Teaching and the origin of the normativity

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Abstract

Norms play a crucial role in governing human societies. From an early age, humans possess an innate understanding of norms, recognizing certain behaviours, contexts, and roles as being governed by them. The evolution of normativity has been linked to its contribution to the promotion of cooperation in large groups and is intertwined with the development of joint intentionality. However, there is no evolutionary consensus on what normatively differentiated our hominin ancestors from the phylogenetic lineage leading to chimpanzees and bonobos. Here we propose that the development of teaching through a process of evaluative feedback between parent and offspring functioned as a prerequisite for the later development of normativity. Parents approve or disapprove of offspring's behaviours based on their own learned knowledge of what is appropriate or inappropriate. We argue our proposition using a simple model of cultural transmission, which shows the adaptive advantage offered by these elementary forms of teaching. We show that an important part of this adaptive advantage can arise from the benefits derived from guidance about which behaviours to adopt or reject. We propose that this type of guidance has fundamental elements that characterise the normative world. We complete our argument by reviewing several studies that examine the emergence of normativity in young children without prior exposure to a normative framework with respect to the behaviours under analysis. We suggest that this normativity is best interpreted as manifestations of teaching among young children rather than as norm recognition among early normative children.

Keywords: social learning; cultural transmission; norm psychology; assessor teaching

1. Normativity in human societies

Norms play a crucial role in governing various aspects of human behaviour (Sellars 1963; Brandom 1994). In this context, norms can be defined as patterns of behaviour that establish what is considered appropriate, correct, required, or forbidden for individuals or groups within a society, depending on different situations. The human mind functions successfully in a normative world. Humans have the capacity to identify the norms that govern their environment, adhere to these norms in their own behaviour, and expect others to do the same (Richerson and Boyd 2005; Sripada and Stich 2006; Chudek and Henrich 2011).

Norms possess several characteristic features (Schmitd and Rakotzy 2019; Schmitd et al. 2019). They involve a sense of right and wrong, indicating that certain behaviours can be deemed as right or wrong. When individuals adopt a norm, it functions both as a guiding rule for behaviour and as a benchmark against which one's own and others' behaviour is evaluated in terms of right or wrong (Popitz 2006; Schmitd and Rakotzy 2019). Norms exert normative force, implying that individuals should adhere to them. They possess a prescriptive character, distinct from mere coercion, and indicate what individuals (including oneself) ought to do in specific situations (Gloor 2014). Norms exhibit generality and are applicable to any member of a given group, including oneself, under equivalent circumstances. Thus, their validity holds in an agent-independent manner (Nagel 1986). Additionally, norms can be internalized, where acting in accordance with a norm becomes an end in itself rather than merely a means to achieve specific goals or avoid social sanctions (Chudek and Henrich 2011; Gavrilets and Richerson 2017). Indeed, all human cultures exhibit some kind of norms and, at the same time, norms appear to be rare or absent in other animals (Jensen 2016; Schmidt and Rakoczy 2019; although for a different approach see, for example, Andrews, 2020; Fitzpatrick, 2020).

Several authors have suggested that, from an early age, humans genetically inherit specialised cognitive and motivational mechanisms for processing norms and possess an innate understanding of these norms, recognizing certain behaviours, contexts, and roles as being governed by them (Sripada and Stich 2006; Rakoczy and Schmidt 2013; Kelly and Davis 2018). The evolution of normativity has been linked to its contribution to our species' ability to cooperate for mutual benefit in large groups of unrelated individuals (Richerson and Boyd 2005; Sripada and Stich 2006; Chudek and Henrich 2011;

Tomasello 2014; Henrich 2015; Gavrilets and Richerson 2017; Sterelny 2021). The significance of norms in the success of human societies has likely driven the cultural evolution of prevalent norms and the evolution of certain psychological traits that enhance normativity. Thus, on one hand, intergroup cultural selection processes have shaped norms, contributing to the dissemination of efficient cooperative norms and institutions (Henrich, 2015; Richerson et al. 2016; Turchin 2018). On the other hand, successful cooperation has exerted in-group selection pressure, reshaping human social psychology and giving rise to tribal instincts and a strong inclination towards norm psychology (Richerson and Boyd, 2005; Mathew et al. 2013).

In contrast to this cognitive-evolutionary approach to norms, Heyes (2024) proposes a cultural-evolutionary (or cognitive gadget) alternative, which suggests that people's actions not only shape and transmit norms, but also create in each new generation mental processes capable of grasping the norms and putting them into practice. The cultural-evolutionary alternative defines normativity in relation to three types of behaviour (compliance, enforcement, and commentary). This hypothesis suggests that normativity depends on implicit processes, genetically inherited and general in nature, and explicit processes, culturally inherited and domain specific.

While these hypotheses provide plausible explanations for the evolution of norm psychology, social norms, and institutions in our species, there is no evolutionary consensus on what normatively differentiated our hominin ancestors from the phylogenetic lineage leading to chimpanzees and bonobos. Recent attempts to address the origins of human normativity have highlighted distinct aspects. For instance, van Schaik and Burkart (2018) propose that the emergence of normativity in our ancestors was an automatic by-product of the development of moral behaviour. Birch (2021) suggests that essential elements of human normative cognition emerged as a solution to the challenges of social learning of complex motor skills related to toolmaking. González-Cabrera (2022) proposes that the coadaptation of phylogenetically old capacities for instrumental reasoning in our great ape lineage and more recent skills for shared intentionality in humans has allowed the representation of social norms and the emergence of our capacity for normative guidance.

In this paper we propose that the evolution of our hominin ancestors as teaching organisms functioned as a prerequisite for the emergence of the human normative dimension. Specifically, we emphasize the role played by elementary forms of teaching based on parents' approval or disapproval of their children's behaviour (Peregrin 2014, 2022; Castro and Toro 2023). This type of teaching, referred to as "assessor teaching" (Castro and Toro 2004), provides information of two types about how to behave: one, to indicate whether a behaviour is being done right or wrong, and the other, to specify what can or cannot be done. The first modality refers to conveying information of the know-how type (e.g., use this wood to make a bow) which brings it closer to the root of what we might call a descriptive normativity (Sripada and Stich 2006; Heyes 2024).

The second modality has in turn two aspects. One involves conveying information about what not to do to avoid harm to the actor of the behaviour (e.g., don't eat that) or to other individuals (e.g., don't hit your little brother) and is close to a prescriptive normativity of a moral nature (Sripada and Stich 2006; Heyes 2024). And another that reaffirms, through positive social reinforcement, the need to behave in a certain way whose immediate advantage the individual does not appreciate for himself (e.g., keep quiet when you go hunting). Obviously, this type of reinforcement can lead to the approval of arbitrary behaviours whose adaptive goodness is non-existent (e.g., wearing earrings in the ears) and to the maintenance of certain cultural traditions with empirically unverifiable or hardly verifiable contents. This may also be the origin of behaviours that differ from one group to another and contribute to define the normative identity of each group (Kish Bar-On and Lamm 2023).

Our proposal argues that that the development of assessor teaching has been a key element that differentiated our hominin ancestors from the phylogenetic lineage leading to chimpanzees and bonobos and functioned as a prerequisite for the later development of normativity. Assessor teaching probably emerged earlier than cooperation for mutual benefit and normativity in the hominin lineage (Castro et al. 2019, 2021). Assessor teaching requires the ability to establish joint attention and joint intentionality between parents and children (Castro et al. 2019). Both capacities (joint attention and joint intentionality) are considered prerequisites for the evolution of cooperation for mutual benefit, first in pairs and then in large groups (Tomasello 2014, 2016).

Furthermore, we suggest that assessor teaching possess some elements that characterize the normative world interpreted from an innate conception of normativity, such as standards of correctness, generality, normative force, and the possibility of internalization (Schmidt and Rakoczy 2019). We also suggest that we can trace in assessor teaching the root of the three types of normative behaviour (compliance, enforcement, and commentary) that characterise the cultural-evolutionary conception of normativity (Heyes 2024).

We argue for our thesis in two ways: a) we show, with the help of a model of cultural transmission, that assessor teaching can be adaptive through the benefits derived from guidance on which behaviour to adopt or reject, leaving aside its effect on increased replication efficiency; b) we suggest that several studies that examine the emergence of normativity in young children without prior exposure to a normative framework are best interpreted as manifestations of teaching among young children rather than as norm recognition among early normative children.

Our model shows the adaptive advantages offered by these elementary forms of teaching based on approval or disapproval of a learner's behaviour. Several scholars have suggested that this advantage can arise by increasing the replication fidelity of a behaviour through guidance on its implementation, which is essential for the cumulative cultural transmission of complex traits (Fogarty et al. 2011; Castro and Toro 2014; Laland 2017). Along with an increase in replication fidelity, we show that other important part of the adaptive advantage of evaluative feedback teaching can arise by providing benefits derived from guidance about which behaviours to adopt or reject. Approval helps to maintain active behaviours that may not receive immediate positive evaluation (Castro et al. 2022), while disapproval allows offspring to quickly acquire negative evaluations about specific behaviours without experiencing all the negative consequences associated with trial-and-error learning (Castro and Toro 2004; Sterelny 2007). It's important to note that this guidance is only possible for behaviours that the teacher has previously categorized as favourable or unfavourable.

In addition, we complete our argument by reviewing several studies that examine the emergence of normativity in young children without prior exposure to a normative framework regarding the behaviours in question. This means that children have not received explicit normative instructions on how to act in a given situation. Children have been observed to develop what is known as promiscuous normativity, whereby they tend to view the actions of adults normatively, even in the absence of explicit instruction (Schmidt et al. 2011; Schmidt et al. 2016). It has also been described that children can generate their own norms on how to act without any prior observation or instruction (Göckeritz et al. 2014). Reinterpreting these results, we suggest that these behaviours are best understood as manifestations of teaching among young individuals, such as toddlers, rather than as early instances of norm recognition.

2. A simple model of cultural transmission

In this study, we present a simple agent-based model that explores the dynamics of cultural transmission. Our model focuses on how socially learned behaviours can be improved through individual learning, leading to an increase in complexity driven by cognitive and ecological factors. We assume that the difficulty of innovating and correctly replicating the behaviour increases with its complexity.
Regardless of the learning method employed (social or asocial), individuals possess evaluative brain structures that allow them to choose whether to maintain or reject a specific behaviour (Galef 1992; Heyes and Galef 1996; Enquist and Ghirlanda 2007; Enquist et al. 2007; Castro et al. 2019). In particular, socially learned behaviours are typically perpetuated because they offer benefits when implemented (Rendell et al. 2010; Baum 2017).

We assume that sustaining a behaviour requires reinforcement, especially during initial implementations, to categorize it as favourable. Such reinforcement can arise from the behaviour itself, such as trial-and-error learning, or from social reinforcement, or even a combination of both. Conversely, if implementing a behaviour leads to an unpleasant experience, it is categorized as unfavourable and deactivated. Lastly, in the absence of reinforcement or punishment, a behaviour ceases to be implemented after a trial period without being categorized as either favourable or unfavourable. It is important to note that if a behaviour is no longer implemented, it cannot be imitated by other individuals.

In our model, we consider four behaviours: *A*, *B*, *C*, and *D*. Behaviours *A* and *C* have positive effects on fitness, while behaviours *B* and *D* have negative effects. Behaviour *A*, when implemented in the absence of social interaction, itself produces a positive reinforcement that categorizes it as favourable in the first five rounds of use. As a result, individuals maintain behaviour *A* throughout their lives. On the other hand, behaviour *B*, when implemented in the absence of social interaction, results in an aversive stimulus that serves as a punishment. Consequently, behaviour *B* is categorized as negative and ceases to be implemented after the first five rounds of use. Behaviours *C* and *D*, when implemented in the absence of social interaction, lack clear signals for categorization as favourable or unfavourable in the first five rounds of use. Behaviour *C* is categorized as favourable with a small probability *w* (set to 0.2 in standard conditions) and, in those cases, remains active throughout an individual's life. However, with a probability of 1-w, it is no longer implemented when individuals fail to perceive any benefits. Behaviour *D*, on the other hand, is categorized as unfavourable with a probability *w* (0.2 in standard conditions) and becomes inactive. Yet, with a probability of 1-*w*, it is no longer implemented when individuals fail to perceive any benefits.

We considered two strategies: *critical Imitator* (c-I) and *assessor critical Imitator* (ac-I). Offspring inherited their parent's strategy unless there was a mutation, in which case the offspring adopted the alternative strategy. Both strategies possess the ability to imitate, innovate, and exhibit criticality by only maintaining behaviours categorized as favourable by their value system. To achieve this, behaviours must receive positive reinforcement when implemented and tested. The strategies differ in that the ac-I strategy incorporates teaching abilities between parents and children. ac-I parent guide their children's learning by approving or disapproving behaviours that they have previously categorized as favourable or unfavourable. Parental approval of offspring behaviour acts as positive reinforcement, leading ac-I children to categorize the approved behaviour as favourable and maintain it throughout their lives. Conversely, parental disapproval acts as a punishment, categorizing the behaviour as unfavourable and rendering it inactive. Additionally, approval or disapproval enhances the replication efficiency of complex cumulative behaviours.

2.1 Simulation model

We designed our simulation model along the lines described by our previous works on cultural evolution (Castro and Toro 2014; Castro et al 2022). Each simulation consists of a population of 100 agents, each capable of acquiring behaviours *A*, *B*, *C,* and *D*. Each behaviour can evolve from a complexity level of 0 to *n* ($A_0 \ldots A_i \ldots A_n$; $B_0 \ldots B_i \ldots B_n$; $C_0 \ldots C_i \ldots C_n$; $D_0 \ldots D_i \ldots D_n$). The basal level, A_0 (and its counterparts B_0, C_0, and D_0), represents the absence of the behaviour, while levels A_1 to A_n represent increasing complexity. We consider two different scenarios: one with a maximum achievable level of cultural complexity of 5 (scenario I) and one with a maximum achievable level of 2 (scenario II).

At the start, all individuals possess level 0 for each behaviour (*A*, *B*, *C,* and *D*) and follow the c-I strategy (or, if applicable, the strategy ac-I). Agents can increase the complexity levels through learning, which involves two forms of social learning, (parental imitation and partner imitation, with probability h_i of acquiring the observed level i) and one form of asocial learning (innovation, with a probability of k_{i+1} by increasing the socially acquired level i by one unit). We assume that higher complexity levels make imitation and innovation more challenging. Agents go through a childhood ontogenetic period, during which they cannot become parents. The childhood period consists of five life rounds: the first two rounds involve social learning, while the remaining three rounds focus on testing and refining the learned behaviours through innovation. The process by which each individual acquires a certain cultural level for each behaviour is described in detail in section 2.2.

Starting from the sixth round, individuals aim to gain benefits from the behaviours they have learned by engaging in Exploit. Exploit represents the performance of the individual's developed behaviour and results in either positive consequences (behaviours *A* and *C*) or negative consequences (behaviours *B* and *D*) in terms of fitness. By the end of the tenth round, c-I individuals make the following categorizations: 1) behaviour *A* is categorized as favourable and remains active throughout their lives; 2) behaviour *B* is categorized as unfavourable and becomes inactive permanently; 3) behaviour *C* is categorized as favourable with a probability of w and remains active permanently, while with a probability of 1- w, individuals perceive no benefit and cease implementing it (w = 0.2 in standard conditions); and 4) behaviour *D* is categorized as unfavourable with a probability of w and becomes inactive, while with a probability of 1 - w, individuals perceive no benefit and cease implementing it. In both cases, behaviour *D* ceases to be implemented permanently, but whether it is categorized as unfavourable or not only influences individuals following the assessor strategy (ac-I). Thus, for c-I individuals, behaviours *B* and *D* behave similarly for practical purposes.

From the sixth round onwards, individuals reach adulthood and can be chosen as parents based on their fitness. The fitness of individuals depends on the cultural level they possess for each behaviour (see section 2.2). Evolutionary dynamics are introduced through a death-birth process. Agents die with a constant probability of 1/50 per round and are replaced by the offspring of other agents. Therefore, the average lifespan of an individual is close to 50 rounds, and the ontogenetic period represents approximately 10% of the average lifespan, equivalent to 5 rounds.

Assessor ac-I individuals behave identically to c-I individuals but possess the additional ability to guide their children's learning based on their previous categorizations. This has three consequences in the model: 1) ac-I offspring imitate parental behaviour with maximum efficiency, regardless of the parent's exhibited level i ($h_i = 1$); 2) Reproval of behaviour *B* (and, if categorized as unfavourable, *D* as well) facilitates its categorization as unfavourable without the need to experience the fitness cost associated with its exploitation during rounds 6 to 10; 3) Parental approval of behaviour *C*, when categorized as favourable by the parent, increases the probability w to 1 for the child to categorize it as favourable and thus keep it active. It's important to note that among assessor ac-I individuals, behaviour *C* is equivalent to behaviour *A*, and behaviour *D* is equivalent to behaviour *B* when $w = 1$.

We conducted a comparison, using standard conditions (as outlined in Table 1 and detailed in the final appendix), between populations composed solely of individuals following the c-I strategy or the ac-I strategy (pure populations). We examined the level of accumulation achieved for each behaviour (*A*, *B*, *C*, and *D*) as well as the average fitness evolution within each population. Additionally, we studied the frequencies of the c-I and ac-I strategies when they competed with each other. To initiate the simulation, we began with a pure population of non-assessor c-I individuals and introduced assessor ac-I individuals through mutation. The mutation rate used was 0.001 in both directions, striking a balance between maintaining qualitative outcomes and reducing drift while offering computational advantages in terms of time to equilibrium. All comparisons were made in each of the two scenarios I and II considered.

2.2 Cultural level and fitness of each individual.

This section describes how individuals acquire their cultural level for each behaviour and, according to them, their fitness. Each agent can learn 4 behaviours during its infancy (i.e., during its first 5 rounds of life). In the first round, agents imitate their parents' behaviours (A_i, B_i, C_i, D_i). Each agent reproduces level i of the imitated behaviour with probability $h_i = 1\text{-}iz$. Otherwise, with a probability of $1\text{-}h_i$, the agent randomly obtains a level between 0 and i-1. The product of the iz parameters measures the increasing difficulty of correctly imitating a behaviour as its complexity level i increases (z=0.05 under standard conditions). If a parent does not implement a behaviour (has level 0), the agent cannot imitate it and remains at level 0.

In the second round, agents select a random adult partner (A_i) as their model. If the partner's behaviour levels (i^*) are higher than the agent's levels after the first round ($i^*>i$), the agent has a probability of $h_{i*} = 1- (i^*-i')z$ to acquire the partner's level i^*. Otherwise, with a probability of $1-h_{i*}$, the agent randomly acquires a level between i^*-1 and i for each behaviour (A, B, C, D) considered. If the partner's behaviour levels (i^*) are equal to or lower than the agent's levels after the first round ($i^* \leq i$), the agent does not change its levels. If the partner does not implement any behaviours, it is considered that those behaviours cannot be copied, effectively behaving as if they were at level 0 for all practical purposes.

In the third, fourth, and fifth rounds, individuals engage in testing and refining the learned behaviour. After this period, agents have the opportunity to innovate with a probability of $k_{i'+1} = 1-i'y$ by increasing the acquired level i' from the first two rounds by one. Alternatively, they can maintain the previous level with a probability of $1-k_{i'+1}$. The parameter $i'y$ represents the difficulty of innovating based on the behaviour's level i' (with y = 0.05 in standard conditions). Innovation is only possible if individuals have not reached the maximum cultural level in the first two rounds.

The probability of an agent being chosen for reproduction is proportional to its payoff. We consider individual fitness as a function of a baseline payoff ($p_0 = 100$) for an individual who does not exploit any behaviour. An individual's payoff depends on the levels they have achieved for the behaviours A, B, C, and D that keep active. At any given time, the payoff (p_m) for an individual m possessing active levels i^A, i^B i^C i^D of the behaviours A, B, C, and D, is calculated as follows:

$$p_m = p_0 + i^A \alpha_A + i^B \alpha_B + i^C \alpha_C + i^D \alpha_D$$

Here, α is a scaling factor that determines the intensity of the payoff increase as the behaviour level changes. We set $\alpha_A = \alpha_C = 4$ and $\alpha_B = \alpha_D = -4$ in standard conditions.

Table 1.

Standard conditions of the simulation

Parameters of both strategies c-I and ac-I	
Probability of parental imitation	$h_i = 1-iz$; with z=0.05 for c-I and z=0 for ac-I
Probability of partner imitation	$h_{i*} = 1- (i^*-i')z$; z=0.05

Probability of innovation	$k_{i'+1} = 1 - i'y$; $y=0.05$
Period of childhood	5 rounds
Behavioural testing period	Rounds 6 to 10 inclusive
Conditions of the simulation	
Population size	100
Behaviours	*A*, *B*, *C* and *D*
Number of cumulative cultural levels (i)	scenario I = 5; scenario II = 2
Probability of individual death	0.02
Basal payoff (p_0)	100
Payoff p_m for cultural level i behaviours *A*, *B*, *C* and *D*	$p_m = p_0 + i^A\,\alpha_A + i^B\,\alpha_B + i^C\,\alpha_C + i^D\,\alpha_D$
The increase of payoff for α values	$\alpha_A = \alpha_C = 4$ and $\alpha_B = \alpha_D = -4$
Number of rounds	1000 (or 5000 in figure 3)
Number of replicates	100
The mutation rate in pure populations	0
The mutation rate in a competition between the strategies c-I and ac-I	0.001 in both directions

3. Results

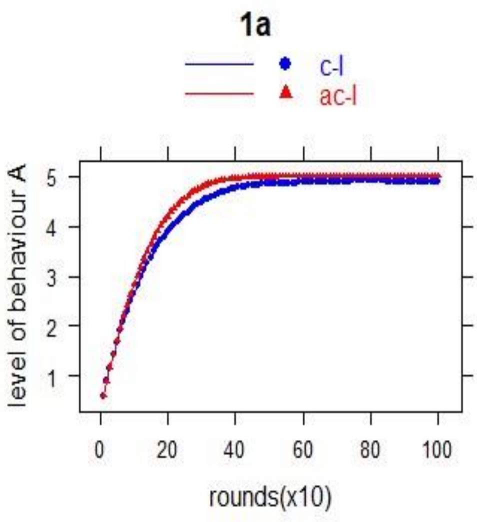
Figure 1 illustrates the levels achieved by behaviours *A*, *B*, *C*, and *D*, after 1000 rounds with 100 repetitions in two pure populations: one consisting of c-I individuals and the other consisting of assessor ac-I individuals. The behaviour levels were determined only for individuals old enough to be chosen as parents (i.e., those who had reached six or more rounds), which accounted for approximately 90% of the population on average. The analysis is carried out for a maximum of 5 cultural levels in scenario I (Figs. from 1a to 1d) and for 2 levels in scenario II (Figs. from 1a* to 1d*).

Fig. 1a presents the evolution of behaviour *A* levels in both populations in scenario I. The ac-I population reaches level 5, the maximum possible level, while the c-I population stabilizes around level 4.90. This disparity arises from the higher efficiency of cultural transmission from parents to children observed in the ac-I individuals compared to the c-I individuals. Fig 1a* presents the evolution of *A* levels in scenario II. Both populations stabilise at level 2, the maximum possible. Assessor teaching does not generate a fitness advantage with respect to behaviour *A* because it is not necessary to reach that level.

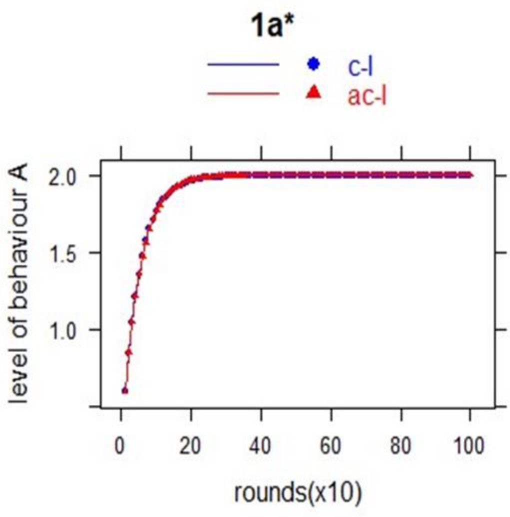
Figs. 1b and 1b* illustrate the evolution of behaviour *B* levels in both populations in scenario I and scenario II respectively. The evolution is practically identical in the two scenarios. Assessor ac-I individuals with level 0 based on a negative categorization actively discourage their offspring from exploring and testing behaviour *B* during rounds 3-5. By doing so, they prevent their offspring from incurring a fitness cost associated with this behaviour. As a result, within less than 200 rounds, all offspring born in the population have mothers with level 0 in behaviour *B*, leading to a mean level of 0 for the entire population. On the other hand, c-I individuals do not actively discourage their offspring from testing behaviour *B* before categorizing it as negative. Consequently, the mean level of behaviour *B* stabilizes at around 0.10 among c-I individuals. This indicates that some individuals in the c-I population continue to engage in behaviour *B*, resulting in a fitness cost for them between rounds 6 to 10.

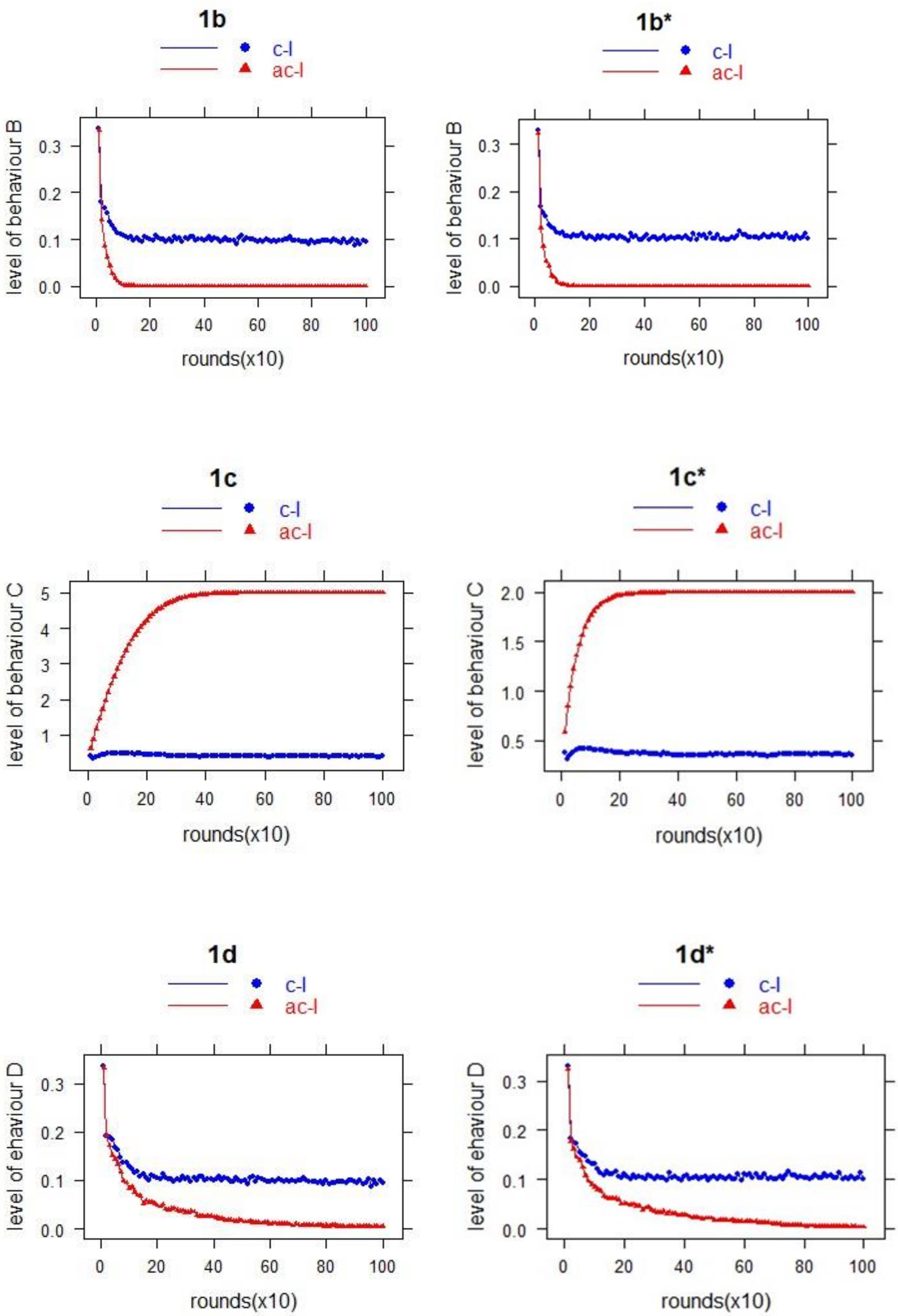
Fig. 1 Levels achieved by behaviours *A*, *B*, *C*, and *D* in c-I (blue) and ac-I (red) pure populations in scenario I (1a, 1b, 1c, 1d) and in scenario II (1a*, 1b*, 1c*, 1d*).

Scenario I



Scenario II





Figs. 1c and 1c* illustrate the achieved levels of behaviour *C* in both populations in scenario I and scenario II respectively. The differences between the populations c-I and ac-I are significant in both scenarios. In scenario I, assessor ac-I individuals actively inform their children about the beneficial nature of behaviour *C* when they perceive it as such (with a probability of $w = 0.2$). Consequently, the level of behaviour *C* rapidly increases, eventually reaching level 5, similar to behaviour *A*. In contrast, c-I individuals who perceive behaviour *C* as beneficial do not transmit this information to their children. As a result, the level of behaviour *C* hardly increases, stabilising below level 0.4. In Scenario II something very similar happens. Assessor ac-I individuals rapidly increases the level of behaviour *C* reaching level 2, while the c-I individuals barely increase their level which remains stable below 0.4.

Figs. 1d and 1d* display the evolution of the level of behaviour *D*. The result is identical in both scenarios. Active engagement in behaviour *D*, with a level greater than zero, is observed only among individuals between 6 and 10 rounds of life, similar to behaviour *B*. Assessor ac-I individuals who perceive behaviour *D* as harmful effectively transmit this information to their children, who subsequently discard and cease exploiting it between rounds 5 and 10. The average level of behaviour *D* quickly drops to nearly zero and eventually reaches 0, mirroring the pattern observed for behaviour *B*. In contrast, c-I individuals do not transmit this information, resulting in the average level of behaviour *D* stabilizing around 0.10.

Figure 2 presents the evolution of average fitness of individuals c-I and ac-I in pure populations of each strategy in both scenarios. The fitness levels are measured only for individuals old enough to be chosen as parents (i.e., those who have reached six or more rounds). In scenario I assessor ac-I individuals reach a stable average fitness of 140.0 after 1000 rounds, while the c-I individuals reach an average fitness of 120.3. This difference in fitness arises from three factors: a) behaviour *A* reaches a slightly higher level in ac-I individuals (5) compared to c-I individuals (4.89); b) behaviour *C* attains a lower level (0.39) among c-I individuals, contributing significantly less to the average fitness compared to ac-I individuals (who reach the maximum level 5 for behaviour *C*); and c) behaviours *B* and *D* disappear among ac-I individuals and persist at low levels (0.10) among c-I individuals, reducing the average fitness of their population. In scenario II the differences in fitness are reduced but remain significant: assessor ac-I individuals stabilise their fitness around 116.0 and c-I individuals around 108.6. This difference does not depend now on behaviour *A* but on behaviour *C* (although to a lesser degree than in scenario I as the maximum level is 2) and on behaviours *B* and *D* which are identical in both scenarios and reduce the fitness of c-I. individuals.

Fig. 2 The evolution of mean fitness of individuals c-I (blue) and ac-I (red) in pure populations of each strategy in scenary I and in scenary II

Scenario I **Scenario II**

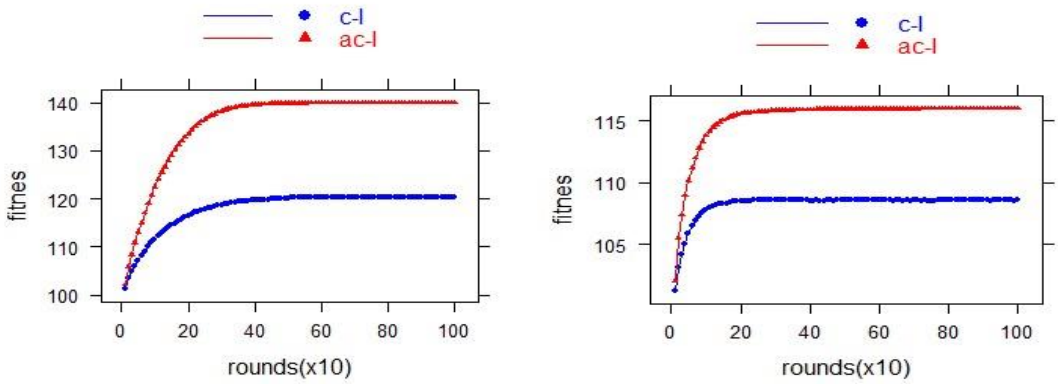
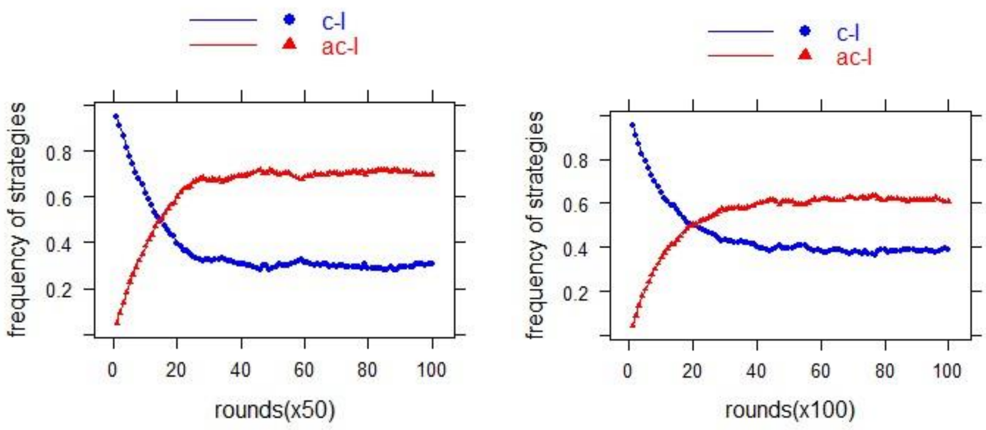


Figure 3 demonstrates the invasiveness of ac-I individuals arising from mutation within a population of c-I individuals. In scenario I, after 2000 rounds, the frequency of c-I individuals decreases to approximately 30%, while the frequency of ac-I assessors increases to 70%. Subsequently, both frequencies fluctuate around these values because the selective advantage of ac-I individuals cannot fully compensate for the high mutation rate (0.001) used, preventing them from completely displacing c-I individuals. Something similar happens in scenario II, although the invasive potential of ac-I individuals is now lower as the difference in fitness between ac-I and c-I individuals is smaller. The frequency of ac-I individuals stabilises at around 60% while the frequency of c-I individuals stabilises at around 40%. Logically, this equilibrium is closer to the 50% that would be expected if there were no fitness differences between ac-I and c-I individuals.

Fig. 3 Evolution of the frequency of ac-I individuals (red) arising by mutation in a population of c-I individuals (blue) in scenario I and II

Scenario I **Scenario II**



The model, as described, did not incorporate an additional cost for assessor ac-I individuals regarding the transmission of information. However, if we introduce the assumption that assessor ac-I individuals experience a 10% decrease in fitness during the 5 rounds of their offspring's infancy due to maternal dedication, the average fitness of the ac-I population would decrease from approximately 140 to 138.4 in scenario I and from 116 to 114.7 in scenario II. It's important to note that even with this added cost, the average fitness of the ac-I population remains significantly higher than that of the c-I population in both scenarios. Thus, the qualitative outcome regarding the invasiveness of ac-I individuals is not altered.

4. Discussion

The evolution of elementary forms of teaching through evaluative feedback have probably shaped the evolution of culture in the hominin lineage (Castro and Toro 2004; Csibra and Gergely 2006; Tehrani and Riede 2008; Kline 2015; Gärdenfors and Högberg 2017). Chimpanzees may observe and attempt to imitate others, as well as generate cultural traditions (Whiten 2005, 2021), and they may classify other individuals’ behaviour as favourable or unfavourable (with respect to themselves), and act accordingly (e.g., by rewarding or punishing that behaviour). However, the ability to assess the behaviour of others from the actor's point of view and provide evaluative feedback to guide learning (i.e., assessor teaching) seems to be absent in non-human primates (Inoue-Nakamura and Matsuzawa 1997; Premack 2004; Tennie et al. 2009; although see Boesch 2003, for a different view). Teaching examples in primates have been described, usually involving mothers attempting to provide their offspring with tools or items that facilitate the learning of complex techniques, such as leaving stones and nuts within reach for nut cracking (Eshchar et al. 2016; Estienne et al. 2019) or providing a large twig for termite fishing (Musgrave et al. 2016; Musgrave et al. 2021). However, these forms of teaching are exceedingly rare and do not involve active intervention in the learning process, such as correction or noting what can and cannot be done.

In contrast, human mothers and fathers possess the ability to guide their children's learning by comparing observed behaviours with their own behaviour in similar situations. This comparison may lead to approve or disapprove the observed behaviours, enabling assessor parents to influence their children's behaviour.

4.1 The adaptive potential of assessor teaching: findings from our model.

Our model explores the potential adaptive advantage of parental approval/disapproval of filial behaviour and its impact on cultural transmission. Assessor teaching affects two key aspects of cultural transmission: efficient replication of observed behaviours and categorization of those behaviours as favourable or unfavourable. In this context, assessor teaching can enhance cultural transmission in three ways, as illustrated by the model: 1) by facilitating the replication of complex behaviours (behaviours *A* y *C*); 2) by preventing individuals from experiencing negative behaviours they could discover on their own (behaviours *B* and *D*); 3) by assisting in the categorization of challenging-to-appraise behaviours as favourable and supporting their persistence (behaviour *C*).

Regarding the first way to improve cultural transmission in the model, the literature suggests that early forms of teaching in human ancestors must have been crucial for the long-term preservation of complex skills (Castro and Toro 2004; Tehrani and Riede 2008; Strauss and Ziv 2012; Fogarty et al. 2011; Castro and Toro 2014; Laland 2017). There is no consensus on when lytic culture is complex enough to require high-fidelity social learning mechanisms (i.e. imitation and/or teaching). Some authors set that point as late in the transition from Olduvayan to Acheulean culture (Morgan et al. 2015; Gärdenfors and Högberg 2017; Shipton and Nielsen 2018). Other authors, however, are sceptical about the need for high-fidelity social learning mechanisms during the first stages of Acheulean technology (Richerson and Boyd 2005; Corbey et al. 2016; Tennie et al. 2016; Andersson and Tennie 2023).

In our model we have compared the results obtained when teaching enhances cumulative cultural transmission (scenario I) and when the maximum level of complexity does not require teaching to achieve it (scenario II). In scenario I, teaching favours behaviours *A* and *C* to reach the maximum possible level, favouring a fitness advantage of assessor ac-I individuals over assessor c-I individuals. However, behaviour *A* provides a small fitness advantage to ac-I individuals because most of the c-I individuals also reach the maximum level. Behaviour *C* provides greater fitness to ac-I individuals because teaching promotes the active persistence of this behaviour, making its cultural accumulation possible. In scenario II behaviour *A* has no influence in terms of fitness because all ac-I and c-I individuals reach the maximum level 2. Assessor teaching facilitates, as in scenario I, the active persistence of behaviour *C* among ac-I individuals which allows them to reach level 2.

In short, the advantage provided by teaching, with the standard parameters we use in the model, does not come from a greater efficiency in the replication of behaviour, but mainly from its effect on the active persistence of behaviour *C* (i.e., the third mode to enhance cultural transmission considered in our model). To this we must add that teaching also provides an advantage to ac-I individuals by decreasing the costs of experiencing negative behaviours *B* and *D* in both scenarios (i.e., the second mode to enhance cultural transmission).

Thus, the model emphasises that assessor teaching contribute to increasing the fitness of ac-I individuals, even if in practice they do not increase do not increase replication efficiency. This advantage probably had to become greater and greater as the evolutionary trajectory of the hominin lineage has been marked by an extended ontogenic period and parental care (Kaplan et al., 2000; Barrickman, 2008; Hrdy, 2009). In this context, teaching through parental approval or disapproval of filial behaviour can enhance parental care (Castro et al 2021). Hrdy (2009) and Hawkes (2014) have suggested that the emergence of human cooperation and the psychological skills of shared intentionality, was a consequence of attempts by early human infants to solicit care and attention from adults in a cooperative breeding context. Children had to spend more time with their parents, siblings, and other close relatives, in groups that were heterogeneous in terms of ages and abilities. Our hypothesis is that assessor teaching helped to cope better in that context.

Assessor teaching has a cost from the time and energy devoted to influence the offspring's behaviour just as many other traits of parental care have. The evolution of assessor teaching will depend on whether the benefit of parental orientation outweighs the cost. However, the fact that assessor teaching has evolved only in the hominin line does not seem to be related to the importance of the implied costs, but rather with the need for complex cognitive development. It is not straightforward to know what cognitive changes have led to the provision of evaluative feedback and at what point did in the hominin lineage emerge. For example, from a phenomenological point of view, Castro and Toro (2004) have suggested that the ability to assessor teaching depends on the ability to conceptually categorize one's own and others' learned behaviour in terms of values (i.e., positive or negative, or good or bad).

4.2 Are young children promiscuous normative creatures or are they precocious teachers?

The prolongation of the ontogenetic period necessitated the regulation of social interactions among siblings and cousins to ensure the well-being of younger children (Hrdy 2009; Hawkes 2014). Children both collaborate and compete with each other, necessitating the establishment of social norms and the categorization of social interactions as appropriate or inappropriate, good or bad, from the perspective of parents. In such collective parenting situations, it can be assumed that children develop the ability to act as young teachers, guiding less experienced children who exhibit incorrect behaviour compared to what more experienced children have learned.

To investigate this possibility of children acting as teachers, we delve into a series of experiments that explore the emergence of normative behaviour in children, even in the absence of explicit normative cues. Various studies have revealed that children not only adhere to social norms but also actively enforce them upon others (Rakoczy et al. 2008; Schmidt and Tomasello 2012; Butler et al. 2015; Schmidt et al. 2016). This enforcement suggests that young children may internalize and identify with the social norms of their culture, surpassing their individual interests.

Several recent investigations focused on 3-year-old children who were taught the rules of a game. When a puppet played the game incorrectly, the children corrected the puppet's behaviour or even taught it the correct way to play (Rakoczy et al. 2009; Rakoczy et al. 2008; Schmidt et al. 2012). This behaviour indicates that, starting at around age 3, children begin to conceive social norms as general guidelines originating from a collective source, applicable universally to anyone engaged in a specific activity (Nagel 1986; Rakoczy and Schmidt 2013; Schmidt and Tomasello 2012).

In these experiments, children demonstrated their ability to interpret behaviours normatively, even without the introduction of normative language or explicit teaching cues by adults (Schmidt et al. 2011; Schmidt et al. 2016). This suggests that children can perceive behaviours as having the potential to be performed either rightly or wrongly, independent of explicit guidance. For instance, Schmidt et al. (2011) discovered that even young 3-year-olds made normative interpretations of adult actions primarily based on the way they were performed, considering aspects such as intentionality and conventionality. Furthermore, a more recent study by Schmidt et al. (2016) demonstrated that 3-year-old children spontaneously inferred the existence of social norms, even in the absence of any indication through language or behaviour from adults. The children even went so far as to enforce these self-inferred norms when a puppet deviated from them.

According to these researchers, children possess a natural and proactive tendency to transition from observing actions to prescribing actions. They do not perceive norms simply as guidelines for their own behaviour but rather as objective and universal rules applicable to everyone. The authors propose that young children exhibit a promiscuous normativists tendency. While they acknowledge that not all intentional actions observed by children are attributed with normativity, they suggest that when actions themselves appear to be the goal of an activity and are performed intentionally, children are inclined to overinterpret them as representative of generic social norms.

We propose that these seemingly normative behaviours can be explained by our capacity to assessor teaching. Initially, children learn how to perform certain activities through imitation. They observe others and mimic their behaviour. The action of reproducing the observed behaviour serves as an indication that children have been drawn to it and have acquired the knowledge of how to act in a specific context. Then they observe the behaviour of a puppet and compare their own actions to those of the puppet. Consequently, they recognize when the puppet's behaviour deviates from what they perceive as appropriate or interesting.

When children express disapproval towards the puppet's behaviour, it signifies that they have evaluated and compared it to their own learned behaviour, finding it unsuitable. Therefore, it is not surprising that when children do not imitate the behaviour observed in the experiment, they do not protest the puppet's behaviour either, or do so less frequently (Schmidt et al. 2011). In our view, this disapproval towards the puppet's actions is better understood as an attempt to correct it, resembling how parent guide their children's behaviour, rather than simply enforcing a rule. Consequently, children have the potential to transition from being young learners to becoming young teachers. In summary, these findings suggest that children's ability to assess and imitate behaviours allows them to develop their own understanding of what is appropriate. By correcting and guiding the behaviour of others, they demonstrate their role as both learners and potential teachers.

In a ground-breaking study by Göckeritz, Schmidt, and Tomasello (2014), they examined how 5-year-old children autonomously developed social norms in the absence of explicit authority dictating what is right or wrong in order to succeed in a particular game. Triads of 5-year-olds engaged in an instrumental task with a shared goal, requiring coordination and cooperation as individual success was unattainable. The children played the game seven times a day over a two-day period, during which they spontaneously established social norms governing the gameplay.

Following this initial phase, the original triads were disbanded, and new groups were formed, consisting of one child who had prior experience with the game (the expert) and two newcomers (the novices). Importantly, the status of each child within the group remained undisclosed. From the very first moment, within these newly formed groups, the expert children transmitted the previously established norms to the novices in an authoritative and inflexible manner, bypassing any new negotiation. The authors suggest that young children possess a basic understanding of the conventional nature and binding power of social norms that apply to all participants. However, our alternative interpretation of the findings proposes that the process can be seen as expert children (who have learned to play in a certain way) teach novice children how to act without the need to assume that the expert children themselves identify an underlying normative structure. If our reinterpretation is accurate, it suggests that the transmission of knowledge from experts to novices can occur without presupposing that the experts explicitly recognize an inherent normative structure.

4.3 Conclusion

In this article, we highlight the potential significance of assessor teaching as a prerequisite for the later development of normativity. For instance, the value structures of the human brain, including the hypothalamic limbic system enable individuals to categorize learned behaviours in terms of their value, appropriateness, or inappropriateness, irrespective of whether the behaviour arises from social or individual learning (Edelman 1990; Baum, 2017). Individuals possess an understanding that their categorization of learned behaviour can be applied to any individual who acts in a similar manner under comparable circumstances. When individuals observe such behaviour being displayed by others, including their children, they may be motivated to express approval or disapproval based on the received categorization. This act of approval or disapproval carries both an expressive and prescriptive intention as it aims to guide the behaviour of the individual to whom the evaluative signals are directed.

Within the parent-child learning dynamic, the signals of approval or disapproval that a child learner receives are interpreted through their personal value structures as indications of the genuine value associated with the behaviour they are attempting to exhibit. From a phenomenological perspective, the underlying rationale of this process can be summarized as follows: if a behaviour is approved, it is considered good; if it is disapproved, it is considered bad (Castro et al 2010). Children acquire information about the value of their behaviour from two sources. Firstly, they gauge direct pleasure or displeasure derived from engaging in the behaviour itself. Secondly, they consider the pleasure or displeasure stemming from its social acceptance or rejection. Based on the array of evaluative cues received, children classify their behaviour as appropriate or inappropriate, perceiving this categorization as an objective property of the behaviour itself.

The children's acceptance of valuations does not stem solely from a submission to authority. Instead, they perceive the social emotions of pleasure or distaste as the value of a specific behaviour. Approval or disapproval works in chimpanzees and bonobos to promote or stop an individual from performing a behaviour when it affects the individual issuing the approval or disapproval signals. For example, the aggressive disapproval displayed by an alpha male chimpanzee towards a young male attempting to approach a female. The alpha male's disapproval is because the approach behaviour is forbidden for the young male but not for him. The young male will approach the female again as soon as. It also differs from approval based on reciprocity and the exchange of favours, as seen in the grooming behaviour between two chimpanzees. These examples, which we can also find similar in humans, differ significantly from assessor teaching, which involves intentional signs of approval or disapproval that orient learning in another individual.

Our proposal suggests that the capacity for assessor teaching has functioned as a prerequisite (adaptive in itself) for the development of cooperation for mutual benefit and for the development of normativity. Although it is not our intention here to take sides for an innate conception of normativity or for a cognitive gadget alternative, we would like to point out that our proposal is compatible with both. Through assessor teaching, approval or disapproval leads to a process of internalization regarding appropriate behaviour. It is within this process that the normative force of assessor teaching lies. The distinct features of norms, such as the sense of right and wrong, generality, normative force, and the possibility of internalization, take on a new significance when viewed through the lens of assessor teaching.

Furthermore, parents approve or disapprove of children`s behaviours based on their own learned knowledge of what is right or wrong. The similarity between this parental behaviour and normative enforcement and between filial behaviour and normative compliance is manifest. Moreover, collective childcare may have provided an ideal context for the formation of initial consensus on how to act collectively (i.e., normative commentary). This cooperative breeding context allows children to transition from being apprentices to becoming teachers in their own right. From an ontogenetic point of view, the available evidence suggests a developmental sequence in which children are able first to learn individually and socially (by observing what others do), then to approve or disapprove of what others do based on what they have already learned, and finally to cooperate with others in a normative context.

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