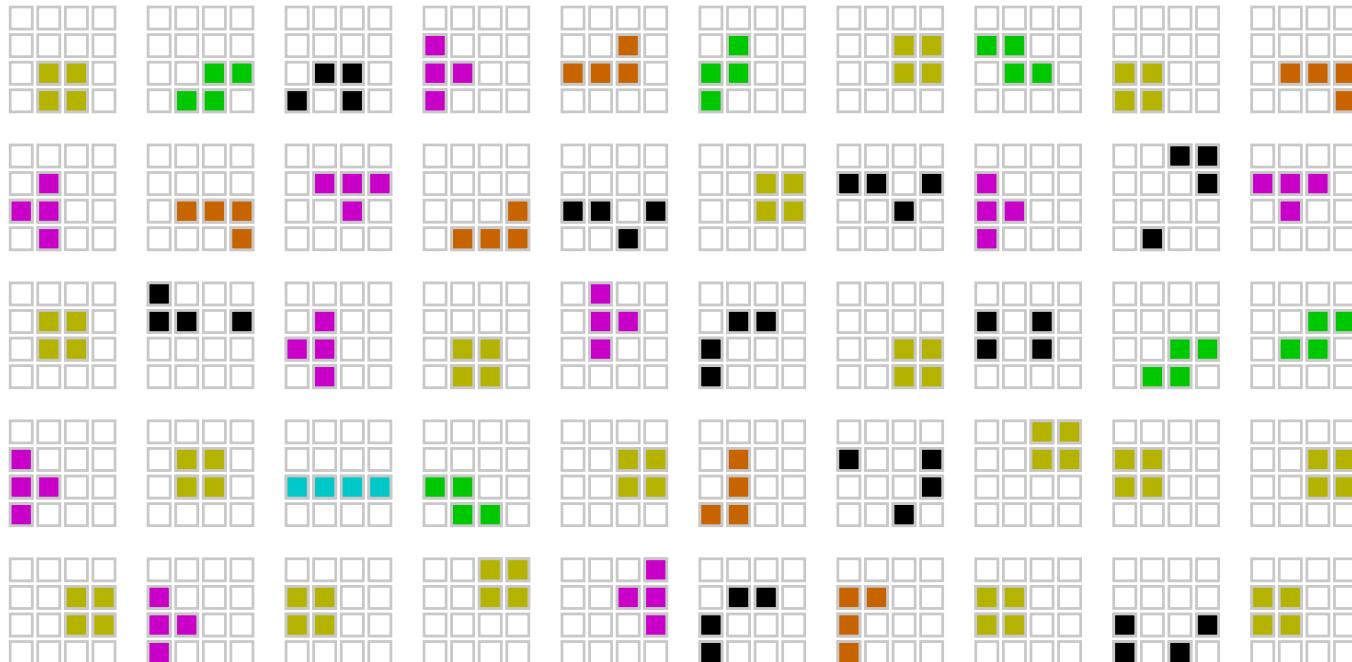
Generation 6



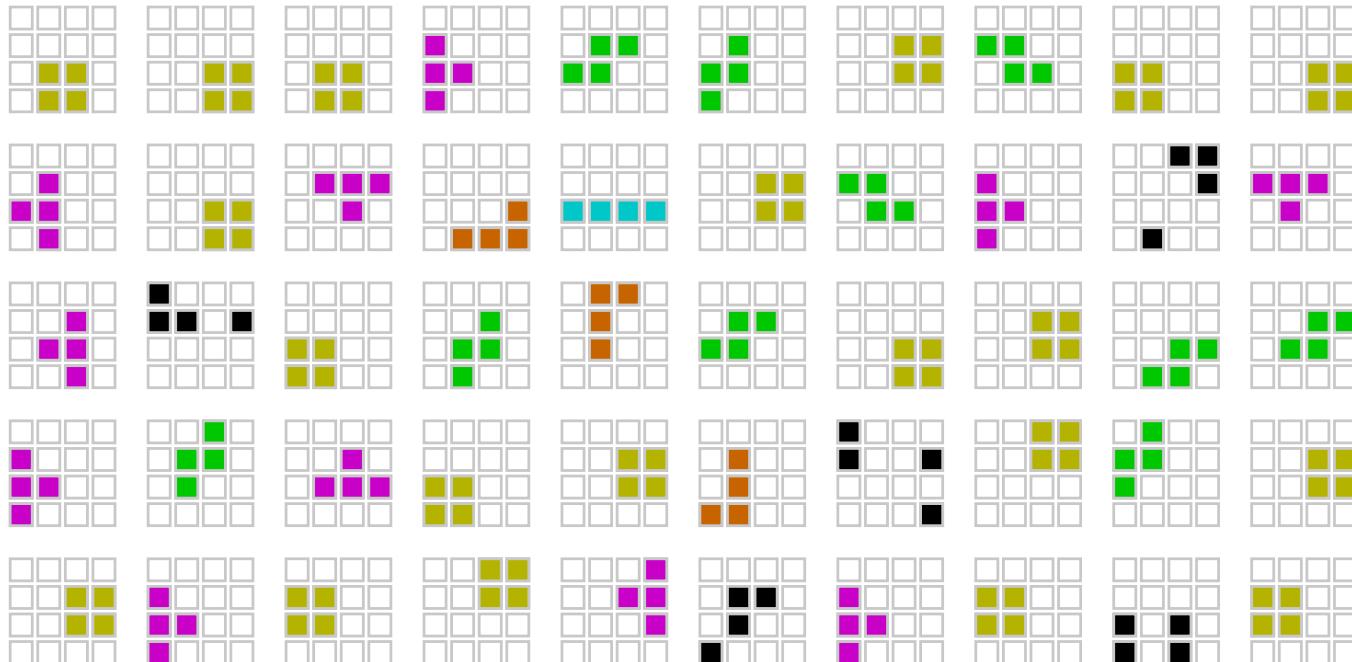
Generation 7



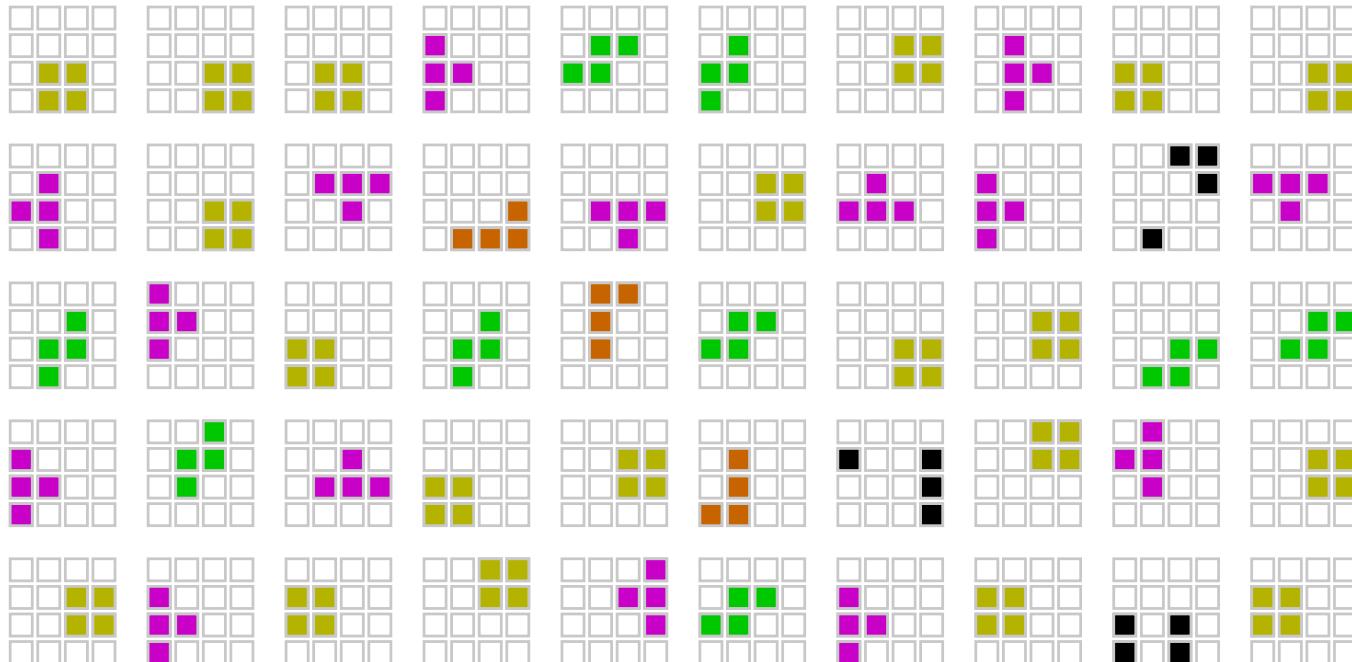
Generation 8



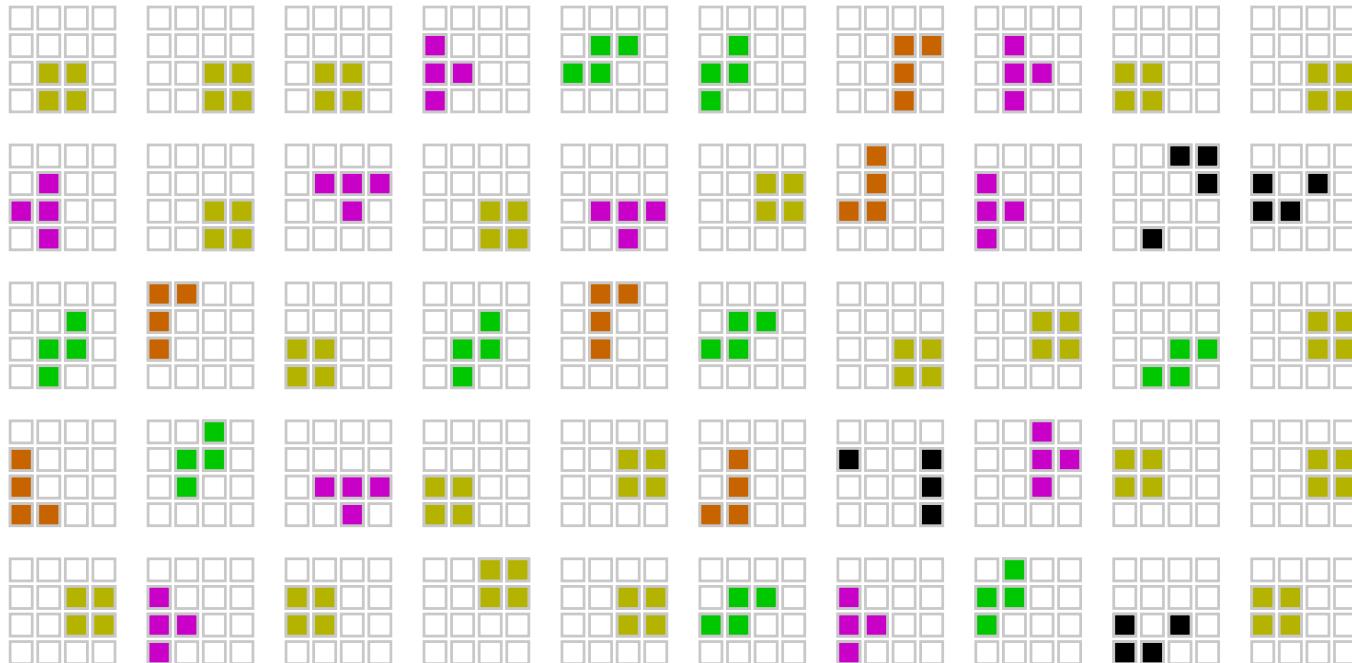
Generation 9



Generation 10

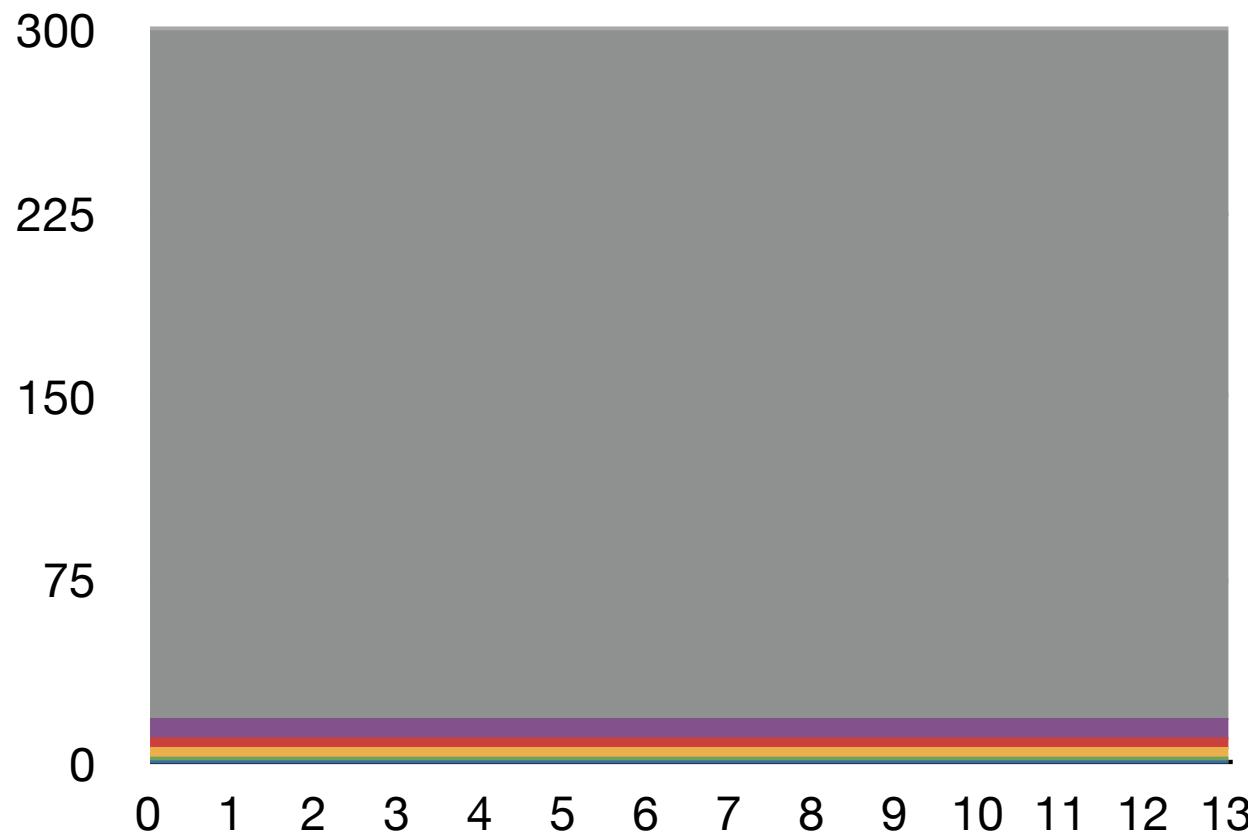


Generation 11

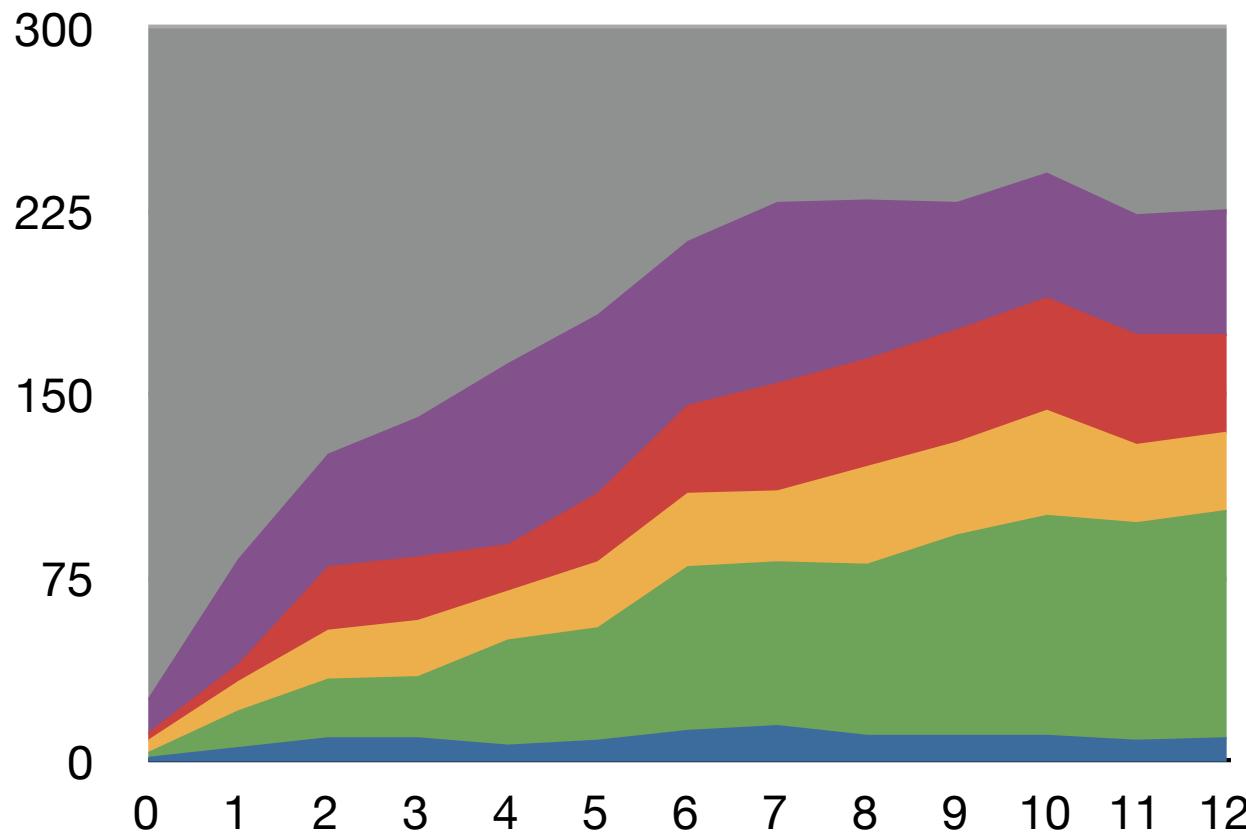


Generation 12

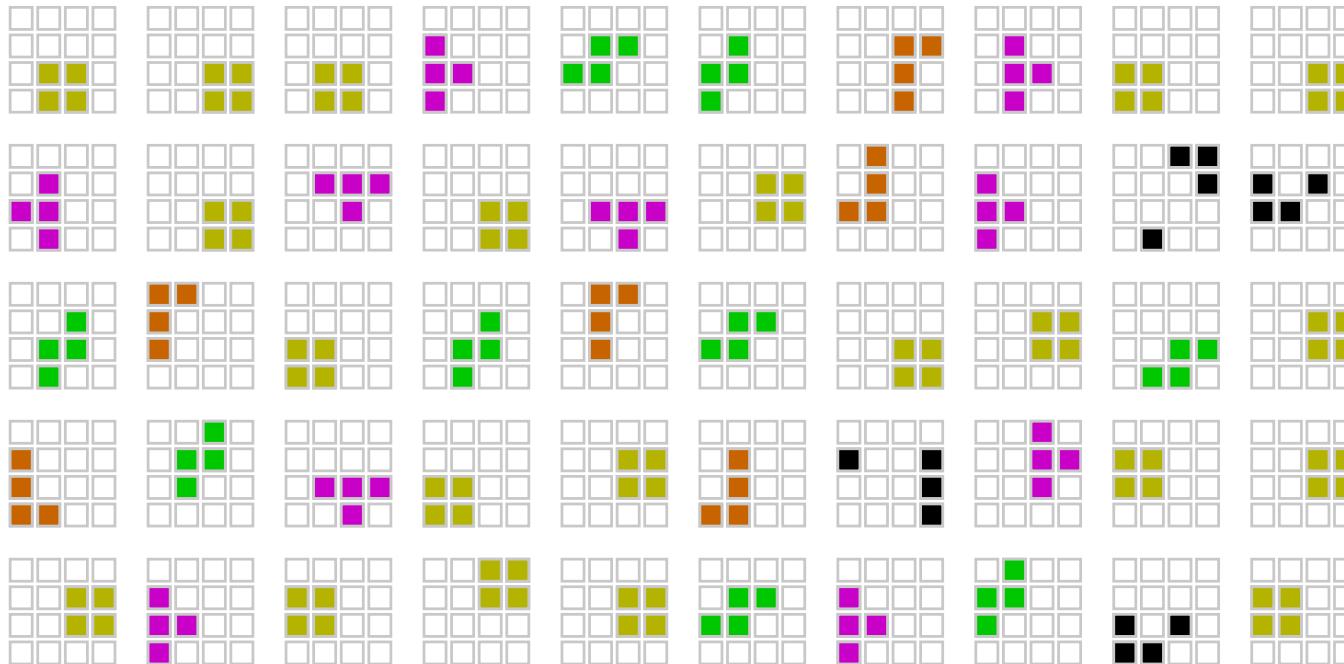
Expected tetrominoes



Actual tetrominoes

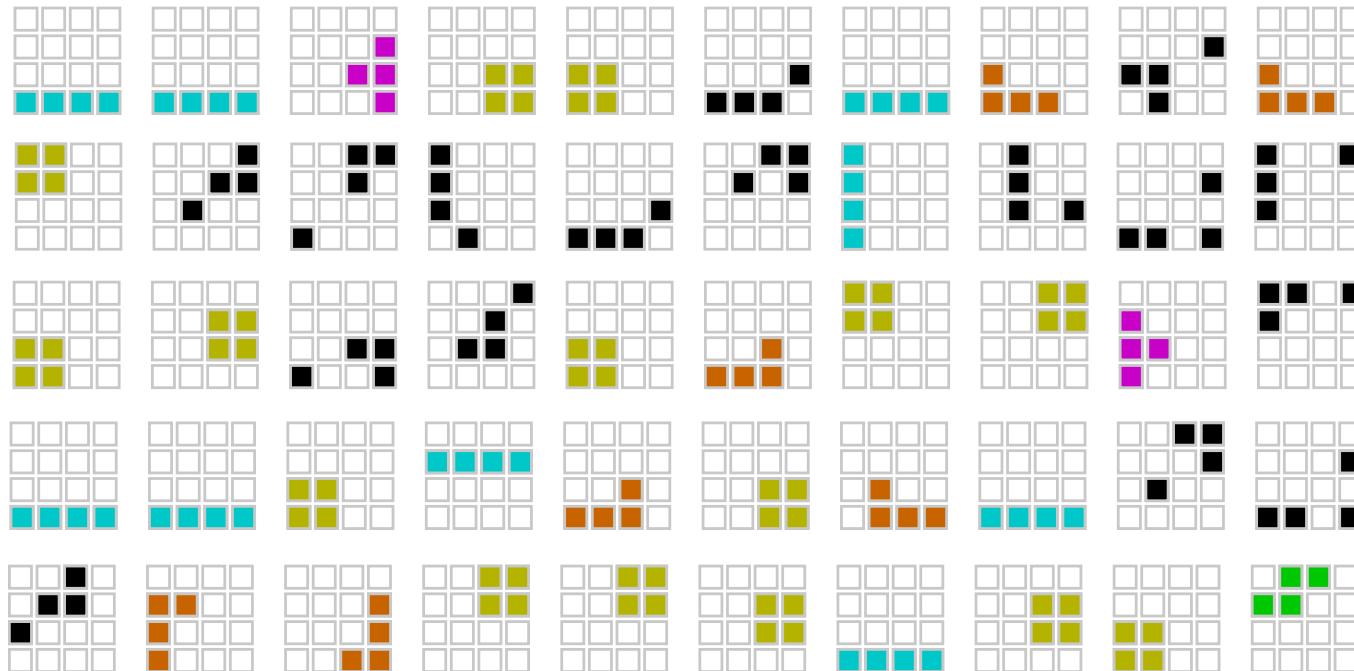


Emergence of a **system**



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 |
| 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 |

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

