

Cognition and Semiotics

MA Cognitive Semiotics, Fall 2020

Lecture 11
Monday Nov 16th

Overview

- Today's lecture: Biology, culture and cognition
 - Connecting topics!
 - Brief notes
 - Guest lecture
 - Follow-up on written assignment
 - Connecting topics
 - Evolutionary biology and culture
 - Brain, cognition and culture
 - Topic connection exercise

Guest lecture

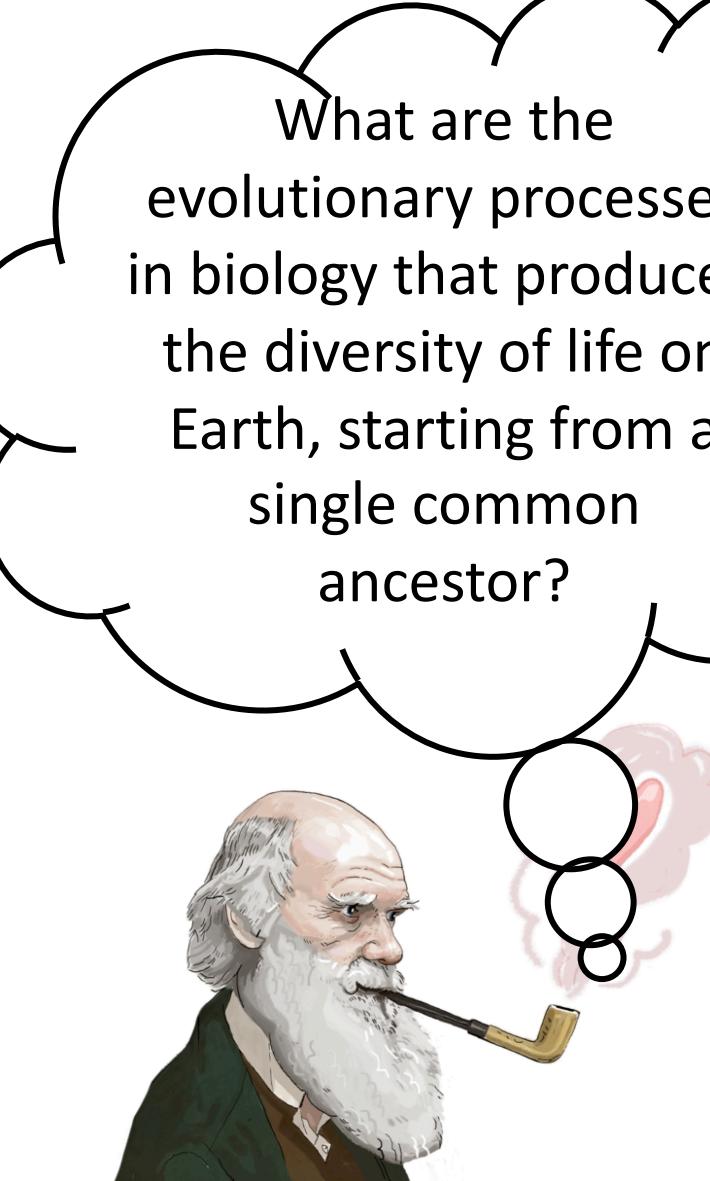
- Next time, Kristian Tylén will give the lecture
 - On distributed / embodied cognition
 - Thinking with artefacts, objects, tools, our bodies
 - It will probably be extremely interesting!



Follow-up

- Peer commentary on assignments
 - Have you checked out your comments?
 - Generally, well-considered and thoughtful comments!
 - Not surprisingly, you are being very nice
 - But caused very different reading and understanding, it seemed – and very different attitude to our literature
 - Good papers, so did you run out of things to say?
 - On a scale, would you do it again?

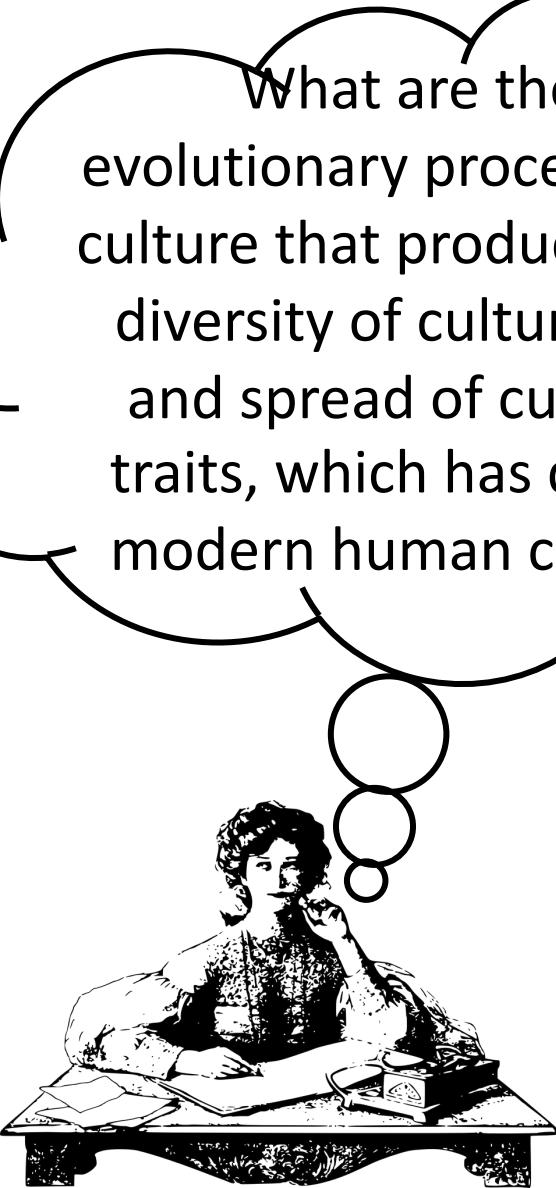
Biology of culture



What are the evolutionary processes in biology that produced the diversity of life on Earth, starting from a single common ancestor?

- Evolutionary biology is concerned with processes that fall under natural selection, adaptive behaviour, genetic mutations, and Darwinian evolution
- Has been used to describe how genetic traits (or even hereditary diseases) spread within and across species and how the development and success of particular traits are driven by biological and evolutionary processes

Biology of culture



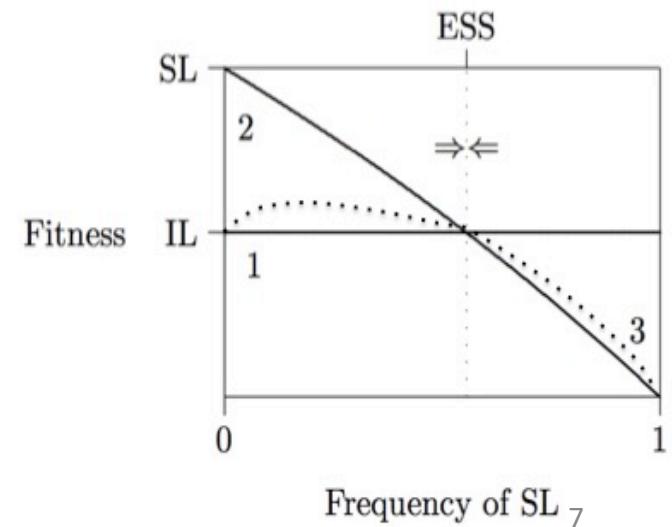
What are the evolutionary processes in culture that produced the diversity of cultural life and spread of cultural traits, which has driven modern human culture

- Cultural evolution may also be concerned with processes that fall under natural selection, adaptive behaviour, “cultural” mutations, and Darwinian evolution
- Uses parallels in biological evolution to describe cultural evolution, e.g. how cultural traits (e.g. technology, knowledge or group-level patterns) spread within and across cultures and how the success of particular traits are driven by evolutionary processes

A.k.a. cultural evolutionary psychology

The role of social learning

- Recall lecture 6: Social learning is '*influenced by observation of or interaction with another individual*' (and opposed to *asocial learning*)
- Social learning is everywhere around us! – Remember *Rogers' paradox*?
- Observed to be a driver behind the social transmission of (cultural) information across individuals and generations – and ultimately cumulative culture



The role of social learning

- *But social learning is, as such, not inherently adaptive!*
- Humans and animals may gain fitness benefits by learning from others
 - e.g. acquiring adaptive information while avoiding costly and risky asocial trial-and-error learning
- But use of social information is **not a guarantee** for success!
 - **Switching** (between social and asocial) is a start, but we need more than that!

Adaptive behaviour enhances survival and reproductive success for the individual

See Lecture 5 & 6 for more

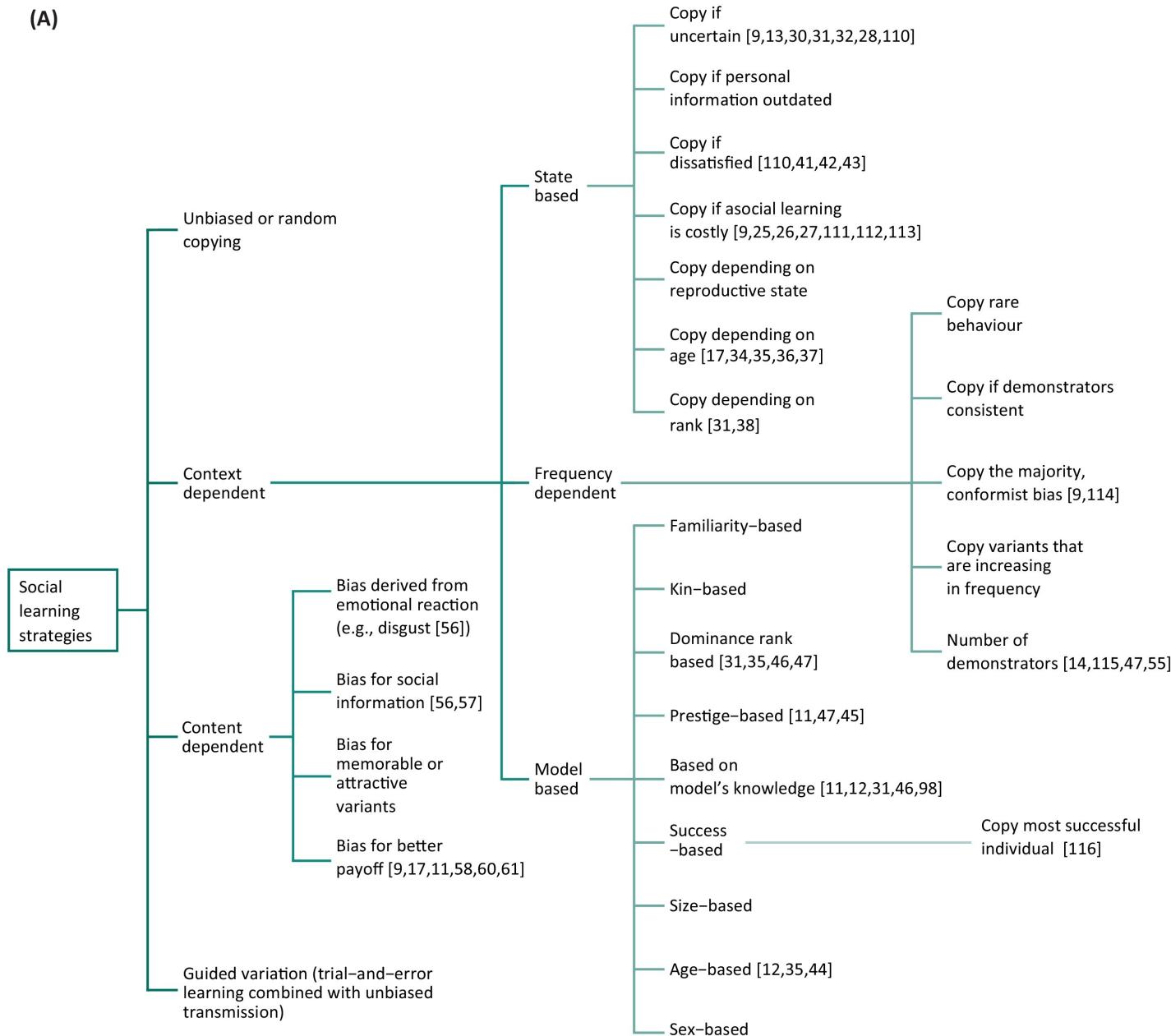


- Instead, we expect and observe that social learning is used in a **selective** rather than indiscriminate manner
- Across species, particular **transmission biases** are observed, which bias individuals to copy particular behaviours in particular contexts in adaptive ways!
- These are so-called **social learning strategies** that can be grouped:
 - “*What*” strategies
 - “*Who*” strategies
 - “*When*” strategies



Not the same as social learning *mechanisms*, which describe the way in which information may be transmitted without alluding to adaptive strategies

(A)



Making social learning adaptive?

First, ‘When’ SLSs concern the conditions in which an individual should engage in social learning (e.g., copy others when hungry)

Second, ‘What’ SLSs concern biases towards particular kinds of information (e.g., copy memorable information)

Third, ‘Who’ SLSs concern biases towards particular social models (e.g., copy successful individuals)

It's not the tool itself (social learning) that is valuable, but the way it is used!

Such selectivity in social learning ensures adaptive benefits by e.g. copying traits with high utility (whether instrumentally fx ‘success bias’ or conventionally fx ‘prestige bias’) as well as the incorporation of novel beneficial modifications (fx ‘payoff bias’)

- Facilitates more accurate cultural inheritance of information and helping to promote cumulative culture

Enter scene: Heyes (2015) paper

- Arrives with a firm foundation in what's beneath behavioural and ecological descriptions from biology:
 - e.g. underlying **cognitive** mechanisms and **levels** of cognitive processing (fx explicit vs implicit)
- In groups of 3, please discuss
 - What are her main critiques?
 - What are her proposed (re)solutions?



Trends in Cognitive Sciences

CellPress

Opinion

Who Knows? Metacognitive
Social Learning Strategies

Cecilia Heyes^{1,2,*}

Research on SLSs has been dominated by disciplines concerned with what agents do, not what they think!



The language used in the literature (the terminology) implies that the SLSs are *domain-specific*, i.e. used *only* for social information!

The language used in the literature (the terminology) implies that rules are being ‘used’ voluntarily – that an agent uses strategies implies an explicit act of deployment!

There may be a small subset of SLSs that are indeed ‘used’ voluntarily and are domain-specific, but for other reasons than previously thought!

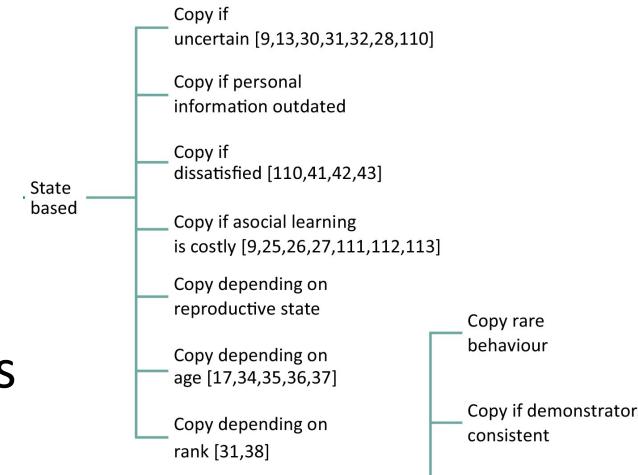
Opinion

Who Knows? Metacognitive Social Learning Strategies

Cecilia Heyes^{1,2,*}

Two-systems approach

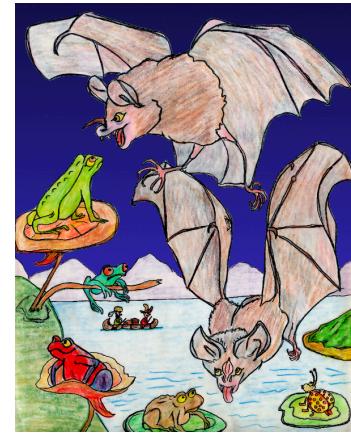
- All of the SLSs listed in the taxonomy (and the body of research that went into it) are characterised in behavioural ecology terms – as deliberate, selective strategies being used
- Animals are like Planets!
- Planets conform to rules, but do not ‘understand’ them - Planetary motion is principled but the rules are in the minds of the scientific observers!
- Most of SLSs can in fact be explained mechanistically by processes of associative learning:
 - Processes whereby individuals learn an association between two stimuli (classical or Pavlovian conditioning) or a behaviour and a stimulus (instrumental or operant conditioning)



“Copy when uncertain”



Frog-eating bats example



- Bats are trained to approach two loudspeakers, A and B, for food:
- First Phase: Always at A
- Second Phase: Variable conditions:

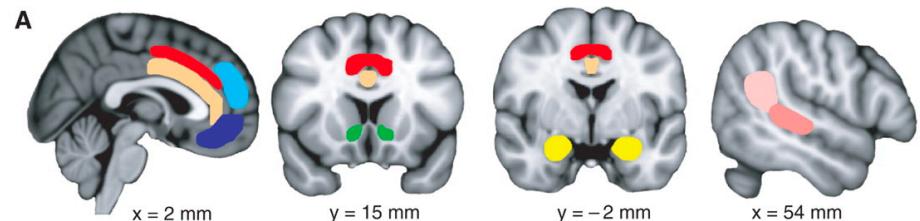
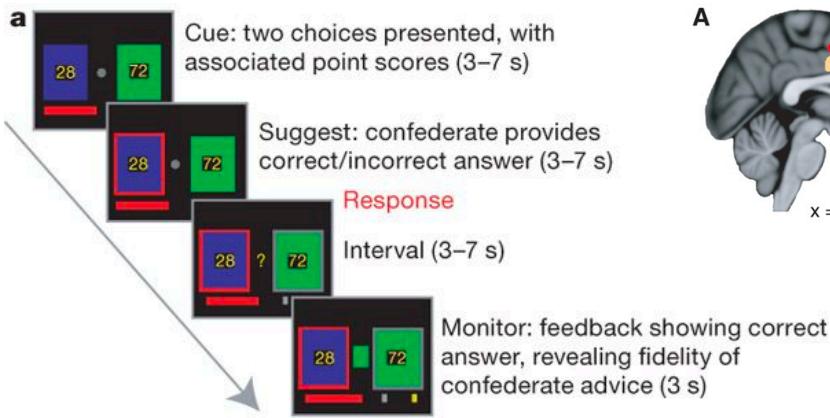
Phase of Training	Group	% Reward at A	% Reward at B
1	All	100	0
2	100-social	100	Satisfied
	50-social	50	Dissatisfied
	50-solitary	50	100 no model

- The bats conformed to the rule “copy when dissatisfied”
- But simpler associative learning can explain the results
 - Group 100-social approached A more often than 50-social
 - Thus, group 50-social approached B more – why?
 - Because approaches to A had only been intermittently rewarded for group 50-social and consistently rewarded for group 100-social - does not make a cue as attractive

Weaker association
for intermittently
rewarded,
unattractive cue

Domain-generality

- Argues that once we go beneath the behavioural descriptions, most SLSs are mainly **automatic and involuntary** outcomes of simple associative learning
- As processes of associative learning are prevalent for non-social contexts and inanimate environments as well, she argues that most SLSs are thus in fact **domain-general!**



Metacognitive social learning strategies

- However, there may be a small subset of SLSs that can indeed be characterised such as all SLSs have erroneously been described, i.e. as **voluntarily and domain-specific** – but for reasons that have not been recognised so far:

- People are (sometimes) like cooks
- Cooks know the rules to which their behaviour conforms, and behaviour is driven by their **explicit knowledge of the rules**
 - People learn through associative learning, but they can also target their social learning by asking “who knows?”
- Humans can utilise metacognitive SLSs, which are related to particular ‘properties of cognitive processes’ **in the rule-user and of other agents**



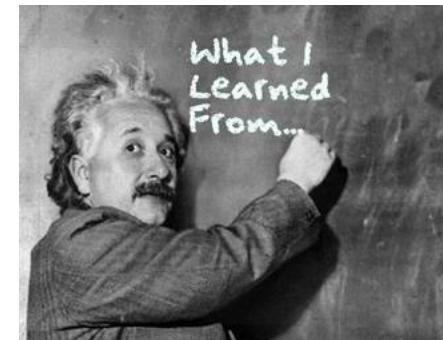
Metacognitive social learning strategies

- These relate uniquely to instances of social learning that involve selection based on **explicit** and **reportable** assessment of own or others' cognitive processes
 - such as “copy when uncertain” (in the rule-user) when we can consciously represent this information
- This additional layer of information allows better weighting of competence and reliability (e.g. metacognitive accuracy) between potential models for copying
- Fx Helps to avoid (over)confident but incompetent individuals → hidden low reliability



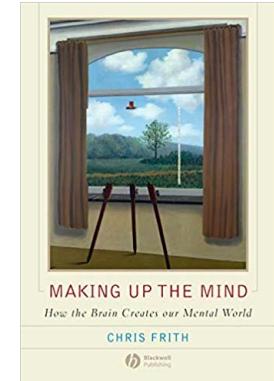
Summing up

- Evolutionary biologists and ecologists characterise all SLSs as domain-specific rules, produced by genetic evolution and natural selection, to promote cumulative cultural evolution (descriptively)
- However, most of them are explained by domain-general associative learning (mechanistically)
- Instead, a few of them, relating to metacognitive assessments, are domain-specific explicit strategies
- SLSs that identify ‘who knows’ improve the accuracy and precision with which agents can track reliable cultural traits, and thereby create conditions in which high-fidelity mechanisms can evolve and operate



How the brain creates culture

- Theoretically touches upon and reviews a lot of concepts and notions from the individual level of social cognition and up to cultural cognition, alignment in communication, and evolution of culture
- In groups of 3, please discuss
 - What is his main message or proposal?
 - And what are the premises for this?





Such two-fold influence is best within a Bayesian framework!

Priors in humans can originate from others and propagate culture

In cognitive terms, there are *two* features of human interaction that are critical for uniquely human cumulative culture

Mimicry; the implicit (and more accurate) process which generates alignment of behaviour and cognitive processes and enhance group oriented behaviour

Introspection and reflective discussion; the explicit processes with top-down effects on behaviour and experience which lead to cultural consensus and responsibility



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How the brain creates culture

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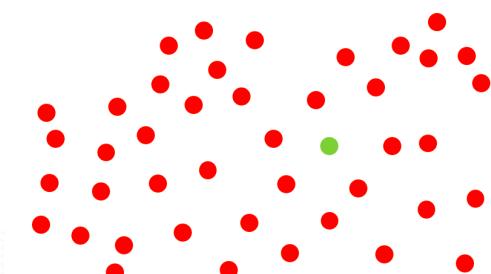
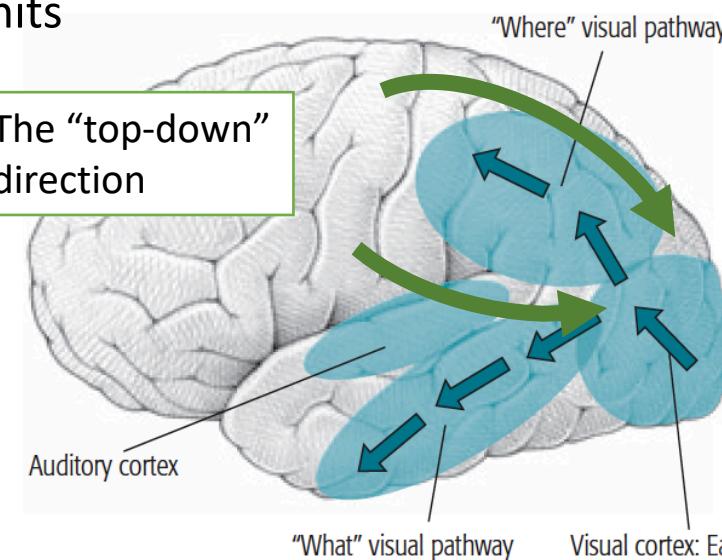
Top-down effects? (here, in visual perception)

- Bottom-up processing
 - e.g. attention is guided or “caught” by low-level and non-conscious (exogenous) cues
- Top-down processing
 - High-level general knowledge and memory contributes to the interpretation of the low-level perceptual units

Information from the **physical stimulus** is used to help cognitive processing

Information from the **general context** is used to help cognitive processing

TAE CAT



The “bottom-up” direction

Bayesian framework in a nutshell

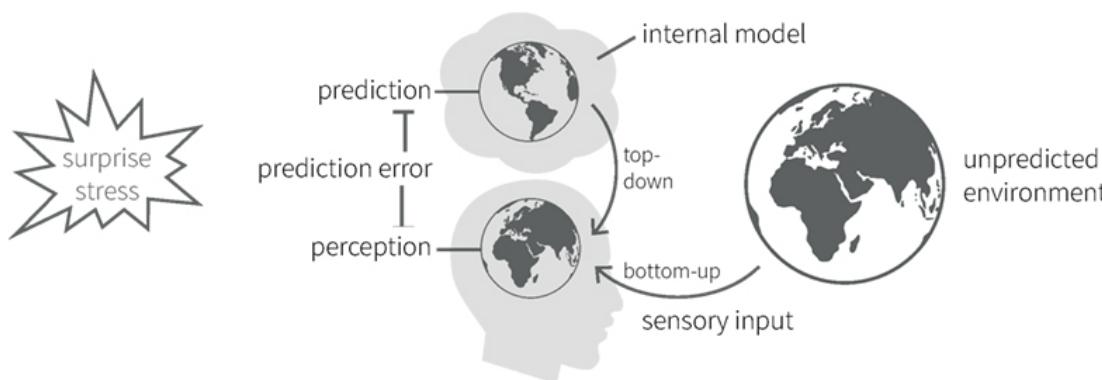
- One of the main functions of the brain is to make **predictions** in order to choose the best actions
 - We have seen an example from predictive coding with the **prediction error** in reinforcement learning, right?
- **Bayesian inference** is an influential cognitive model of how we think and navigate in the world
 - The workhorse in Bayesian inference is Bayes' theorem, which has 3 major components

$$p(\text{hypothesis}|\text{evidence}) = \frac{\underbrace{p(\text{evidence}|\text{hypothesis}) \times p(\text{hypothesis})}_{\text{likelihood}}}{\underbrace{p(\text{evidence}|\text{all hypotheses})}_{\text{normalizing constant}}} \quad \begin{matrix} \text{posterior} \\ \hline \\ p(\text{hypothesis}|\text{evidence}) \\ \hline \end{matrix} \quad \begin{matrix} \text{likelihood} & & \text{prior} \\ \hline \end{matrix}$$

Here, 'p' means *probability* and ' | ' means *given*, so $p(\text{hypothesis}|\text{evidence})$ means *probability that the hypothesis is true given the evidence*

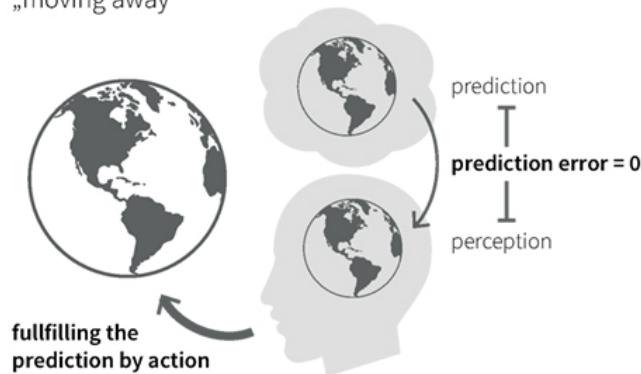
- **Prior**; prediction or expectation of what happens (top-down driven)
- **Evidence**; that is then observed from the senses (bottom-up driven) - depends on our *model of how the world works*
- **Posterior**; the resulting *outcome* of prior and evidence – tell us the extent to which the prior should be altered, given the new evidence!

A Predictive coding in the „Bayesian brain“



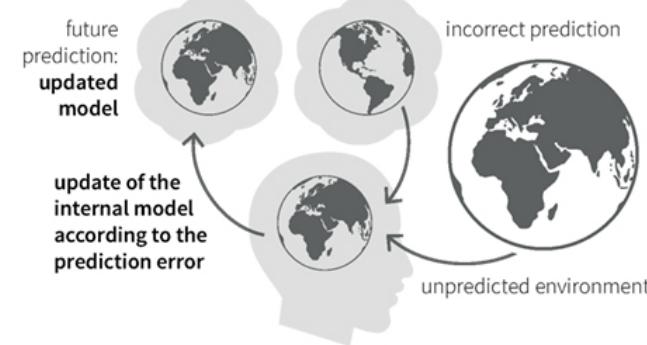
B Minimising prediction error by action

„moving away“

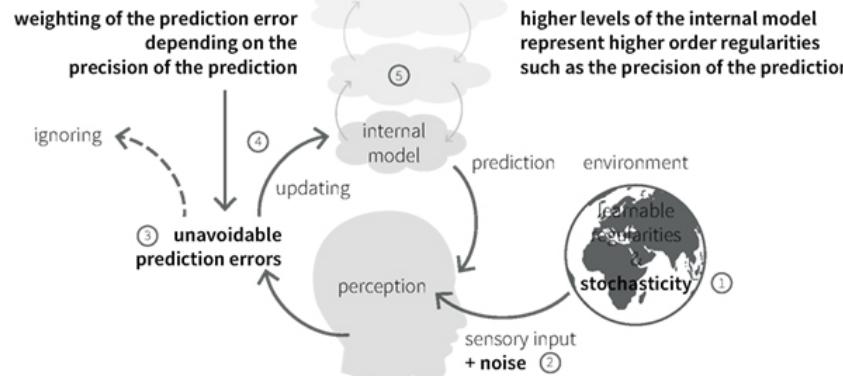


C Minimising prediction error by learning

„explaining away“



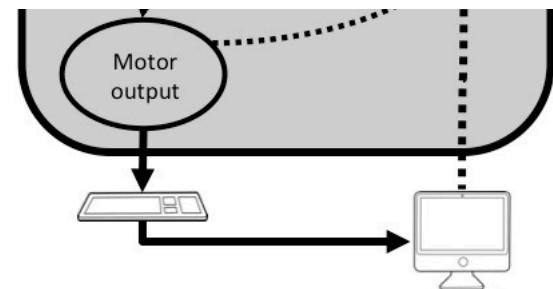
D Hierarchical Learning in a noisy environment



Broadening the source of priors

Other minds

- Frith argues that prior beliefs may not only originate from our past experiences etc. – but as a uniquely human ability also from the beliefs and expectations of others
 - Similar to how we can better acquire and learn other information
 - Indeed, the prior beliefs acquired from others may prioritised over own direct experiences
- Discovering which others that are reliable sources of priors is often derived through explicit discussion or reputation (or gossip!)
- Implication: priors and prediction errors work **hierarchically!**



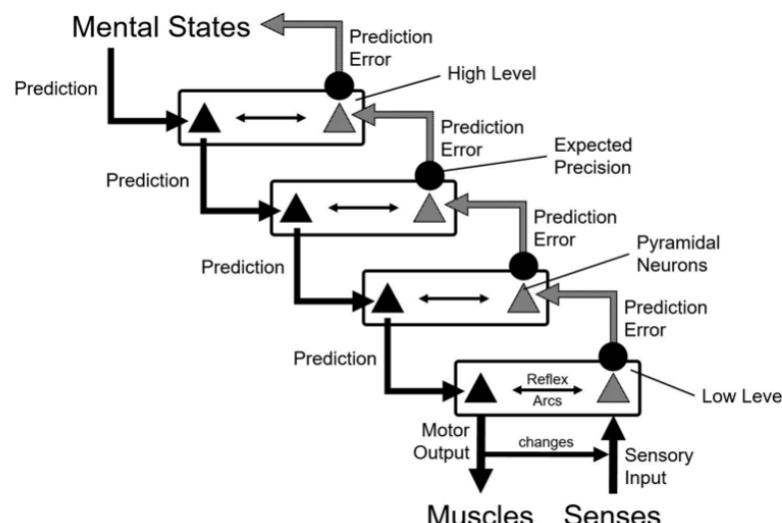
Example of one source of and influences on priors
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'Outside' social information influences prior expectations (and how we think)

- Priors derived from direct discussions (or reputation and gossip) can extend to also influence inner workings of the mind, e.g.

Ego Depletion

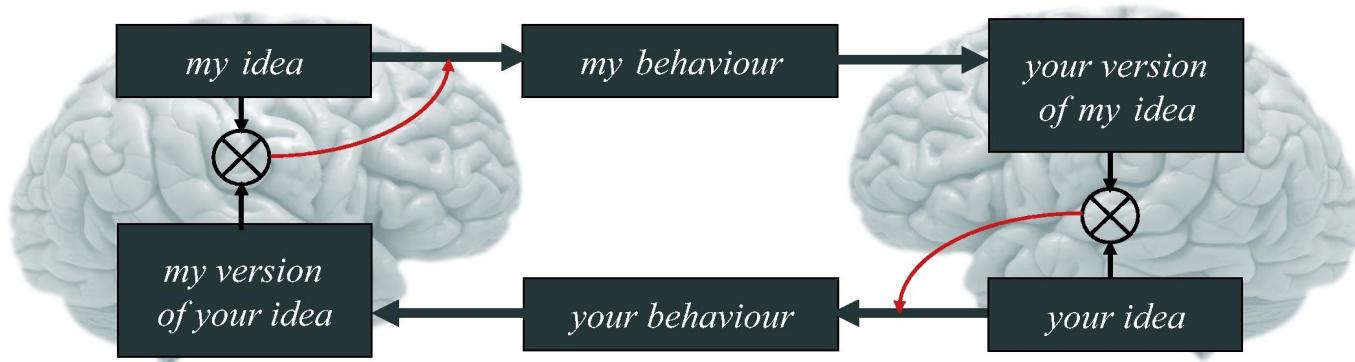
Volition and beliefs of free will



Shows how far down the hierarchy these instructions are able to influence behaviour

Social predictive account

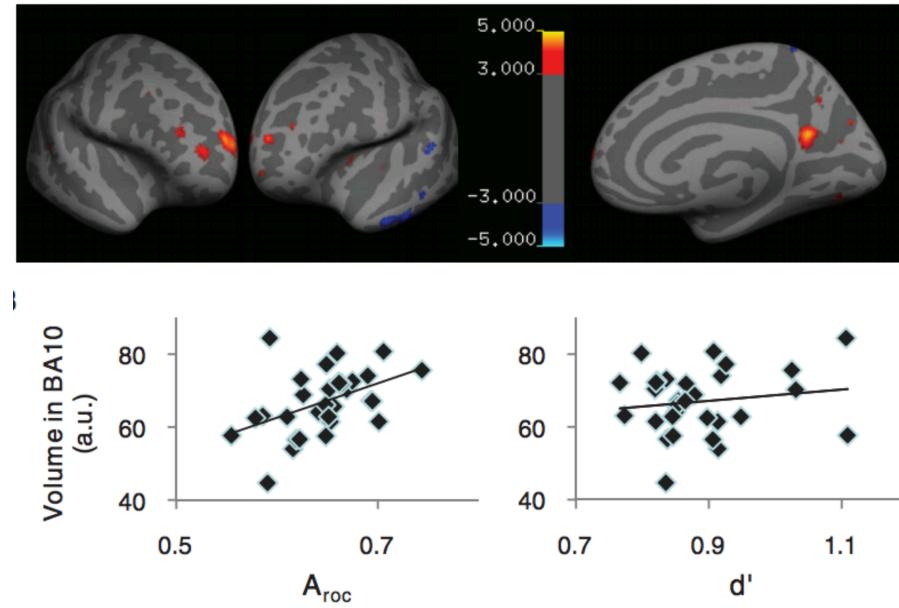
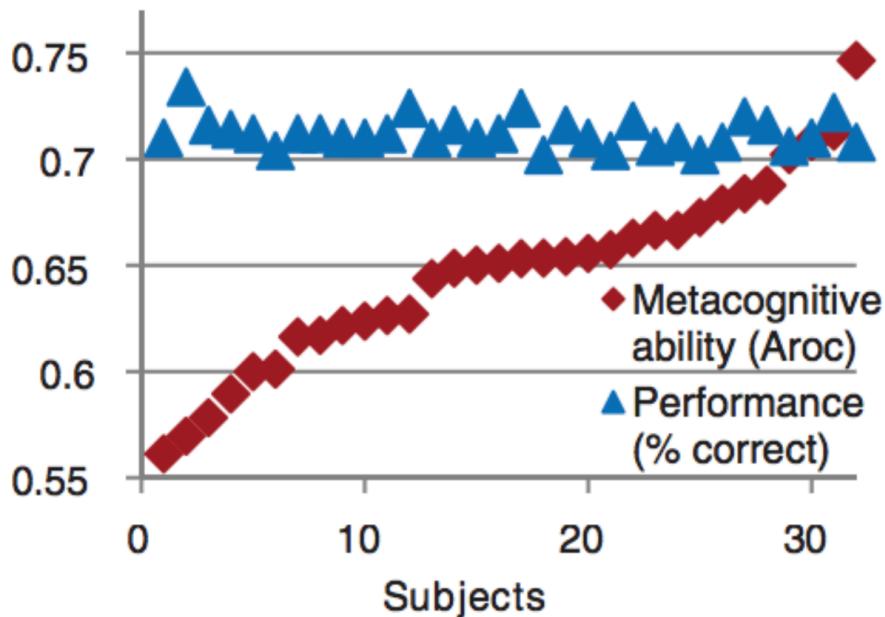
- The explicit processes of introspection, posterior experiences and communication of said information has top-down effects
 - Enhances problem-solving by combining evidence
 - Enhances cooperation within groups
 - Enhances transmission of accurate information
- By also updating based on the experiences of others, we can make increasingly better models of the world and of ourselves



- The **scientific method** is basically the institutionalised and principled version of Frith's account of cultural development

Biology of culture – brain basis

- Neurobiological correlates of explicit reflection of cognitive processes include anterior prefrontal cortex (BA 10) (**metacognitive accuracy/ability**)
 - and language areas



Summing up – shared predictions

- Suggests that our interactions with the world, both physical and mental, depend upon a process of **hypothesis testing** in which prior expectations and beliefs are continuously modified through the evidence from our senses
 - a hierarchy with those at the top being concerned with more abstract and long-term properties of the world
- Cumulative culture is possible because the highest loop in this hierarchy extends beyond the individual mind
- In this loop the prior expectations come from other minds thereby creating shared narratives about how the mental and physical worlds work.



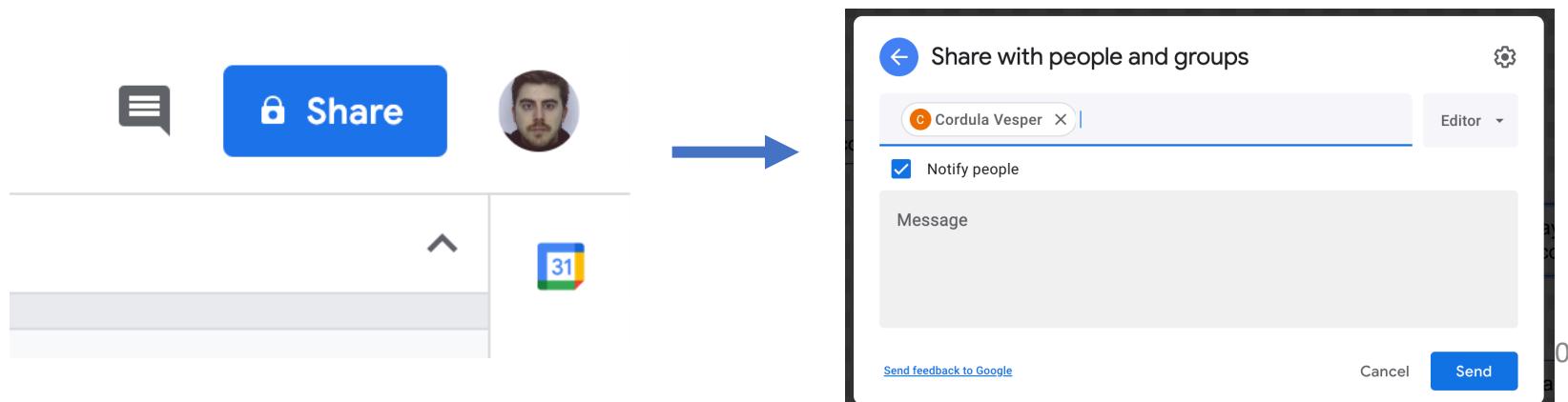
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How the brain creates culture

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Topic connection exercise

- These papers cross a lot of the topics we have discussed, as already mentioned
- In groups of 3, use the papers, the slides and your notes to identify as many concepts and links to other lectures and topics as possible
- Go to docs.google.com/drawings, name it with your names and share with each other in order to co-edit
 - and send me the sharable link when you're done!



See you next time