Language, Culture and Biology:
does language evolve to be passed on by us, and did humans evolve to let that happen?

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- It's a complex dynamical system on three timescales:
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  2. social coordination/cultural transmission
  3. biological evolution
- But does this matter?
  - Do we need to take this into account to explain why language is the way it is?

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- Genetically determined Language Faculty shapes what languages we can learn, and this has fitness impact
- To explain **adaptive** structure in language, look to natural selection of learning constraints

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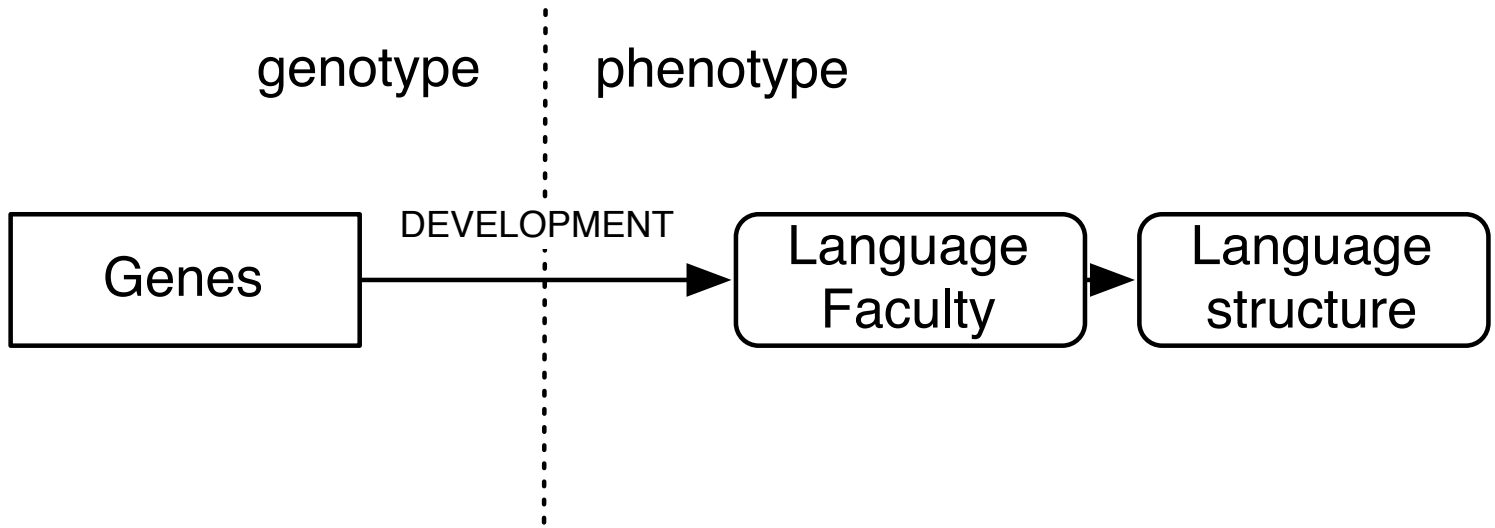

- *Human nature* determines *human behaviour*, i.e. innate learning mechanism determines language structure

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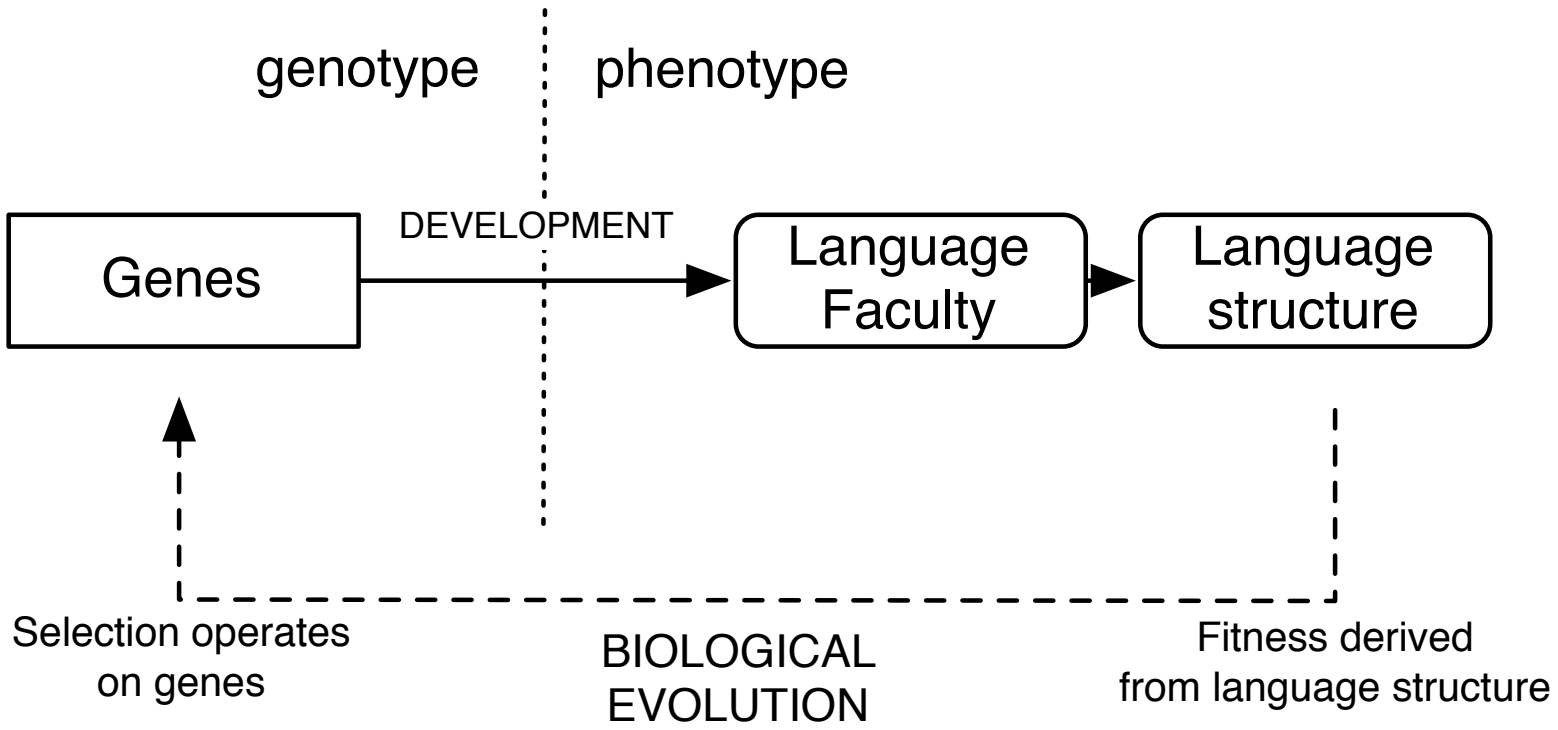

- Biological evolution explains adaptive behaviour, i.e. communicatively functional language

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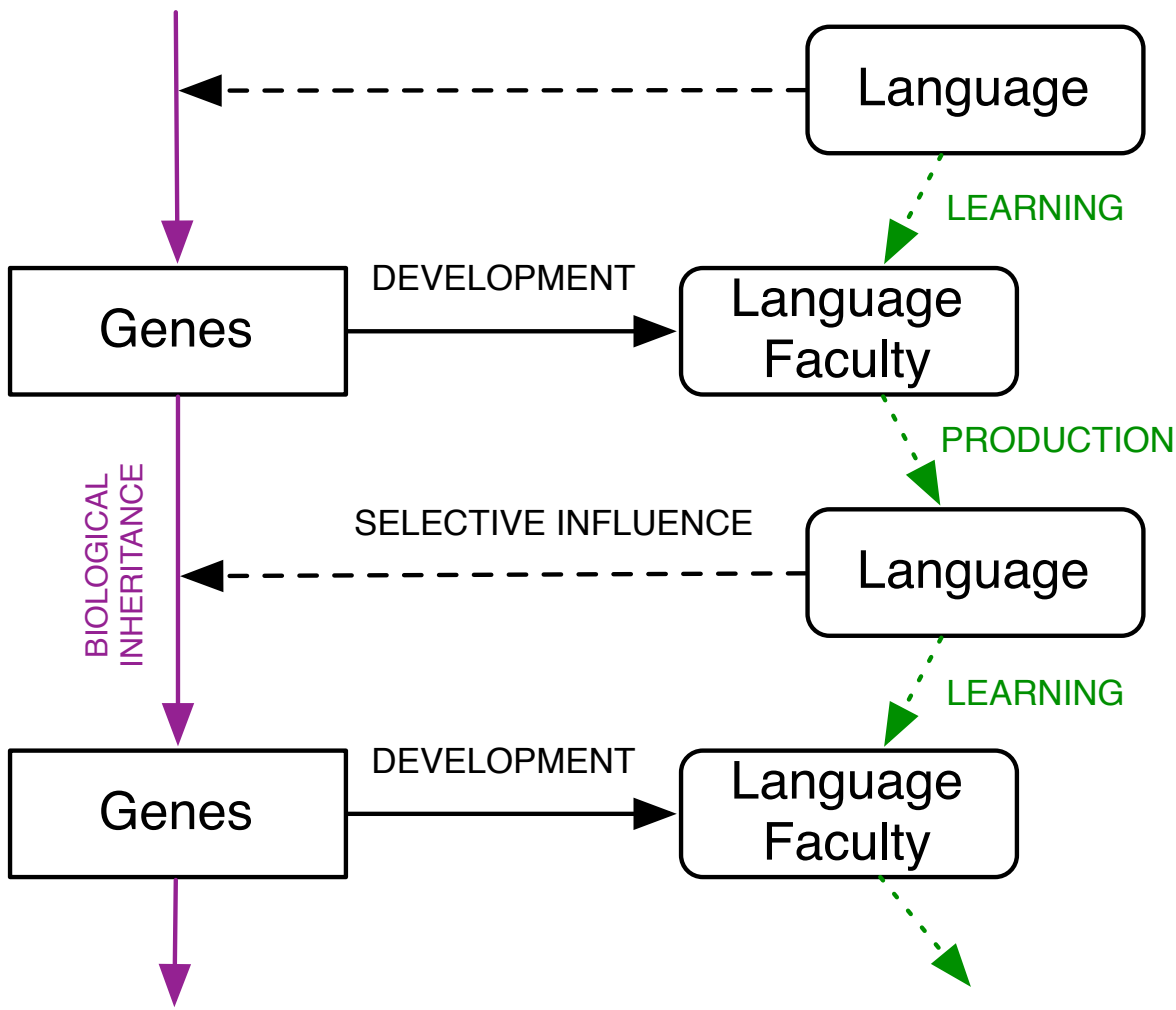
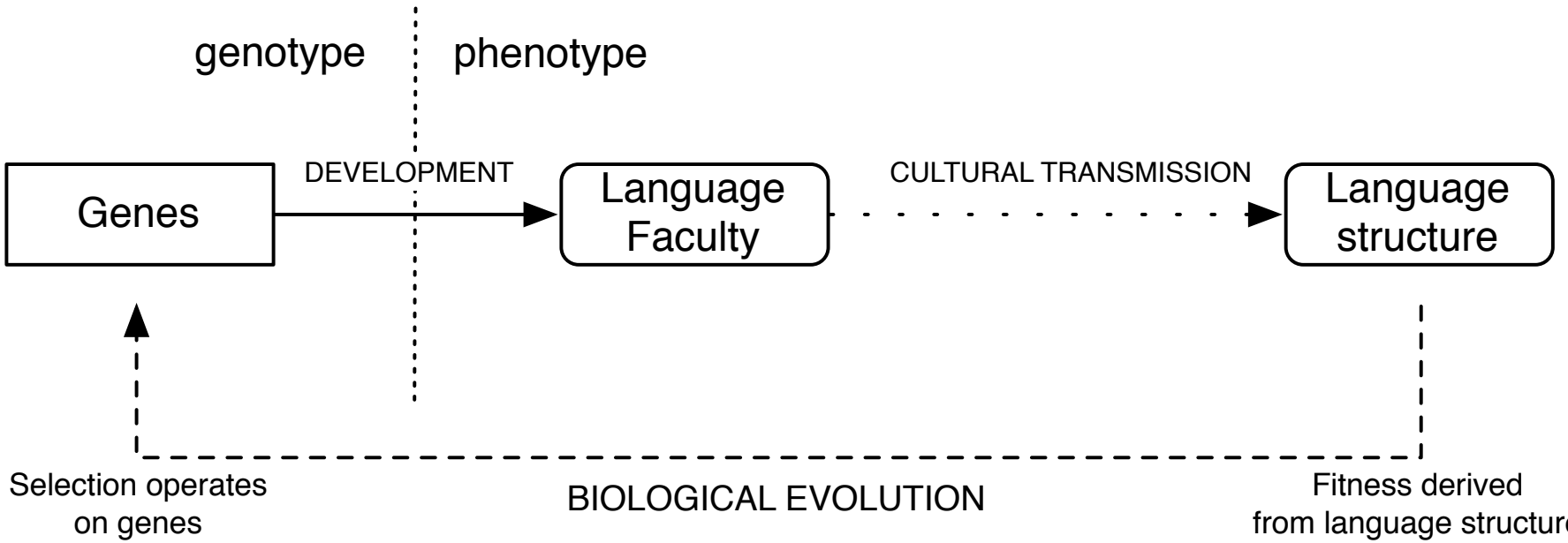
- Dual inheritance:
  - biological inheritance of language faculty, cultural inheritance of languages

Dual Transmission



How this fits in with our previous picture



- Our genes affect our learning biases/constraints, which *somehow* influence the socio/cultural process to give us the structural properties of language, which go on to affect our fitness

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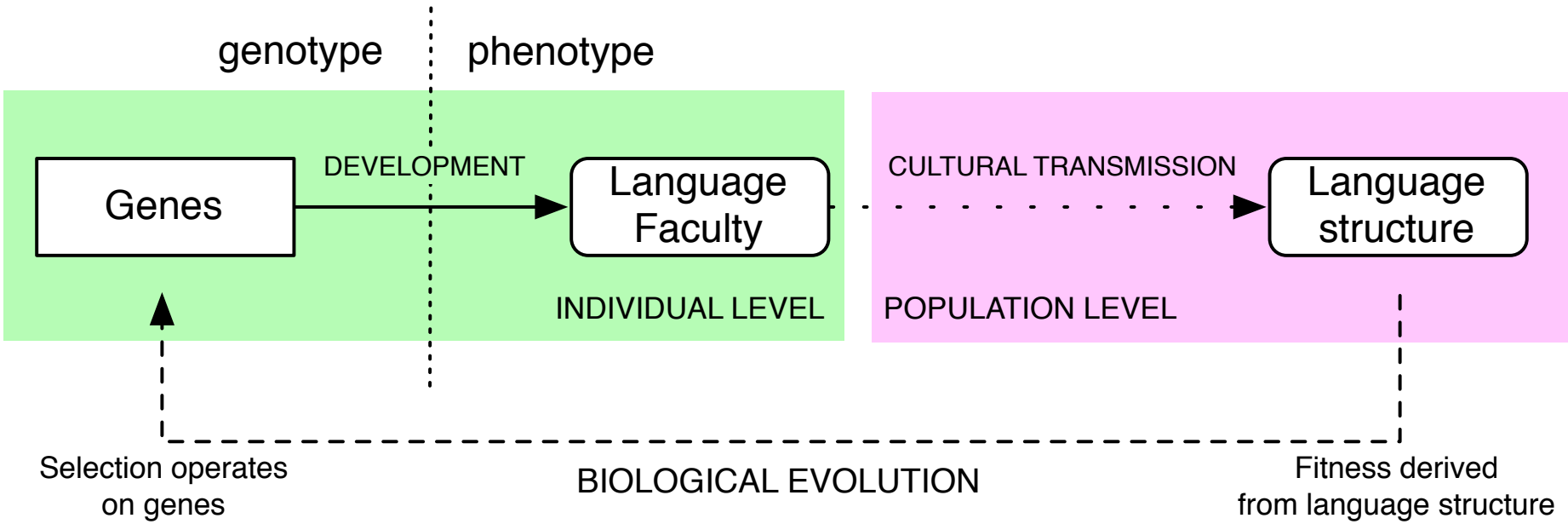

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Can't we just ignore this difficult stuff?

- Can simply ignore cultural transmission when making evolutionary arguments?
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- Research programme initiated by Hurford in the early 90s to try and answer this

Methodology: how to study the influence of cultural transmission

- Intuitions about interacting dynamical systems are poor
  - *Models* allow us to study the mechanisms in an idealised setting.
  - Apply understanding gained to real systems later.

Methodology: how to study the influence of cultural transmission

- Three broad types of models:
  - **Computational/robotic**
    Castello; Damper; de Beule; Bleys; Briscoe; Dowman; Gasser; Gong; Hawkey; Hoefler; **Hurford**; Kirby; Lakkaraju; Laskowski; Mehler; Schulz; A. Smith; K. Smith; **Steels**; Swarrup; Uno; Wang; Wellens; Worgan; Yamauchi; Zuidema...
  - **Mathematical**
    Baronchelli; Dowman; **Griffiths**; **Kalish**; Kirby; Nakamura; K. Smith...
  - **Experimental**
    Beqa; **Cornish**; Dowman; Feher; Flaherty; Kirby; Roberts; Scott-Phillips; A. Smith; K. Smith; Tamariz...

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3. Individuals also *produce* behaviour that is the input to others' learning

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  - What is the population structure?
    e.g., size; population turnover; spatial structure; social networks; horizontal vs. vertical transmission.

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- Clear imperative on culturally transmitted language (Deacon, Christiansen):
  - To be transmitted with fidelity it must be learnable despite constraints placed on that transmission
  - Languages adapt to the nature of the transmission *bottleneck*

Structure as a hallmark of cultural adaptation

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- This is a cultural rather than biological adaptation

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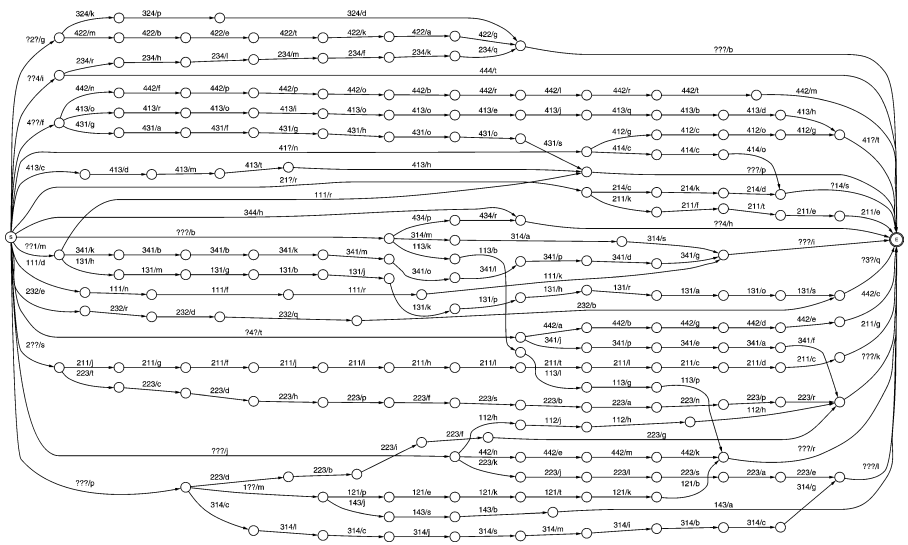

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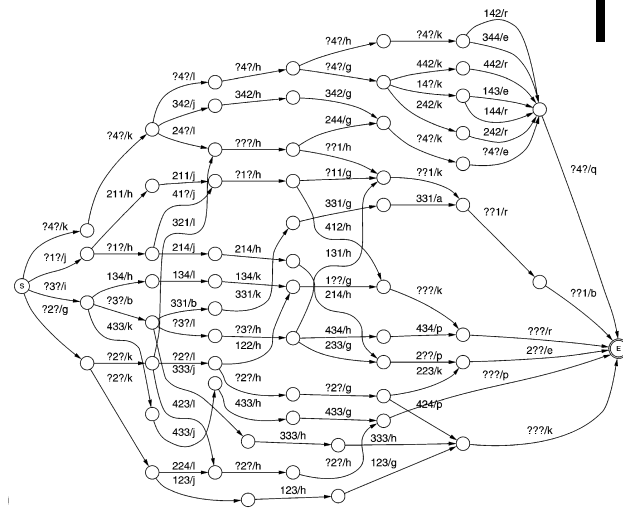

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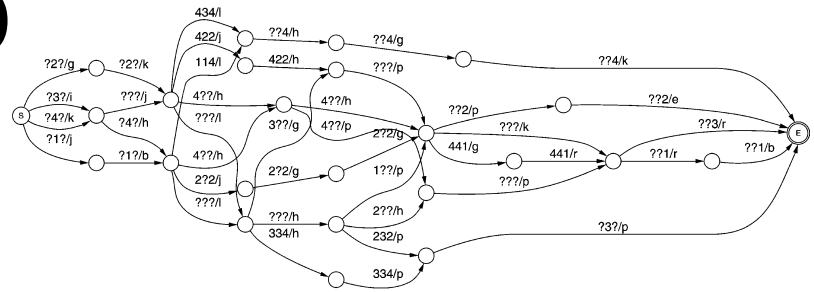

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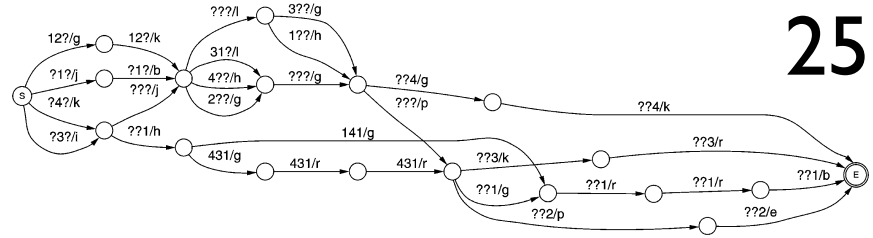

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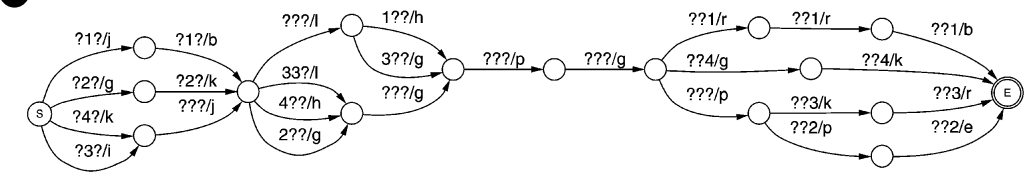

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- **Math models** (Kirby, Dowman Griffiths):
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- **Experimental models** (e.g. Cornish):
  - Give us direct evidence in the lab

Cultural evolution in the lab

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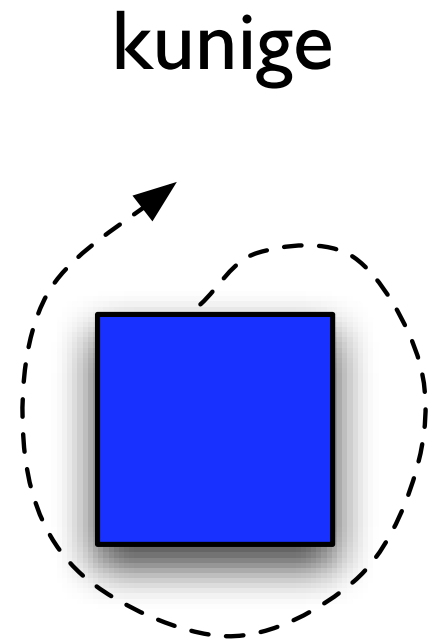

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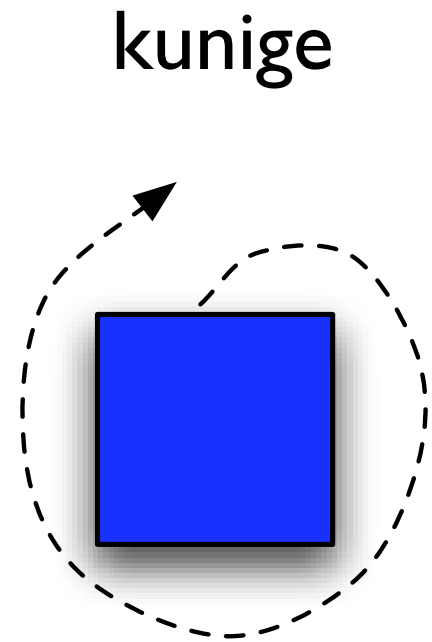

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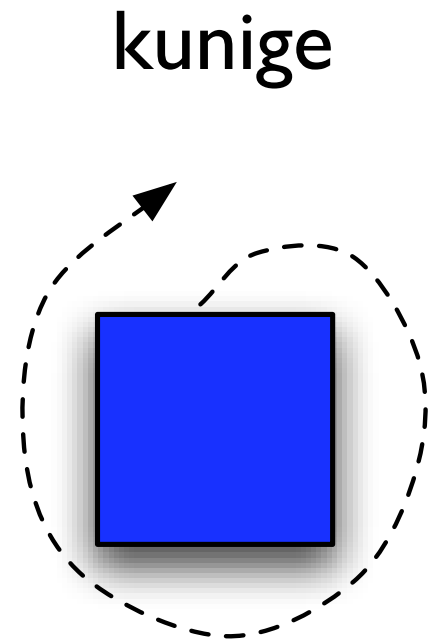

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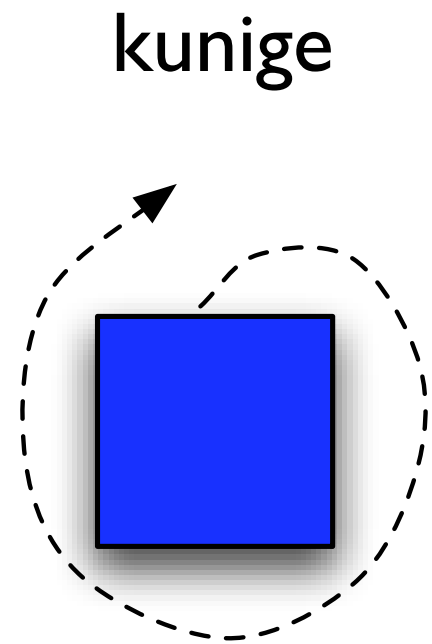
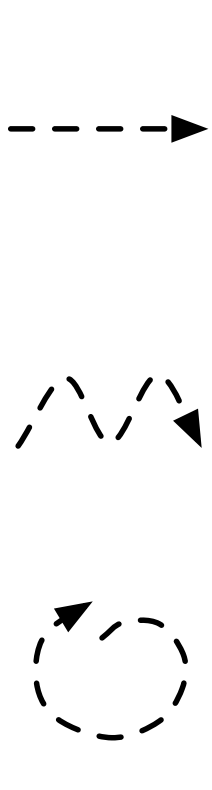
- Sample of output on test used as input language for next participant

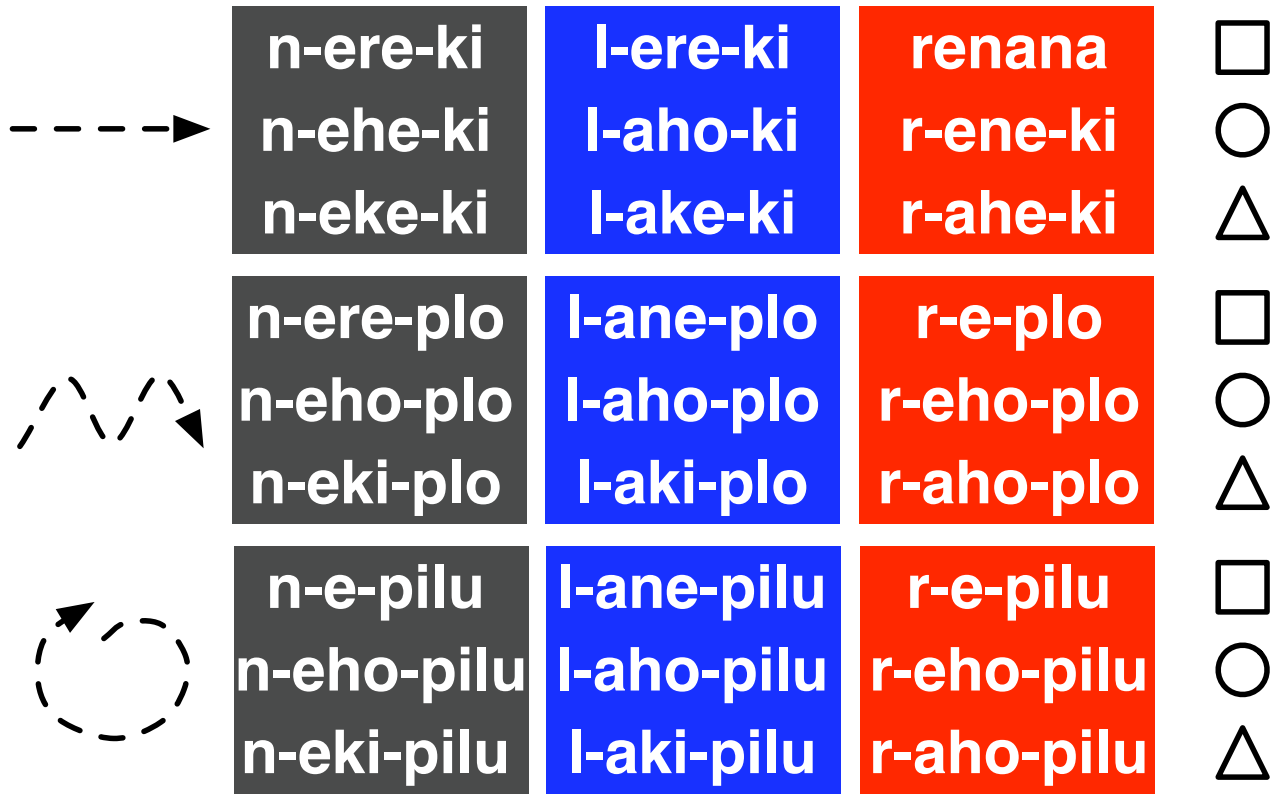


Example initial language



umonamo	kinahune	lahupine	□
nelu	kanehu	namopihu	○
kapihu	humo	lahupiki	△
moki	luneki	lanepi	□
kalu	mola	pihukimo	○
nane	kalakihu	mokihuna	△
kilamo	kahuki	neluka	□
pilu	neki	pinemohu	○
luki	namola	lumoka	△

Example final language
(10 "generations" later)



- Confirms computational results: structure emerges that optimises *learnability* and *expressivity*

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  - Fits observations about genes and tone languages (Dediu & Ladd)

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- The real evolutionary story?
  - Not: natural selection of innate constraints that determine language structure
  - Instead: pre-adaptations that enable iterated learning

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- Transmitted by iterated learning, but do not carry semantics
- Evolves for other reasons
  - Complex learned song is fitness indicator (e.g. Ritchie, Kirby & Hawkey; Okanoya)

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- Intentional inference plausibly evolves for reasons other than communication

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- Once this is in place, linguistic structure is delivered by adaptation through iterated learning

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  3. Cultural transmission of such mappings leads to adaptation of partially predictable structure optimising learnability and expressivity
  4. The key structural characteristics of human language are the inevitable consequence of this cultural adaptation process
- Still much work to be done, but multiple modelling strategies represent the best approach.