Social Learning in Non-humans and Humans: Cumulative culture

The "Cultural Intelligence" Hypotheses

van Schaik & Pradhan 2003
Whiten & van Schaik 2007

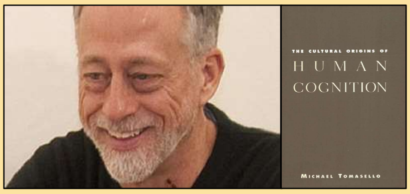
Not restricted to humans

Positive selection of characteristics associated to socially biased learning

Sociality: evolution of tolerance
→ opportunities for SBL
Cognition: biases for social learning?

The "Cultural Intelligence" Hypothesis

Michael Tomasello (1999)
The Cultural Origins of
Human Cognition



Animal "Culture" based in distinct/simpler processes ("*stimulus enhancement*")

Theory of Mind → Attention
Imitation
Teaching

The **ratchet effect**: cumulative culture

The Primate Cognition Test Battery (PCTB)

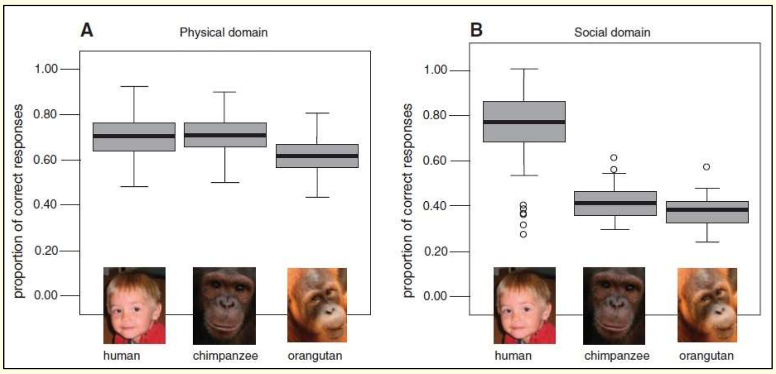
Table 1. The PCTB, including domains, scales, and tasks (*25*).

Domain	Scale	Task	Description
Physical	Space	Spatial memory (1 item, 3 trials)	Locating a reward.
		Object permanence (3 items, 9 trials)	Tracking of a reward after invisible displacement.
		Rotation (3 items, 9 trials)	Tracking of a reward after a rotation manipulation.
		Transposition (3 items, 9 trials)	Tracking of a reward after location changes.
	Quantities	Relative numbers (1 item, 13 trials)	Discriminating quantity.
		Addition numbers (1 item, 7 trials)	Discriminating quantity with added quantities.
	Causality	Noise (2 items, 6 trials)	Causal understanding of produced noise by hidden rewards.
		Shape (2 items, 6 trials)	Causal understanding of appearance change by hidden rewards.
		Tool use (1 item, 1 trial)	Using a stick in order to retrieve a reward which is out of reach.
		Tool properties (5 items, 15 trials)	Understanding of functional and nonfunctional tool properties.
Social	Social learning	Social learning (3 items, 3 trials)	Solving a simple but not obvious problem by observing a demonstrated solution.
	Communication	Comprehension (3 items, 9 trials)	Understanding communicative cues indicating a reward's hidden location.
		Pointing cups (1 item, 4 trials)	Producing communicative gestures in order to retrieve a hidden reward.
		Attentional state (4 items, 4 trials)	Choosing communicative gestures considering the attentional state of the recipient.
	Theory of mind	Gaze following (3 items, 9 trials)	Following an actor's gaze direction to a target.
		Intentions (2 items, 6 trials)	Understanding what an actor intended to do (unsuccessfully).

Herrmann, Call, Hernández-Lloreda, Hare & Tomasello (2007)

The "Cultural Intelligence" Hypothesis

Supporting the **cultural intelligence hypothesis** and contradicting the hypothesis that humans simply have more "general intelligence," we found that the children and chimpanzees had very similar cognitive skills for dealing with the physical world but that the children had more sophisticated cognitive skills than either of the ape species for dealing with the social world.



Herrmann, Call, Hernández-Lloreda, Hare & Tomasello (2007)

Tomasello et al (2005). Understanding and sharing intentions: The origins of cultural cognition

Intentional action

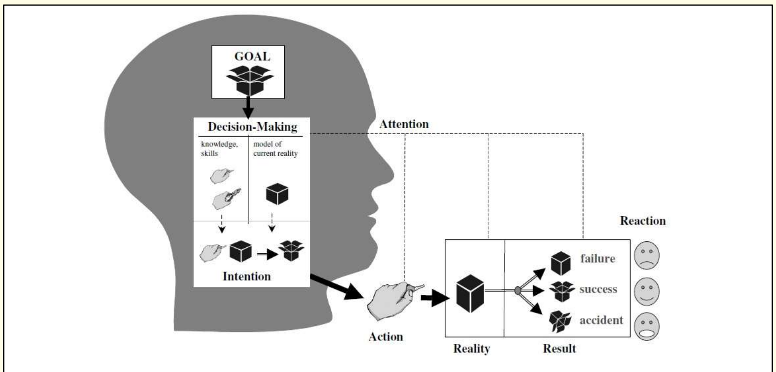


Figure 1. Human intentional action. The goal is an open box; reality is a closed box. The actor chooses a means (plan), depicted as hands doing things, which forms an intention. The resulting action causes a result, which leads to a reaction from the actor.

Goal
Intention (plan of action → goal)
Decision making (hierarchical structure: goals and means)

Tomasello et al (2005). Understanding and sharing intentions: The origins of cultural cognition

Human children's skills of shared intentionality develop gradually during the first 14 months of life as two ontogenetic pathways intertwine:

(1) the general ape line ability of **understanding others as animate, goal-directed, and intentional agents**.

[Understanding **beliefs** does not emerge until around age 4 in human ontogeny, but understanding **intentions** begins to emerge at around a child's first birthday; it is only if a young child understands other persons as intentional agents that she can acquire and use **linguistic symbols**]

(2) a species-unique motivation to share emotions, experience, and activities with other persons: **shared intentionality**

Tomasello et al (2005). Understanding and sharing intentions: The origins of cultural cognition

Shared intentionality

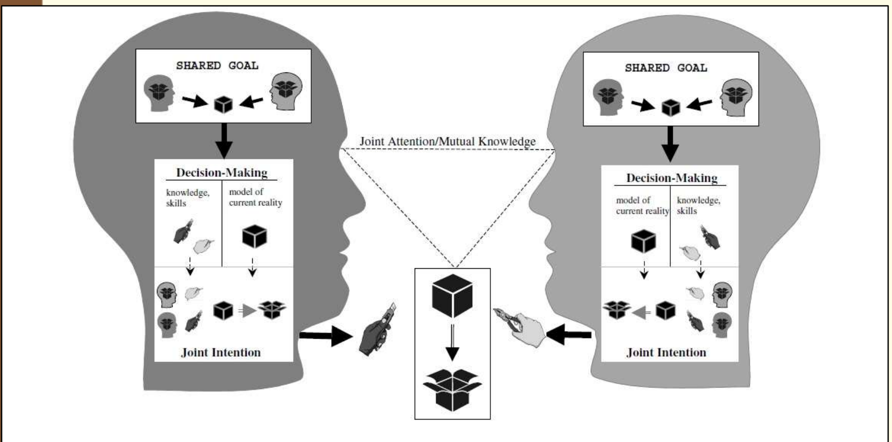


Figure 2. Each partner's conception of a collaborative activity in which a shared goal and joint intention (with complementary roles) are formed.

Tomasello: Joint attention

Tomasello et al (2005). Understanding and sharing intentions: The origins of cultural cognition

Shared intentionality and institutions

Only human beings are biologically adapted for participating in collaborative activities involving shared goals and socially coordinated action plans (joint intentions).

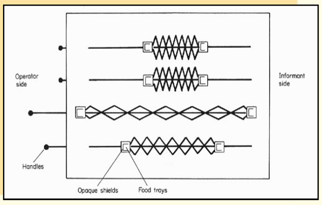
When individuals in complex social groups share intentions with one another repeatedly in particular interactive contexts, the result is habitual social practices and beliefs that sometimes create **social or institutional facts** (Searle 1995): such things as **marriage**, **money**, and **government**, which only exist due to the shared practices and beliefs of a group.

Understanding of joint roles
(Chimpanzees X Rhesus)

Rhesus, role-reversal experiment
(Povinelli *et al* 1992)

Understanding of joint roles
(Chimpanzees X Rhesus)

Povinelli *et al* 1992a/b



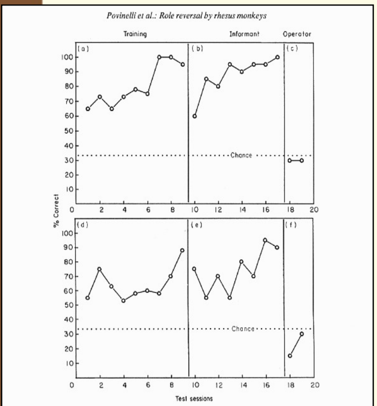


Figure 1. Performance of Stud (a–c) and Tuck (d–f) across all phases of the experiment. In training (a, d), the subjects visually located food on the apparatus and pulled a handle to retrieve it. As informants (b, e), the subjects were trained to reliably produce a 'pointing' gesture to a naive human operator. As operators (c, f), the subjects responded to the pointing gestures of a human informant.

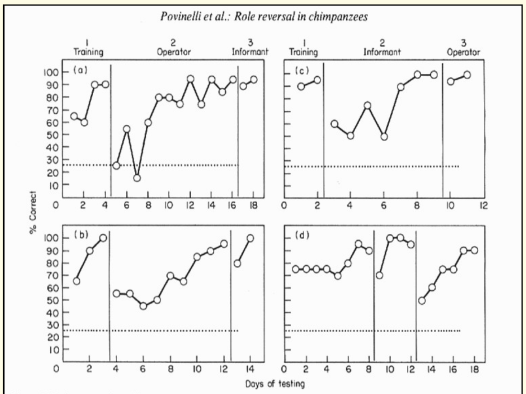
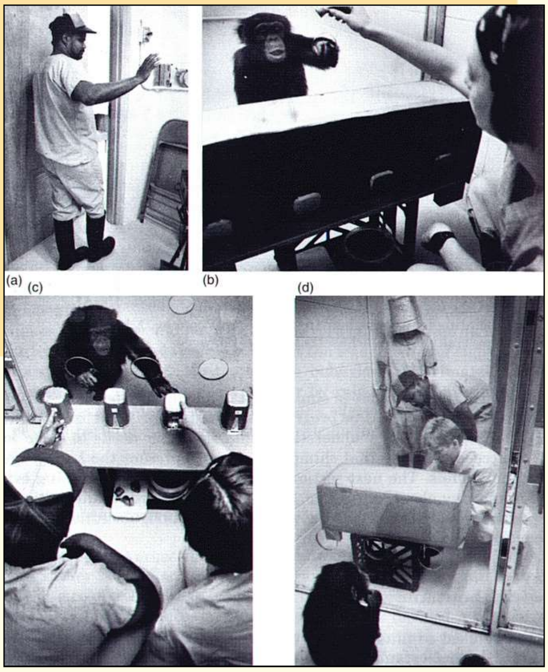


Figure 2. Performance by subject across all three phases of the experiment. Graphs a (Sarah) and c (Sheba) display the results for the two chimpanzees that were trained as operators and later tested as informants; b (Darrell) and d (Kermit) depict the results for the two subjects that were trained as informants and later tested as operators. Data are presented by session, which each consisted of 20 trials. Dotted horizontal lines represent levels expected by chance.

Understanding the relation between sight and possession of information?

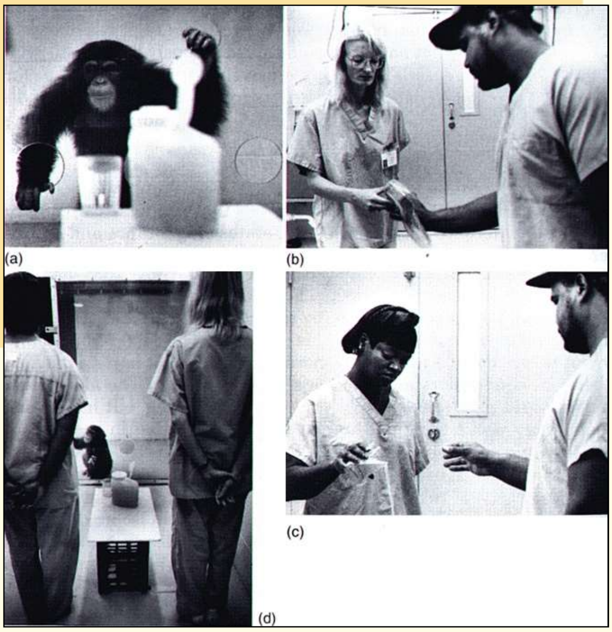


Povinelli, Nelson & Boysen,1990

X

Povinelli & Eddy, 1996

Understanding the difference between purposefulness and accident?



Povinelli *et al* 1994

Tomasello et al (2005). Understanding and sharing intentions: The origins of cultural cognition

Apes

There are now new data which compel us to attribute to great apes the ability to understand **intentional action** in terms of **goals** and **perceptions**.

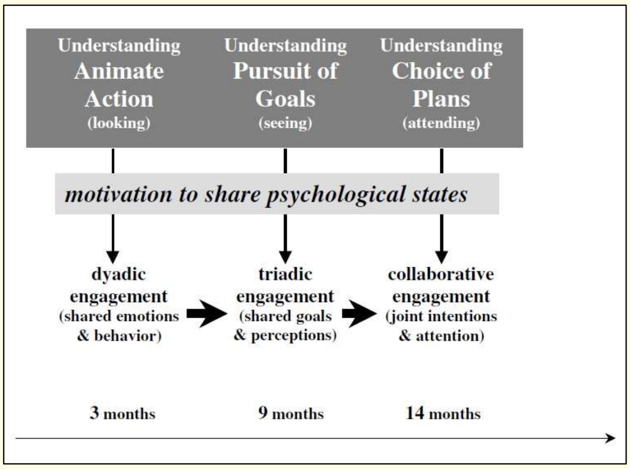
Apes understand both **trying** and **accidents** – and that others have goals and behave toward them persistently, and that this is governed by what they perceive.

BUT

Apes still seem to lack the motivations and skills for even the most basic forms of **sharing psychological states** with others; they engage in very few **triadic interactions** with others around objects, and, although apes know that others have **goals** and **perceptions**, they have little desire to **share** them.

Tomasello et al (2005). Understanding and sharing intentions: The origins of cultural cognition

Ontogeny of intentional action understanding
(long before doing it in explicit language)



Tomasello et al (2005). Understanding and sharing intentions: The origins of cultural cognition

Children with autism

Children with autism clearly understand other persons as animate beings who produce behavior spontaneously, and show some signs of understanding that others have goals and that others see things.
Shared intentionality: children with autism, though, have special problems in recognizing, understanding, and sharing emotions with others, and they do not seem to engage in protoconversations.
Deficits in shared triadic engagement and joint attention: diagnostic criteria.
Deficits in gaze following
Eye fixation: decay after 2-6 months (Jones & Klin 2013)

Tomasello et al (2005). Understanding and sharing intentions: The origins of cultural cognition

A phylogenetic hypothesis

In addition to competing with others (and coordinating with others generally), humans evolved skills and motivations for collaborating with one another in activities involving shared goals and joint intentions/attention.

Increased within-group tolerance ("self-domestication")
see van Schaik see Wrangham

Motivation to share feelings, experiences, and activities with other persons.

Humans motivationally built for strong reciprocity, "fairness"...

Tomasello et al (2005). Understanding and sharing intentions: The origins of cultural cognition

An ontogenetic hypothesis

If our **phylogenetic hypothesis** is correct, selection for good collaborators means selection for individuals who are (1) good at **intention reading** and (2) have a strong **motivation to share psychological states** with others.

Our **ontogenetic hypothesis** is that it is precisely these two developing capacities that interact during the first year of life to create the normal human developmental pathway leading to participation in collaborative cultural practices.

Tomasello et al (2005). Understanding and sharing intentions: The origins of cultural cognition

Alternatives?

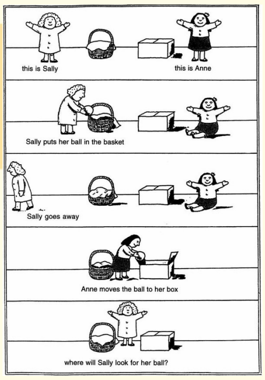
Language is not basic - it is derived.

ToM:
(in the sense of belief-desire psychology with which school-age children and adults operate X understanding and sharing of intentions, that emerges ontogenetically in all cultural settings at around 1 year of age):

"*While the understanding of **beliefs and desires** is clearly a critical component in uniquely human cognition and culture, we do not believe it is basic, but rather it, too, is derived from the understanding and sharing of **intentions***"

"Theory of Mind" (ToM) and child development: Verbal x nonverbal tasks

The "Sally & Anne [or "false belief] test" (Frith 1999)



X

Onishi & Baillargeon 2005

Non-verbal "false belief" task (violation-of-expectation): 15-Month-Old Infants

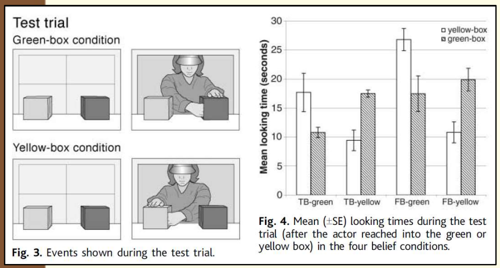
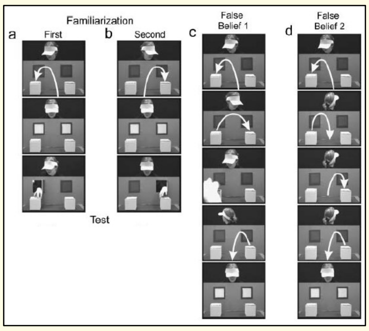


Fig. 3. Events shown during the test trial.

Fig. 4. Mean (±SE) looking times during the test trial (after the actor reached into the green or yellow box) in the four belief conditions.



Southgate et al 2007 (25mo, eye-tr.)
(Krupenye et al 2016: apes)

Csibra & Gergely 2011
Natural pedagogy as evolutionary adaptation

Natural Pedagogy: **communicative knowledge transmission** (as opposed to **non-communicative social learning** and **communicative information sharing**): a hominin adaptation?

1. likely to be human-specific
2. universal (x anthropologists: alleged absence in traditional societies)
3. an independently selected adaptive cognitive system
(not a by-product of some other human-specific adaptation, such as language).

Children: sensitivity to **ostensive signals** (direct eye contact, infant-directed speech, contingent reactivity) + **interpretive biases** (they are expected to learn from them)

Csibra & Gergely 2011
Natural pedagogy as evolutionary adaptation

Both **social learning** and **communication** are widespread in non-human animals. It is thus a plausible assumption that these two phenomena will overlap in some species, producing instances of communication that transfers knowledge from one party to another. However, so far we have not been able to find convincing examples for this kind of communication in non-human species.

Referential communication in non-human animals tends to be inherently episodic in nature, transferring only pre-specified types of information about particulars, but not generalizable knowledge. **None of the documented cases of animal teaching seem to qualify as communicating generalizable knowledge.**

This does not necessarily mean that it would be impossible to find such an adaptation in non-human animals (whales?) [but independently evolved, since there are no examples in nonhuman primates]

Csibra & Gergely 2011
Natural pedagogy as evolutionary adaptation

In human cultures, almost any action, even when it seems **arbitrary**, **unnecessary**, or even **counter-productive**, could, for some reason, be relevant and important to be learned.

Csibra & Gergely 2011
Natural pedagogy as evolutionary adaptation

In human cultures, almost any action, even when it seems arbitrary, unnecessary, or even counter-productive, could, for some reason, be relevant and important to be learned.

Natural pedagogy was made necessary by the **cognitively opaque knowledge and skills** required by technological inventions during early human evolution. However, **communicative knowledge transfer**, with its assumptions about genericity and culturally shared information, must have opened up **new domains of cultural contents** to be preserved or stabilized by communicative means: **Conventions**, **rituals** and **novel symbol systems** could also be transmitted to the next generation by natural pedagogy, and the operation of **modern social institutions** is unimaginable without communicative knowledge transfer.

(Washoe & Loulis: Natural Pedagogy of ASL?)

Heyes (2012)
Grist and mills: on the cultural origins of cultural learning

Cultural learning can be itself culturally inherited.
Rather than being genetic adaptations, the psychological processes that make cultural inheritance possible are learned in the course of ontogeny through social interaction.

Social learning: current evidence suggests that the core mechanisms of learning have not been adapted—either genetically or culturally—to promote cultural inheritance. However, there are signs that input mechanisms can be biased towards social sources, and, in humans, that these adaptive biases can be **driven by social interaction**.
Reading and **imitation**: the evidence indicates that core cognitive mechanisms, new modules, are constructed through social interaction.

Imitation

FIGURE 2.38. The model and its imitation in a 2- to 3-week old infant. From A.N. Meltzoff and M.K. Moore (1977).

Imitation in infants and newborns

Meltzoff & Moore 1977, 1983

The cultural origins of cultural learning

Heyes (2012)

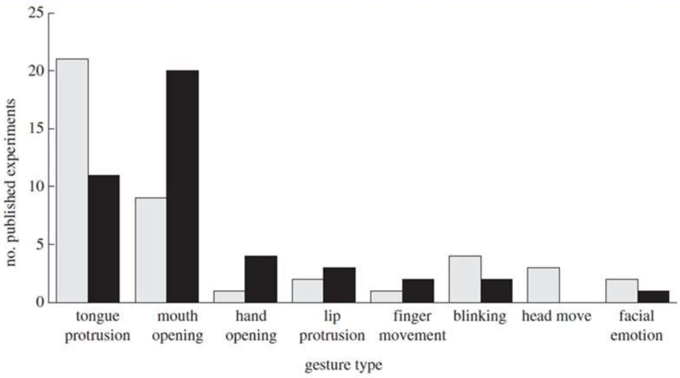


Figure 3. Summary of research on imitation in neonates and young infants. The number of published experiments reporting positive results (grey bars) and negative results (black bars) for each of the eight gestures tested [39].

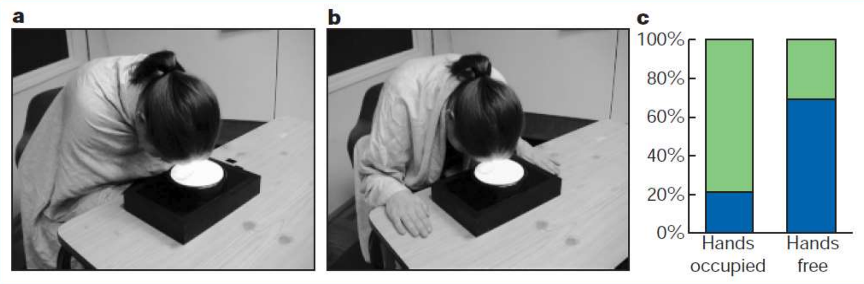
Gergely et al 2002

Rational imitation in preverbal infants

X Meltzoff 1988 (model turning a light on with her head:
14-mo observers, 1 week later, imitate the means)

14-months-old infants

Gergely & Csibra 2005



Model with occupied hands: “underimitation” (emulation of result only)

X

Model with free hands: there must be some reason for the action → imitate

Schwier, von Maanen, Carpenter & Tomasello 2006

Rational imitation in 12-month-old infants

~ Gergeli et al 2002, (but NS in Trial 1...)

a)

FIGURE 1 The materials: The do
open. (The dog is in the start positio

b)

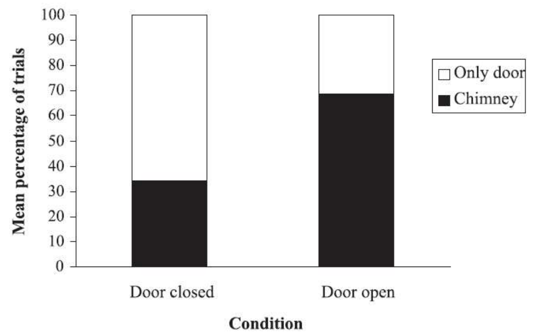


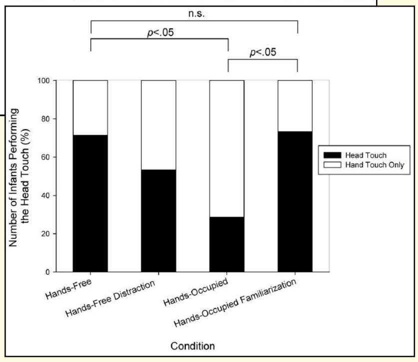
FIGURE 2 The mean percentage of trials in which infants used the chimney in each condition (along with the mean percentage of trials in which infants did not use the chimney, i.e., used only the door).

Understanding of goals x intentions (strategies to achieve goals)

Beisert et al 2012

"Rational imitation" X "Perceptual distraction"

Figure 1. Experimental setup. The model before performing the head touch action in the hands-occupied and hands-occupied familiarization condition (A),
the hands-free condition (B),
and the hands-free distraction condition (C).

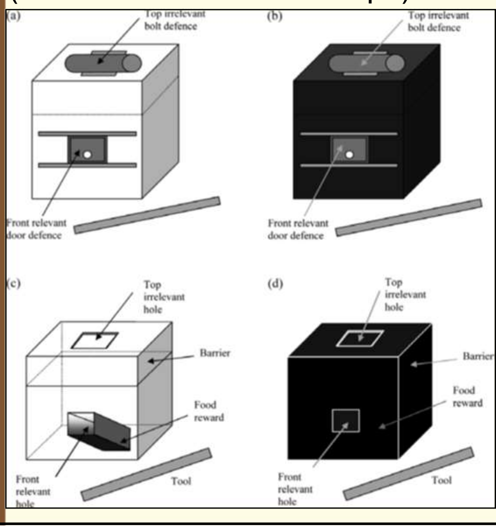


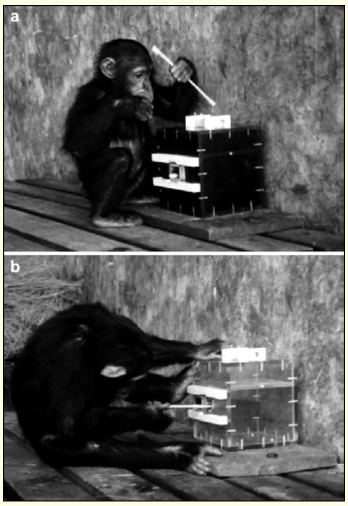
Heyes (2012): "Beisert et al 2012 results undermine a major plank of the current evidence for natural pedagogy, and the component that relates natural pedagogy most directly to imitation"

Imitation in chimpanzees and human children

Horner & Whiten (2005)

Opaque x transparent "two-action" puzzleboxes
(Relevant + Irrelevant steps)





Imitation in chimpanzees and human children
Horner & Whiten (2005)

Chimpanzees Ngamba island (Young, wild-born; Exp.1):
Groups A/B: opaque box first
Groups C/D: transparent box first

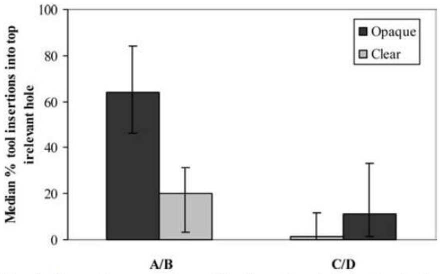


Fig. 4 The median percentage of tool insertions into the top, irrelevant hole by subjects from groups A/B and C/D in both the opaque and clear conditions. *Error bars* represent the inter-quartile range

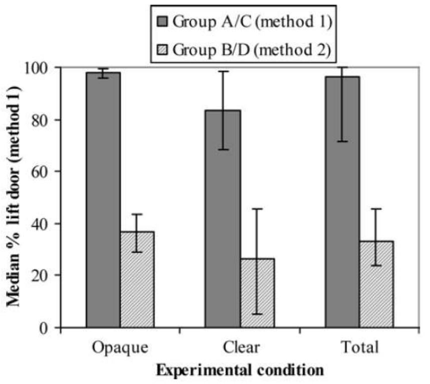


Fig. 5 Median percentage of lift door (method 1) used by group A/C who saw method 1, and group B/D who saw method 2. *Error bars* represent the inter-quartile range

Imitation in chimpanzees and human children
Horner & Whiten (2005)

Children (2-3 yo; Exp.4):
Groups A/B: opaque box first
Groups C/D: transparent box first

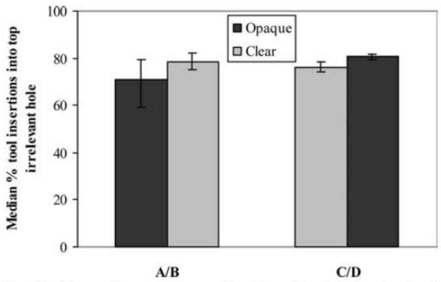


Fig. 10 The median percentage of tool insertions into the top, irrelevant hole by subjects from groups A/B and C/D in both the opaque and clear conditions. *Error bars* represent the inter-quartile range

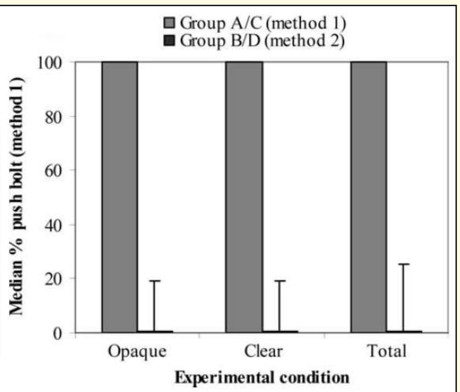


Fig. 11 Median percentage of method 1 (push bolt), used by subjects from groups A and C who observed method 1, and groups B and D who observed method 2

“Overimitation” in human children

“Overimitation” in human children

Horner & Whiten (2005):

Transparent puzzle box: chimpanzees drop irrelevant steps (*emulation*), children still imitate (with limited verbal instruction, and in the absence of the demonstrator).

Emulation is the favoured strategy of chimpanzees when sufficient causal information is available. However, if such information is not available, chimpanzees are prone to employ a more comprehensive copy of an observed action. **In contrast to the chimpanzees, children employed imitation to solve the task in both conditions, at the expense of efficiency.**

"Overimitation" in human children

Overimitation in Kalahari bushman children

Nielsen & Tomaselli 2010

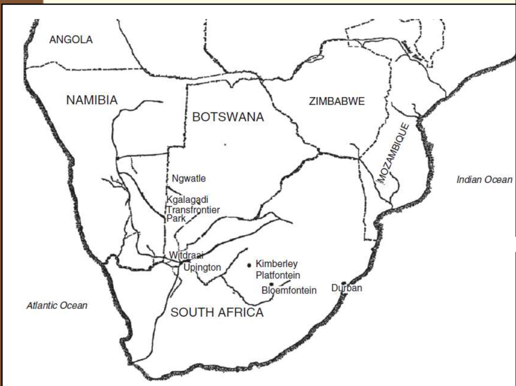


Fig. 1. Southern Africa test locations for Experiment 1 (Witdraai and Ngwatle) and Experiment 2 (Kimberley).

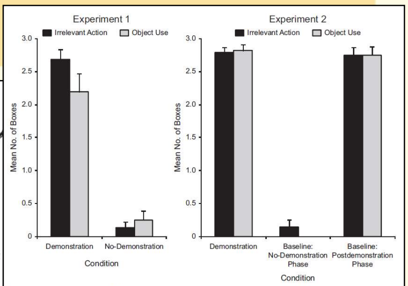


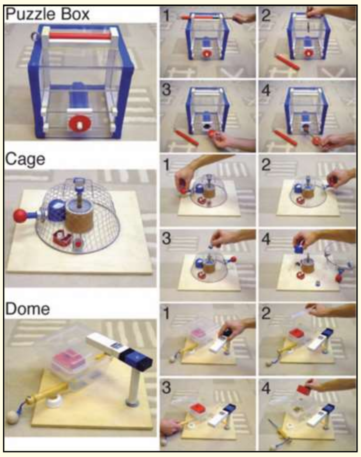
Fig. 3. Mean number of boxes on which children produced the irrelevant actions and mean number of boxes children opened using the accompanying objects in Experiments 1 (left) and 2 (right). Results are shown separately for the demonstration and no-demonstration conditions in Experiment 1 and for the demonstration condition and the two phases of the baseline condition in Experiment 2. Error bars indicate standard errors.

The imitative behavior of children living in remote Bushman communities in the Kalahari Desert was indistinguishable from that of children living in a Western, industrialized city (Brisbane).

The hidden structure of overimitation
Lyons et al 2007

Overimitation:
a purely social exercise? X ACE [*Automatic Causal Encoding*]

Children who observe an adult intentionally manipulating a novel object have a strong tendency to encode all of the adult's actions as **causally meaningful**. This automatic causal encoding process allows children to rapidly calibrate their causal beliefs about even the most opaque physical systems, but it also carries a cost. When some of the adult's purposeful actions are unnecessary - even transparently so - children are highly prone to misencoding them as causally significant. The resulting distortions in children's causal beliefs are the true cause of overimitation, a fact that makes the effect remarkably resistant to extinction.



The hidden structure of overimitation
Lyons et al 2007

Movie 1. An excerpt from the training task used in each of the described experiments. The participant correctly answers that tapping on the jar with the feather is unnecessary for retrieving the dinosaur and receives positive reinforcement from the experimenter.

The hidden structure of overimitation
Lyons et al 2007

Movie 2. A participant overimitating on the Puzzle Box by removing the irrelevant red bolt and then tapping on the floor of the box's empty upper compartment. The participant also reproduces the causally irrelevant "control tap" elements used to equate the two versions of the experimenter action sequence for this object.

The hidden structure of overimitation
Lyons et al 2007

Movie 3. A participant overimitates on the Cage by unnecessarily rotating the wire basket 180° around its central axis. The experimenter's control taps are also reproduced.

The hidden structure of overimitation
Lyons et al 2007

Movie 4. A participant overimitates on the Dome by pulling the irrelevant metal bolt out of the base of the plastic box. The participant also reproduces both of the experimenter's control taps on the white wooden locking arm and on the handle of the irrelevant bolt.

The hidden structure of overimitation
Lyons et al 2007

Movie 5. An example of the surreptitious procedure used in Experiment 1B. This participant has just completed Experiment 1A and is picking out her prize. The busy experimenter then requests a simple favor, asking the participant to check whether the assistant remembered to put the toy turtles back into the puzzle objects. As shown, despite time pressure and the fact that the study has apparently ended, overimitation persists. Rather than simply opening the lid of the Dome directly, the participant first pauses to pull the irrelevant metal rod out of the base of the object.

Heyes 2012b: “Overimitation” as higher-order conditioning

Different hypotheses about what is going on in the minds of children during over-imitation. **Causal hypotheses: over-imitation as a window on children’s developing understanding of causality**; **Social hypotheses: over-imitation results from distinctively social motivation.**

Some discussions imply that heightened social motivation is a genetic adaptation for cultural inheritance - but it has not yet been tested against the obvious alternative: in the course of early development, children are reliably and richly rewarded by adult approval for imitating a broad range of actions (...). Through an associative process known as higher-order conditioning, it could **make imitating or agreeing with others, rewarding in its own right.**

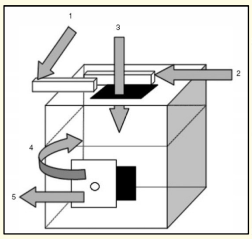
It is an open question to what extent the motivational processes that guide imitative behaviour are genetically and/or culturally adapted in ways that support cumulative cultural evolution.

Ontogeny of overimitation

McGuigan et al (2007)

Overimitation gets stronger with age, from infancy to adult age: 3- and 5-year-olds imitated the model’s irrelevant actions regardless of the availability of causal information, after a live demonstration.

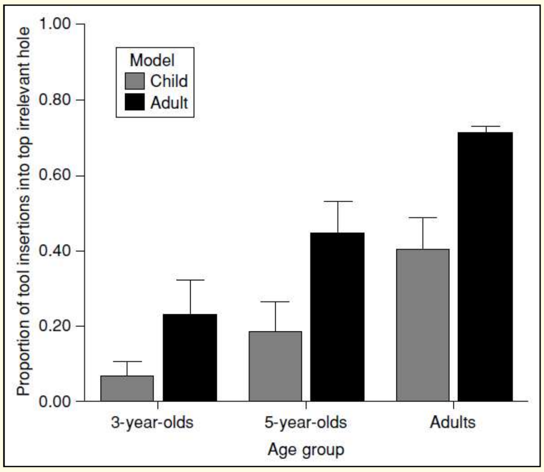
In contrast, when available information was degraded, in a video recorded demonstration, the 3-year-old children employed an “emulative” approach, omitting irrelevant actions, while the 5-year-olds were not affected, employing an “imitative” approach.

2-year-olds:  

McGuigan & Whiten (2009): 2yos did not overimitate (dyadic test)
Flynn (2008): “chain-diffusion”: irrelevant actions dropped from the start.

Ontogeny of overimitation
McGuigan et al (2011)

Models: child: 5yo / adult: 30yo (females)
Adult subjects: "over-copiers": "conformist" bias?



Overimitation and transmission biases

Wood et al (2012)
Models' ages:
children "overimitate" more readily adult models than age peers.

McGuigan et al (2012)
Adult subjects.
Diffusion chain paradigm (same transparent/opaque 2-action boxes)
Decrease in fidelity in the copy of irrelevant actions (esp. transp. box),
BUT corrupted irrelevant actions arose and spread.
More faithful copy by female observers, esp. from male models

When / What / Whom to (over)imitate?
Transmission biases (Richerson & Boyd 2005)
Opacity of processes, selectivity and biases:
"Content-based biases"
"Frequency-based biases" (ex: "conformist bias")
"Model-based biases" (ex: "expertise bias" / "age bias")

Imitation and transmission biases

Wood, Kendal & Flynn (2013). Whom do children copy? **Model-based biases** in social learning.

What makes children's social learning truly impressive is their ability to implement strategies of model-based biases. These biases are adaptive in that they enable children to source the 'best' trait variant without the cost of assessing every trait variant displayed within the environment. Whilst some biases seem automatic, children need a suite of cognitive skills to use other model-based biases (…) **Model-based biases and some of the accompanying cognitive skills required to learn and maintain these biases are not unique to humans**. However, the combination of model-based biases and children's development of species-unique socio-cognitive skills, such as language and understanding another's mental states, means that children stand alone in their ability to source the right model for them, in the right context, and use this model's behaviour to guide their own behaviour, resulting in a uniquely adaptive form of social learning.

Imitation and transmission biases

Wood, Kendal & Flynn (2013). Whom do children copy? Model-based biases in social learning.

The adaptive value of model-based biases

Propositions:

1: Children are biased towards those who intend to teach;

2: Children are biased toward copying the most proficient models;

3: Children are biased toward copying models belonging to a group which has a reputation for being proficient;

4: Children are biased toward copying models that resemble themselves;

5: Children are biased towards copying models with high status.

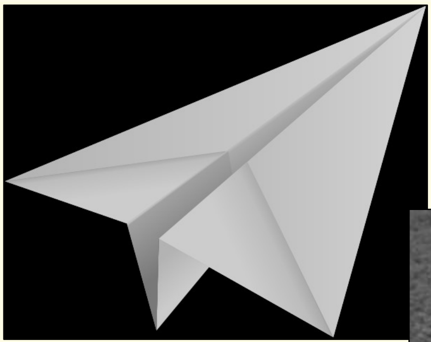
Overimitation and transmission biases

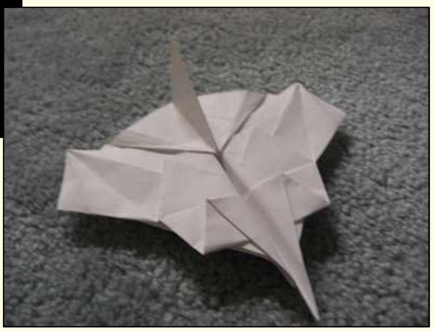
Chudek et al (2012): Imitation and "prestige"
3- and 4-year-old children learning from an adult model to whom bystanders had previously preferentially attended the "prestigious" model (x a model whom bystanders ignored).

Chudek et al (2016): Unselective overimitators
Children preferred the adult who received greater payoffs or bystander attention when asked questions like "Who do you think is smarter?" but overimitated both adults' unnecessary actions equally.

Ladeia & Ottoni (in prep.):
Children overimitate "prestigious" and "non-prestigious" models: Others' X self-reports of competence/lack of competence in the task did not affect overimitation.

Cultural evolution: field & lab





Cultural evolution in the field: evolutionary ethnography

Experiments: powerful means of testing hypotheses, but lack **external validity**: lab x everyday life. **Time scale**: an experiment that lasts a few hours cannot easily capture long term-processes like parent-child vertical cultural transmission

Field studies: lack of ***internal* validity** (test of causal hypotheses by manipulation of variables, random assigning people to different conditions, replication).

Complementarity of approaches

Studying cultural evolution in the field

Updating ethnographic method with modern statistical techniques: the relative influence of vertical / oblique / horizontal transmission in determining cultural beliefs, skills, and knowledge.

San father & son

Studying cultural evolution in the field

Testing predictions about different transmission pathways: vertical (slow) x horizontal (fast) transmission.

Hewlett & Cavalli-Sforza 1986:
Cultural transmission among Aka pigmies
(Central African Republic / Rep. of the Congo)

- Lack of formal education & literacy.
- Little change in lifestyle in thousands of years.
- Interviews about 50 skills (from whom they acquired each).
- 81% of skills reported to have been acquired from a parent.
- Next-largest influence: unrelated people from other villages.
- Food-gathering skills: parents (89% x 4% other villages) x
- Dancing & singing (52% parents x 42% other villages).
- Exceptions in F-G: new technologies: horizontal (ex: crossbow), elephant hunting (very difficult, "*ntuma*": prestige bias?)

Studying cultural evolution in the field

Potential problem in H&C-S study: reliance on self-reports (vertical transmission exaggerated?)

Aunger 2000:
Food taboos in Congo horticulturalists

- Self-reports similar to H&C-S: 76% parents, 6% grandparents, 15% unrelated elders, 3% unrelated age-peers.
- **X** Correlations (transm. biases → similarities [parents/age-peers]): more complex pattern: 2 types of taboos:
- **1. Prohibition of foods incompatible with bloodline**: male lineage (mostly fathers → sons).
- **2. "Homeopathic taboos"** (what pregnant women should eat): similarities best explained by mother → sons/daugthers (some father → daughter transmission, little father → son).
  Since society patrilocal, greater similarity between villages.
- BUT Vertical transmission weaker than suggested by self-report: children do not learn about taboos, 10-20 yo learn from parents, over 20yo ++ horizontal transmission (reports: "normative bias"?)

Studying cultural evolution in the field

Tehrani & Collard 2002
Phylogenetic analyses of Turkmen textiles

Iranian tribal textile patterns: transmitted primarily from **mothers to daughters** (~ Congo food taboos), but in this case, women do not marry out of local tribes, so textile patterns did not spread between groups (resulting in a tree-like phylogenetic pattern).

Studying cultural evolution in the field

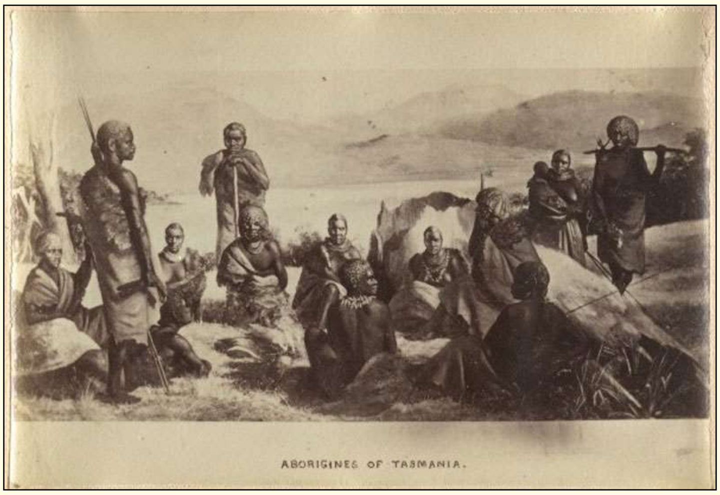
Reyes García 2009

Transmission of ethnobotanical knowledge and skills in the Amazon Tsimane.

- 8.000 horticulturalists/hunter-gatherers in Bolivian rainforest.
- Face-to-face transmission (no formal education).
- Mother ethnobotanical knowledge/skills relevant to children health.
- Survey of plant use knowledge/skills.
- Multiple regression analysis: Transmission of competence primarily oblique, some vertical x rarely horizontal (both sexes).
- Vertical transmission stronger in women (division of labor? girls share tasks with mothers, young boys do NOT go hunting with fathers [dangerous])
- Skills more likely acquired by vertical transmission than knowledge;
- Vertical transm. stronger / oblique, weaker for younger individuals.

Cultural complexity and demography

Cultural learning and social group characteristics: size, density, interconnectedness



Cultural complexity and population size

The Tasmanians: the longest isolation, the simplest technology (Diamond 1978)

Isolated from mainland Australia (12k8kya)

Late 18th century: pop.: 4000.

Material culture: few stone tools, unhafted; no agriculture or animal domestication. No bone tools or boomerangs. No making of new fire, almost no dwelling except windbreaks, no clothing except wallaby skin capes.

Exterminated by Europeans or scattered.
Last full-blodied Tasmanian died in 1876.

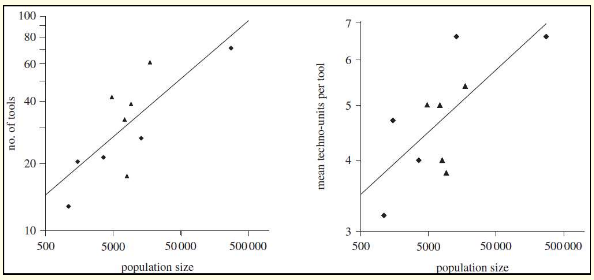
Demography and cultural evolution: how adaptive cultural processes can produce maladaptive losses: the Tasmanian case (Henrich 2004)

Cultural complexity and population size

Population size predicts technological complexity in Oceania Kline & Boyd 2010

1. Innacurate learning compensated by choice of models (smaller pool of experts in small populations)
2. Cultural “drift”: loss of variants higher in small populations (lost traits can be reintroduced: equilibrium depends on rate of contact with other populations)

In Oceania, around the time of early European contact, islands with small populations had less complicated marine foraging technology.



N tools X population size

Tool complexity (techno-units) X population size

Cultural complexity and population size

Population size does not predict artifact complexity: analysis of data from Tasmania, arctic hunter-gatherers, and Oceania Dwight 2012

Empirical validation of the model has been attempted with archaeological data from Tasmanian hunter-gatherers and ethnographic fishing data from Oceania, but these data do not support the model.

Data from a wide variety of hunter-gatherer groups show, instead, that **implement complexity varies with an interaction effect between risk and number of annual moves** and not with the interaction population size. Data from the Polar (Inuit) Eskimo and the Angmaksalik Inuit on the east coast of Greenland show that complex implements were part of both group’s technological repertoire even though each had interaction population sizes limited to a few hundred individuals.

Cultural complexity and population size

Population size does not predict artifact complexity: analysis of data from Tasmania, arctic hunter-gatherers, and Oceania Dwight 2012

The simplest explanation for why the Tasmanians stopped making the bone tools they had been using to make clothing during extremely cold periods is that the climate ameliorated substantially, they no longer needed to make clothing, and so they stopped making bone points.

Cultural complexity and population size

Experimental evidence for the influence of group size on cultural complexity Derex et al 2013

Dual-task computer game (arrowhead / fishnet): When group size increases, cultural knowledge is less deteriorated, improvements to existing cultural traits are more frequent, and cultural trait diversity is maintained more often.

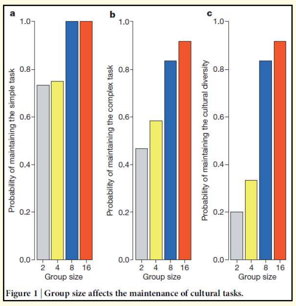


Figure 1 | Group size affects the maintenance of cultural tasks.

Arrowhead:
15 steps/
1638 LUnits

Fishnet:
39 steps/
2665 LUnits

N=2/4/16

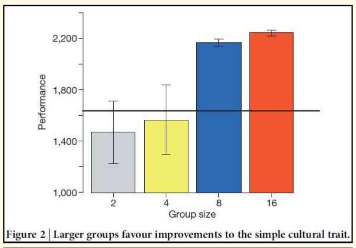


Figure 2 | Larger groups favour improvements to the simple cultural trait.

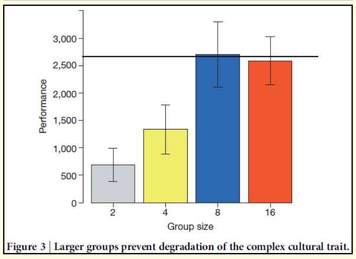
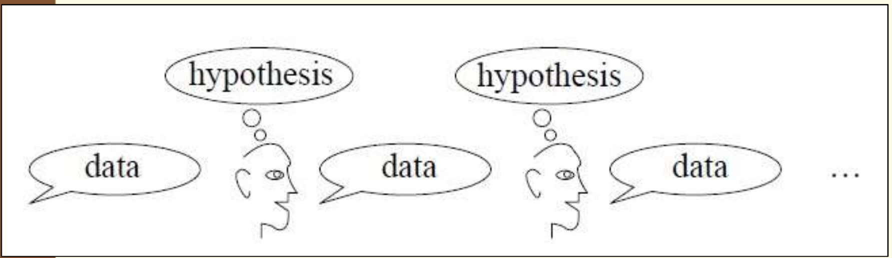


Figure 3 | Larger groups prevent degradation of the complex cultural trait.

Cultural microevolution:
Information diffusion experiments in the lab

Cognitive biases in the propagation of information
ex: "chinese whispers"
Bartlett (1932)

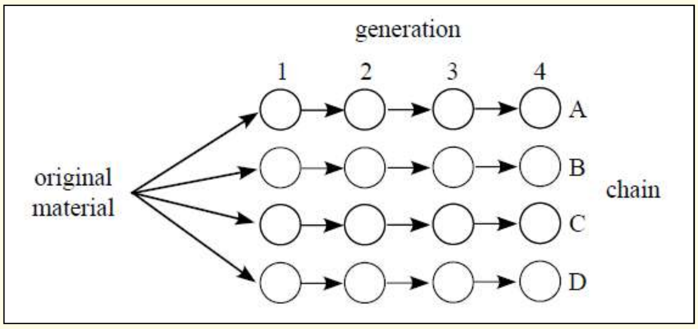


Griffiths et al 2008: memory & learning constraints
"Inductive biases": "*a highly counter-intuitive hypothesis will fail to dominate a population, even if there are strong advantages to adopting it*"
Information "degrading" and "cultural universals"

"Microssocieties"
(diffusion chain paradigm)

Transmission chain method.
Information is passed along linear chains of participants

Used to **identify content biases** in cultural transmission (kind of information transmitted)

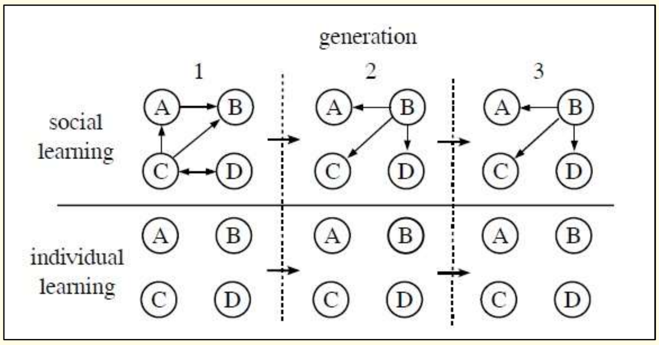


Mesoudi & Whiten 2008

"Microssocieties"
(diffusion chain paradigm)

The closed-group method

Participants learn in groups with no replacement.
Used to explore issues such as **whom people choose to learn** from and when they learn culturally as opposed to individually.

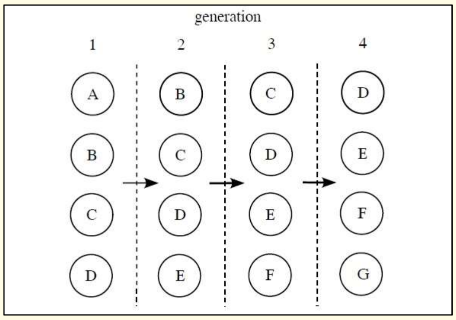


Mesoudi & Whiten 2008

"Microssocieties"
(diffusion chain paradigm)

The replacement method

Participants in groups are gradually replaced or moved across groups.
Used to study phenomena such as **cumulative cultural evolution**, **cultural group selection** and **cultural innovation**.



Mesoudi & Whiten 2008

Cultural evolution in laboratory microssocieties: Arbitrary traditions
Jacobs & Campbell 1961

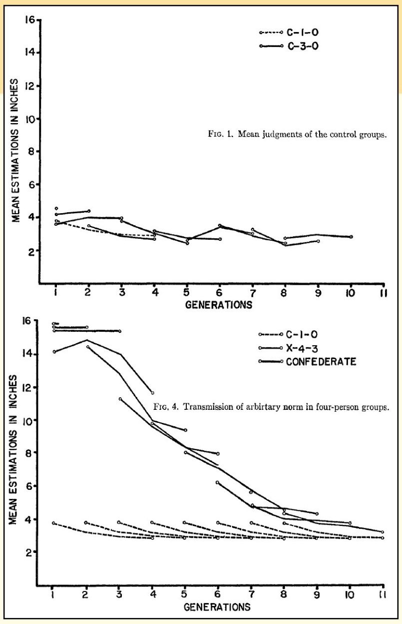
Autokinetic movement illusion: (static light in a dark room appears to be moving).

Magnitude evaluations: Confederates overestimated apparent movement.

Replacement method (different group sizes).

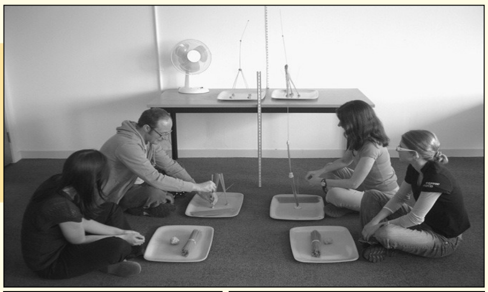
TABLE 1
EXPERIMENTAL PARADIGM

Condition	Size of Group	Number of Confederates	Trials per Generation	Number of Generations	Generations per Respondent	Number of Replications	Number of Naive Respondents
C-1-0	1	0	30	—	4	24	24
C-3-0	3	0	30	10	3	3	30
X-2-1	2	1	30	9	2	3	27
X-3-2	3	2	30	10	3	3	30
X-4-3	4	3	30	11	4	3	33
X-3-1	3	1	30	9	3	3	29

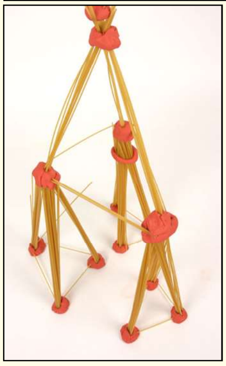


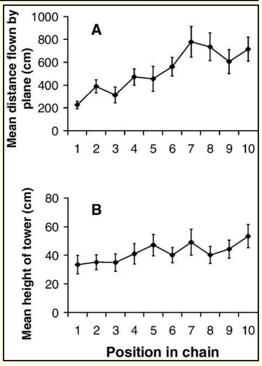
"Microssocieties": cumulative culture in the lab

Building paper airplanes and spaghetti towers



time minutes	participants present in test group
00.00	1 2 3
02.30	1 2 3 4
05.00	2 3 4 5
07.30	3 4 5 6
10.00	4 5 6 7
12.30	5 6 7 8
15.00	6 7 8 9
17.30	7 8 9 10
20.00	8 9 10
22.30	9 10
25.00	10





Caldwell & Millen 2008a, 2008b

Measures of success over generations
A: paper airplanes; B: Spaghetti towers.

Cumulative cultural evolution in the laboratory: An experimental approach to the origins of structure in human language

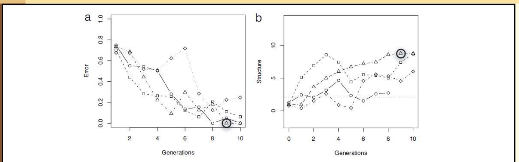


Fig. 2. Transmission error and a measure of structure by generation in 4 chains. *a* shows the increase in learnability (decrease in error) of languages over time. *b* shows structure in the languages increasing. The dotted line in *b* gives the 95% confidence interval so that any result above this line demonstrates that there is a nonrandom alignment of signals and meanings. In other words, structure in the set of signals reflects structure in the set of meanings. In 2 cases, this measure is not defined and therefore is not plotted (see *Methods*). The language discussed in the paper is circled.

Fig. 3. An example evolved language in the first experiment. This language exhibits systematic underspecification, enabling learners to reproduce the whole language from a fragment.

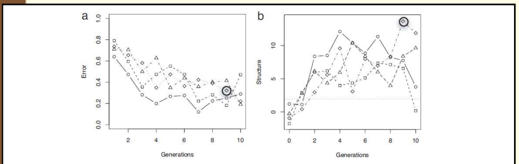


Fig. 4. Transmission error and structure by generation in the experiment in which ambiguous data were removed from the training set at each generation. *a* gives error for the whole language; *b* gives structure. These results show that, despite the blocking of underspecification, structure still evolves that enables the languages to become increasingly learnable. The language discussed in the paper is circled.

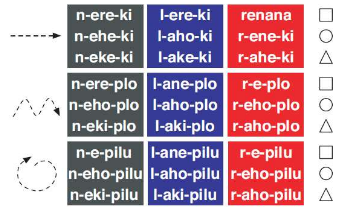


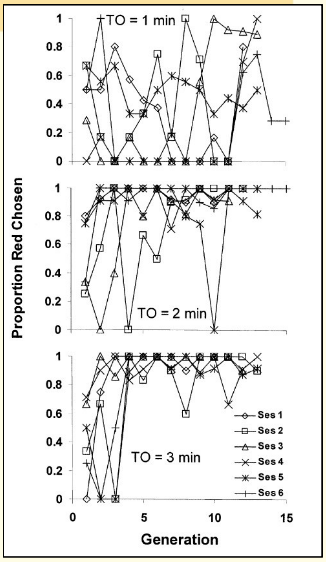
Fig. 5. An example evolved language in the second experiment. The language is structured: the string associated with a picture consists of substrings expressing color, shape, and motion, respectively. The hyphens represent 1 way of analyzing the substructure of these strings and are added purely for clarity; participants in the experiment always produced strings of characters without spaces or any other means of indicating substructure.

Increase in learnability / Linguistic structure
Cultural adaptation without intentional design
Kirby et al 2008

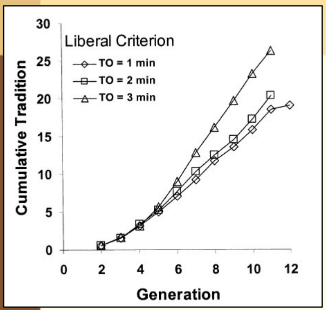
Cultural evolution in laboratory microssocieties
Traditions of rule giving and rule following

Baum et al 2004

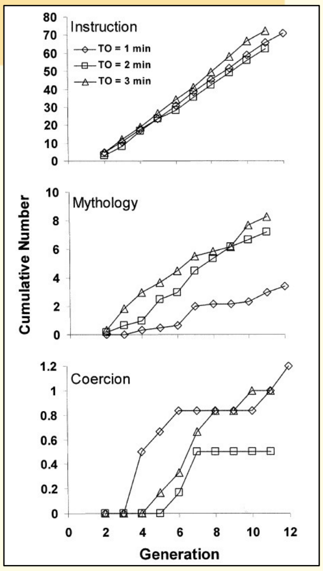
Groups of four participants chose by consensus between **solving anagrams** printed on **red cards** and on **blue cards**. Payoffs for the choices differed [**red: dime**; **blue: quarter**]. After 12 min, the participant who had been in the experiment the longest was removed and replaced with a naïve person. These replacements, each of which marked the end of a generation, continued for 10–15 generations, at which time the day's session ended. Time-out duration [blue], which determined whether the group earned more by choosing red or blue, and which was fixed for a day's session, was varied across three conditions to equal 1, 2, or 3 min (**blue better with 1m timeouts**)



Cultural evolution in laboratory microsocieties including traditions of rule giving and rule following



Baum et al 2004



The groups developed choice traditions that tended toward maximizing earnings. The stronger the dependence between choice and earnings, the stronger was the tradition.
Once a choice tradition evolved, groups passed it on by instructing newcomers, using some combination of accurate information, mythology, and coercion.

Socially Biased Learning and Cumulative Culture

- Stimulus/local enhancement
- Observacional conditioning
- Emulation
- "Scaffolding"

→ **Behavioral Traditions**

- Imitation
- "Purposeful" Teaching

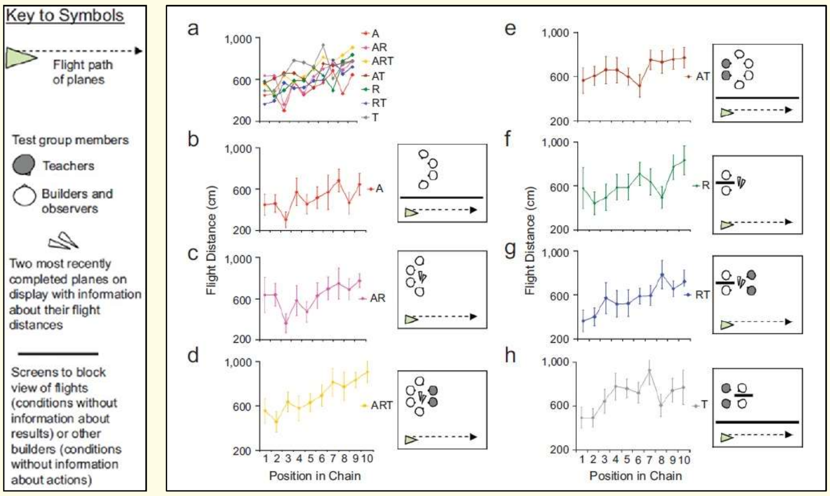
→ **Cumulative Culture**

Lewis & Laland 2012:
Transmission fidelity is the key to the build-up of cumulative culture

Social learning mechanisms and cumulative cultural evolution: is imitation necessary?

Caldwell & Millen 2009

Actions (→Imitation) / **R**esults (→ Emulation) / **T**eaching

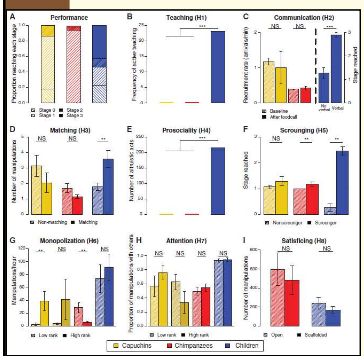


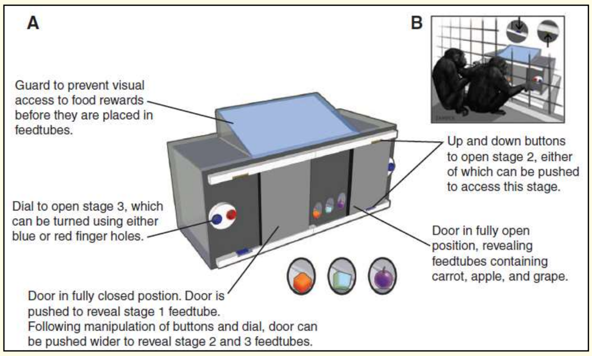
In every one of the seven conditions, there was a significant trend toward improvement further along the chain, demonstrating cumulative culture.

SB Learning and Cumulative Culture

Dean et al 2012

Sequential problem solving: experimental puzzlebox
Three stages - rewards of increasing desirability
capuchin monkeys X chimpanzees X children

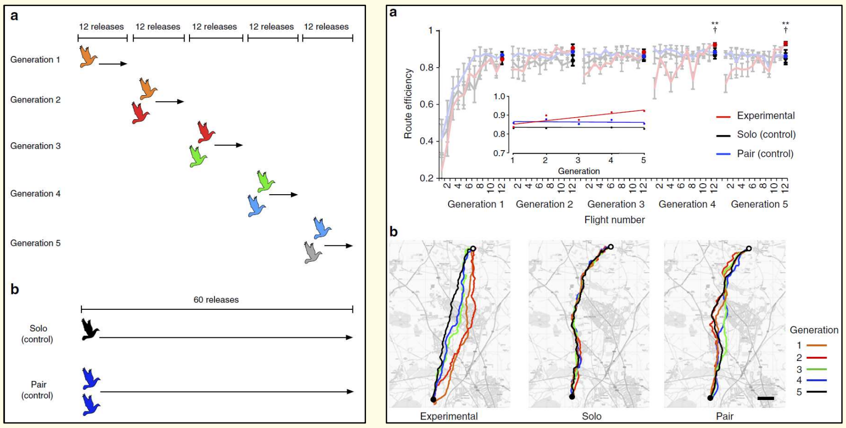




Success of children, but not of chimpanzees or capuchins, in reaching higher-level solutions was associated with sociocognitive processes (**teaching through verbal instruction, imitation, and prosociality**) observed only in children and covaried with performance.

SB Learning and Cumulative Culture

Sasaki & Biro (2017). Cumulative culture can emerge from collective intelligence in animal groups



The place of culture in Evolution

- The place of culture in Evolutionary Psychology
- The place of culture in Ethology / in Primatology
- The place of culture in Evolutionary Biology

Next lecture

Development and evolution