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Human Nature, Natural Pedagogy, and Evolutionary Causal Essentialism

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4.1 Introduction

The concept of human nature is used not only by academics but a great deal in private and public life. Like Agatha Christie's Miss Marple, many people regard their day-to-day interest in the activities and motivations of others as an interest in human nature, and it is common for public figures—journalists, judges, politicians, and public intellectuals of all stripes—to invoke human nature when discussing aspects of our behaviour or mentality that they regard as important, deep-seated, or immutable. Indeed, the concept of human nature has so much currency outside academic circles that it is hard to believe its abandonment by scientists and philosophers of science—no matter how compelling the reasons—would prompt a similar move in the outside world. Rather, if the concept of human nature is eliminated from scientific discourse, it will almost certainly continue to be used 'out in the world', but that usage will not be informed or constrained by science; an important channel of communication between science and the public will close down. For this reason, and because the concept of human nature plays an important role in defining explanatory projects within science (Sterelny, Chapter 6 this volume), I believe it should be patched up rather than eliminated.

This chapter discusses the 'theory of natural pedagogy': an account of how genetic evolution has made human infants receptive to teaching. This theory does not appeal explicitly to the concept of human nature. However, the inclusion of 'natural' in its name, and the purpose of the theory—to describe universal and distinctively human cognitive mechanisms—make the theory of natural pedagogy representative of the widely held view that human nature is rooted in genetic evolution. Challenging this

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view, I argue that empirical research relevant to the theory of natural pedagogy—and, viewed from a certain angle, the theory itself—highlight the importance of cultural evolution in shaping human nature. At the end, I outline an 'evolutionary causal essentialist' way of patching up the concept of human nature that, among other assets, recognizes the importance of cultural evolution in shaping distinctively human cognitive mechanisms (Heyes 2012).

4.2 Natural Pedagogy

The theory of natural pedagogy has been an important focus of research on the development and evolution of human cognition for ten years (Csibra and Gergely 2006; Gergely and Csibra 2005). It offers an account of how teaching evolved, and of the psychological processes that make infants and children receptive to teaching. In essence, the theory proposes that human infants genetically inherit a 'well-organised package of biases, tendencies and skills' (Csibra and Gergely 2006: 8) making them receptive to deliberate attempts by adults to convey information. This package constitutes a biological adaptation for teaching: it was favoured by natural selection operating on genetic variants because it enhanced the fidelity of cultural inheritance (Csibra and Gergely 2011).

When summarizing the components of the natural pedagogy package, Csibra and Gergely use three headings: ostension, reference, and relevance.

Ostension: Infants' sensitivity to *eye contact*, *contingencies*, and *infant-directed speech* make them more likely to learn by observing information that the adults intend the infants to learn.

Reference: In the presence of ostensive or communicative cues (i.e. when an adult is making eye contact, responding contingently, and/or using infant-directed speech), infants tend to shift their attention in the direction indicated by the adult's gaze. This *gaze cuing* increases the probability that the infant will learn about the object or event that the adult intends the infant to learn about.

Relevance: In the presence of ostensive cues, in a 'communicative context', infants are more likely to copy features of an adult's behaviour that are opaque to them than features that the infant can already understand. This *rational imitation* bias increases the probability that, as the teacher intends, the infant will acquire through observation of the teacher's behaviour information that is new to them, and that can be used in a range of contexts.

It is sometimes unclear whether Csibra and Gergely are proposing that infants are receptive to teaching by virtue of low-level sensorimotor processes or high-level inferential processes. Consequently, their theory has been criticized both for being too lean—placing too much emphasis on automatic psychological processes (Nakao and Andrews 2014)—and for being too rich—attributing to infants inferential feats that are likely to be beyond their cognitive power (Beisert et al. 2012). In this chapter and elsewhere (Heyes 2016), I take it that the theory of natural pedagogy assumes that low-level mechanisms make young infants receptive to teaching, and that when describing infants' competence in high-level terms—using words such as 'believe', 'conceive', 'infer', and 'rational'—the authors of the theory are adopting the intentional stance (Dennett 2009: 339). In other words, I take it that Csibra and Gergely use intentional terms as a way of presenting their hypotheses about the adaptive functions of infants' competence, not about the psychological mechanisms underlying that competence. This view is consistent with Csibra and Gergely having stated explicitly that many components of the natural pedagogy package can be mediated by low-level processes, their denial that natural pedagogy depends on language or theory of mind (Csibra and Gergely 2006), and references to Dennett's intentional stance in their previous work (Gergely et al. 1995).[1]

In a recent article (Heyes 2016), I reviewed evidence from studies of infants, children, adults, and non-human animals relating to each of the five principal components of the natural pedagogy package: eye contact, contingencies, infant-directed speech, gaze cuing, and rational imitation. In each case, the review asked whether there is compelling evidence that the component is (1) real, (2) a genetic adaptation, and (3) adapted specifically to promote teaching. A component was judged to be real when it had been shown to be a reliable feature of infant minds and behaviour. Following the lead of Gergely and Csibra, and other developmental psychologists who are interested in evolution, a component was taken to be a genetic adaptation when there was evidence that it is present at birth (or 'inborn') and/or that its development depends on specialized, rather than domain-general, mechanisms of learning. Finally, whether a component is an adaptation for teaching (3) was addressed by task analysis—asking whether there are other functions it could subserve—and by looking at the phylogenetic distribution of the trait; specifically, whether the component is present in species where teaching has not been observed. The conclusions of the review are summarized in Table 4.1. It found:

[1] Csibra and Gergely's views may well have evolved in the last decade, such that they are now more inclined to believe that high-level mechanisms implement natural pedagogy. If so, treating these innovations as part of the theory would make the theory more vulnerable, because it would add to claims about the adaptive function of pedagogy a set of hypotheses about the psychological mechanisms that implement those functions (Dennett 2009). I believe that the original version of the theory remains coherent, interesting, and ripe for further development as a functional account. Therefore this chapter does not target any additional—and, in my view, weaker—claims about high-level psychological mechanisms.

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Table 4.1 Summary of the evidence from infants, children, adults and non-human animals relating to four questions about the components of natural pedagogy (eye contact, contingencies, infant-directed speech, gaze cuing, rational imitation). For each component, the empirical review presented in Heyes (2016) asked: (1) Is it a reliable phenomenon? (2) Is it a genetic adaptation? (3) Is it a genetic adaptation specifically for teaching, rather than social bonding or social learning? (4) Is it cultural adaptation for teaching, produced by domain-general mechanisms of learning through social interaction?

	Reliable phenomenon	**Genetic adaptation**	**Genetic adaptation for teaching**	**Cultural adaptation for teaching**
Eye contact	✓	?	✗	?
Contingencies	✓	✓	✗	?
Infant-directed speech	✓	✓	✗	✓
Gaze cuing	✓	✗	✗	✓
Rational imitation	?	✗	✗	✓

Eye contact: Current evidence confirms that humans are, from a very young age, highly sensitive to whether another agent is looking at them directly. However, it is possible that, rather than being present at birth, sensitivity to eye contact is a rapidly developing consequence of an inborn preference for face-like stimuli. If eye-contact sensitivity is, in this sense, secondary to a face preference, it may or may not be a genetic adaptation. It is possible that natural selection favoured the genes that promote a face preference in environments where a face preference did not support the early development of eye-contact sensitivity, or where the development of eye-contact sensitivity, via domain-general mechanisms of learning, did not have a positive impact on fitness. Moreover, evidence that our sensitivity to eye contact is shared with a wide range of non-human animals suggests that even if it is a primary genetic adaptation, its function is not specific to teaching. It is possible that, in humans, natural selection has amplified the inborn salience of eye contact, but quantitative change does not appear to be what the theory of natural pedagogy is proposing, and currently there is no evidence that it has occurred.

Contingencies: There is stronger evidence that humans have an inborn attraction to response-contingent stimulation—for example, to movements of an adult face or a toy that are correlated rather than uncorrelated with the infant's movements. However, data on imprinting in precocial birds suggest that, like eye-contact sensitivity, this component of natural pedagogy has deep evolutionary roots, and has not been invented by natural selection specifically to make human infants receptive to teaching.

Infant-directed speech: Similarly, human infants appear to have an inborn preference for high-pitched, emotional speech, but evidence that this preference is also present in non-human animals suggests that, if it is a genetic adaptation, its function is to promote social bonding and coordination rather than a kind of learning that supports cumulative cultural inheritance.

Gaze cuing: Motion cuing—a tendency to track movement with the eyes or head—seems to be an inborn, evolutionarily conserved trait. However, the current evidence suggests that the development of gaze cuing in humans—a specific or exaggerated tendency to follow the movement of eyes—is powered by domain-general mechanisms of learning that detect predictive relationships between eye movements and the location of valuable objects and events. These mechanisms may also detect that eye movements are especially good predictors of value when they have been preceded by eye contact and name calling, and thereby support the modulation of gaze cuing by eye contact and infant-directed speech.

Rational imitation: It is not clear whether imitation in infancy and childhood is reliably modulated by communicative context (e.g. eye contact, infant-directed speech) and opacity (the degree to which the observed behaviour is comprehensible in the light of the infant's previous experience). Even if imitation is rational in this evolutionary sense—i.e. in the sense that this modulation is likely to be adaptive in typical ecological circumstances—there is no evidence that modulation by communicative context and opacity develops so early that it is more likely to be a genetic adaptation than a product of domain-general learning. In either case, the modulation of imitation by communicative context and opacity may function to facilitate teaching, to increase the probability that a novice will learn what an expert model intends the novice to learn. However, unless rational imitation can trump or overwrite individual learning when the two are in conflict, it has limited potential to mediate cumulative cultural inheritance.

Thus, it looks as if eye-contact sensitivity, attraction to response-contingent stimulation, a preference for infant-directed speech, and gaze cuing are real phenomena, but it is not clear whether imitation is rational. There is evidence that two of the five components of natural pedagogy are inborn—attraction to response-contingent stimulation and a preference for infant-directed speech—and therefore prima facie evidence that these two are genetic adaptations. However, like eye-contact sensitivity and gaze cuing, attraction to response-contingent stimulation and a preference for infant-directed speech have operating characteristics and a phylogenetic distribution suggesting that their functions relate to social bonding and/or social learning, not specifically to teaching.

This picture clearly does not support the view that natural pedagogy is a set of genetic adaptations for teaching. Nonetheless, I believe the theory of natural pedagogy contains three fundamental insights about the psychology of cumulative cultural

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inheritance: imitation is not enough; the extra comes not only from smart thinking, but also from blind trust; and tweaking is a powerful source of cognitive change. The sections that follow discuss each of these insights in greater depth than in Heyes (2016), explaining why they are important in relation not only to teaching but to all forms of cultural learning.

4.3 Imitation is not Enough

The groundwork for much contemporary research on cultural evolution was laid in the 1970s and 1980s by researchers with backgrounds in anthropology, biology, and mathematics (e.g. Boyd and Richerson 1988; Cavalli-Sforza et al. 1982). Echoing the views of many psychologists who had previously assumed a special relationship between imitation and culture (e.g. Washburn 1908; Piaget 1962; Bruner 1978), they suggested that imitation is the cultural analogue of the mechanisms of genetic inheritance; it allows cultural traits—contributing to skills, practices, institutions, and languages—to be passed down from one generation to the next with sufficient fidelity to allow improvements to accumulate over time. In the 1970s and 1980s, it was widely believed that imitation is a distinctively human capacity, or one that humans share only with other great apes. Since it was (and is) also widely assumed that cumulative cultural evolution is distinctively human, this fitted well with the idea that imitation is the primary, or perhaps the only, form of cultural learning. However, in the late 1980s and early 1990s, evidence began to emerge that not only apes but a broad range of non-human animals are capable of imitation, and other doubts about the sufficiency of imitation began to be raised (Custance et al. 1995; Heyes 1993). Csibra and Gergely are not alone in having responded to these developments by rethinking the relationship between imitation and culture, but their voices are the freshest and most radical. Their theory of natural pedagogy retains a role for imitation, but states clearly that imitation—or what they sometimes call ‘blind imitation’ (Csibra and Gergely 2006)—is not enough. They make a persuasive case that to understand how cumulative cultural evolution is possible, we need to think harder about the receptive side of teaching, about the ways in which novices derive information, not from experts who are going about their business oblivious to the novices’ needs, but from experts who are striving to inform them.

Although I think that Csibra and Gergely are right to insist that imitation is insufficient, I am not entirely convinced by their reasons for this conclusion. They suggest that imitation ceased to be an efficient means of cultural learning with the emergence of ‘mediated tool use’—the use of objects, not merely to obtain intrinsically attractive outcomes, such as access to the soft flesh inside an animal hide, but as tools to make other tools, or ‘second-order tools’. According to Csibra and Gergely’s teleological theory (Gergely and Csibra 2003), a precursor to their theory of natural pedagogy, infants and children are prepared by genetic evolution to learn about actions by identifying each action’s purpose or goal, and, crucially, to search for goals among the action’s

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intrinsically attractive effects. Since the actions involved in making second-order tools do not have intrinsically attractive effects, the teleological theory suggests that they present a 'learnability problem'; this problem cannot be overcome by blind imitation—by copying a model's actions on an object without understanding their goals—because a blind imitator 'would not know what conditions are appropriate to use the tool' or 'which aspects of its observed use are essential and relevant, and which are superfluous' (Csibra and Gergely 2006: 4).

These reasons for denying the sufficiency of imitation strike me as too local in several respects. First, they focus exclusively on tool use, but our hominid ancestors are likely to have had many more targets for cultural inheritance. Indeed, Csibra and Gergely's own helpful list of culturally inherited traits includes not only the 'function and use of tools', but the 'valence of objects or animals, some aspects of language (primarily words), non-linguistic symbols (for example, gestures), cultural conventions, and even abstract beliefs expressing the world view of the community' (Csibra and Gergely 2006: 11). Consequently, it is possible that any 'learnability problem' was more general: that it related to the encoding of gestures and vocalizations, as well as the construction of tools.

Second, Csibra and Gergely's reasons presume the soundness of a controversial theory of the way that children learn about action. The teleological theory is certainly interesting but it is not widely accepted, and for some alternative theories second-order tools present a quite different learnability problem. For example, there is a wealth of evidence that infants and children learn how to use tools via domain-general mechanisms of learning that are present in a wide range of vertebrate species (Gopnik et al. 2004; Klossek and Dickinson 2012). If this is correct, the advent of second-order tools presented a sequence learning challenge, rather than an opacity problem; learners needed to represent chains or hierarchies of action–outcome relationships, rather than purely binary relationships. However, since on this alternative account the long-established mechanisms had not been directed to identifying a definitive goal for any given action, it was not a problem that second-order tools made ultimate goals difficult to track. Thus, the teleological theory created the learnability problem that the theory of natural pedagogy is designed to solve.

Third, it is likely that what Csibra and Gergely call 'blind imitation' can solve the problems that they consider to be beyond its power. If a novice only ever got to see an expert using a second-order tool on one or a very few occasions, it would indeed be difficult for the novice to work out under what conditions the tool should be used, and 'which aspects of its observed use are essential and relevant, and which are superfluous' (Csibra and Gergely 2006: 252). But if the technology is important, novices are likely to have many opportunities to observe use of the second-order tool, and multiple demonstrations would allow domain-general processes of statistical learning to extract recurrent elements of the context and technique. Recurrent elements are likely to be essential and relevant, whereas variable or occasional elements are likely to be superfluous.

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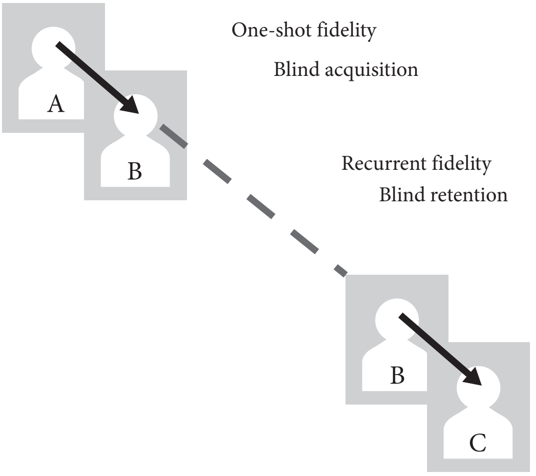

Figure 4.1 One-shot and recurrent fidelity in cultural inheritance. The solid arrows represent two episodes in the cultural inheritance of a trait, *t*: when *t* is learned by agent *B* from agent *A* (upper arrow), and later when *t* is learned by agent *C* from agent *B* (lower arrow). 'One-shot fidelity' refers to the extent to which *t* is unchanged within social learning episodes of this kind. The broken line represents the interval between these episodes of social learning; the period after *t* is learned by *B* from *A* and before *t* is learned by *C* from *B*. 'Recurrent fidelity' refers to the extent to which *t* is unchanged during this kind of interval. The fidelity of cultural inheritance as a whole depends on both one-shot and recurrent fidelity. Each of these types of fidelity require blind trust—i.e. processes that incline agents to adopt *t* (one-shot fidelity, blind acquisition) and retain *t* (recurrent fidelity, blind retention) regardless of what their personal experiences may imply about the instrumental function of *t*.

Finally, and most important in my view, Csibra and Gergely's reasons for thinking that imitation is not enough are too local in focusing, as most psychologists do, on 'one-shot fidelity': on the fidelity with which a trait, *t*, is initially learned from an expert, *A*, by a novice, *B* (Figure 4.1). A fair degree of fidelity at this initial stage is undoubtedly necessary for cumulative cultural evolution, but it is radically insufficient. For improvements to accumulate, 'recurrent fidelity' is needed: *B* must retain *t*—keep doing what *A* did, or keep believing what *A* believed—until *C*, a novice of the next cultural generation, acquires *t* from *B*. In other words, *t* needs to be insulated from modification by individual learning between acquisition and 're-transmission'—and, as far as I am aware, there is no evidence that acquisition by imitation, or any other kind of social learning, has this insulating effect (Heyes 1993; Shea 2009).[2]

[2] The results of a recent study by Hernik and Csibra (2015) suggest that infants retain information about tool functions, in the face of 'counter-evidence', more reliably when the tool functions are demonstrated with infant-directed speech than in the absence of ostensive cues. Ultimately, this line of research may reveal that learning with ostensive cues promotes recurrent fidelity. However, to find out whether the effect is specific to ostensive cues and to information retention, it will be necessary to compare ostensive cues with other attention-grabbing stimuli, and to establish that infants who see ostensive and control

4.4 Smart Thinking and Blind Trust

Most researchers who recognize that imitation is not enough seek the 'extra' among the fanciest—the most complex, or at least the most obscure—processes in the catalogue of cognitive science. They suggest that if one adds theory of mind (also known as 'mind reading', 'mentalizing', and 'shared intentionality') and/or language to imitation, the resulting compound is enough to support cumulative cultural inheritance (Byrne and Rapaport 2011; Tomasello 2014). But Csibra and Gergely have taken a different path, and one that is better suited to explaining the early origins of cultural inheritance: they ask how cultural evolution got off the ground (Sterelny 2012). The theory of natural pedagogy suggests that blind trust is at least as important as smart thinking. When it comes to acquiring cultural traits, infants and children need to take what they are given, regardless of whether it makes sense to them. Indeed, according to Csibra and Gergely, children should be especially inclined to learn from others the things that *don't* make sense to them.

Working from their teleological account of action learning, and focusing on one-shot fidelity, Csibra and Gergely suggest that blind trust is necessary because some cultural traits, such as those involved in mediated tool use, cannot be acquired via insightful, teleological thinking, and suggest that the blind trust that solves this problem is the kind embodied in their theory of pedagogy: a propensity on the part of novices to learn selectively what an expert directs them to learn. In the previous section, I suggested a broader perspective in which the insufficiency of imitation applies across different types of cultural trait and lies mainly in its incapacity to insulate them from individual learning for recurrent fidelity. From this broader perspective, the kind of trust embodied in pedagogy is likely to be part of the solution, but other insulation mechanisms will be at least as important. A tendency to attend to, and therefore to learn, the things that an expert intends to teach will increase the fidelity with which *B* inherits *t* from *A*, but the biases postulated by the theory of natural pedagogy—whether inborn or otherwise—will not, by themselves, increase the fidelity with which *B* retains *t* until *t* can be inherited by *C*. Faithful cultural inheritance requires recurrent as well as one-shot fidelity, blind retention as well as blind acquisition (Figure 4.1).

Tomasello and his colleagues suggest that human children have two psychological attributes that seem well suited to promoting recurrent fidelity through blind retention, i.e. insulation of *t* between acquisition by *B* and re-transmission to *C*. These are 'social motivation', an intrinsic desire to be like others in one's social group, and 'normative thinking', including a capacity to think 'I must do it the way I was taught' (Schmidt et al. 2011; Tomasello 2014). The broader perspective I am offering suggests that attributes such as social motivation and normative thinking may be more important in relation to cultural inheritance than the theory of natural pedagogy

demonstrations have learned equally from the demonstrations before they are exposed to counter-evidence. Without the latter check, any effect on retention of ostensive cues would be reducible to an effect on acquisition, and therefore unlikely to have long-term effects.

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acknowledges. However, as discussed elsewhere (Heyes 2018), I think Csibra and Gergely are rightly reluctant to treat whole, big psychological attributes—like social motivation and normative thinking—as primitives when trying to explain the origins of cultural learning.

4.5 Genetic Tweaking is a Powerful Source of Cognitive Change

On my intentional stance reading of the theory of natural pedagogy (see section 4.2), one of its central claims is that small changes to psychological processes—inflections or tweaks (Heyes 2003; Milius 2013) that create biases in favour of certain perceptual inputs—can make a huge difference to the way the processes function. For example, natural pedagogy theory shows us that tweaking imitation, so that it is more likely to occur when a demonstration is preceded by eye contact, and tweaking motion cuing, so that it becomes especially sensitive to eyes (i.e. gaze cuing), could transform imitation and motion-cuing into major conduits of high-fidelity cultural inheritance (Heyes 2016). I think this emphasis on the power of small changes is exactly right; but we should not assume that the small-but-crucial changes are underpinned by genetic variation—that genetic evolution is doing the tweaking.

The evidence reviewed in Heyes (2016) indicates that imitation may not be as reliably modulated by eye contact as the theory of natural pedagogy suggests, and that both imitation and motion cuing may be biased or specialized by domain-general processes of learning in the course of development, rather than having been tweaked by genetic evolution in the hominid line. But this evidence does not undermine Csibra and Gergely's basic approach, their attempt to find the roots of cultural inheritance in small changes to psychological processes. Rather, it suggests that we should be more catholic when examining the drivers of change, more open to the possibility that the crucial changes are made not by genetic evolution, but by domain-general processes of learning operating in a sociocultural context.

This openness could, I think, be usefully extended from the components of natural pedagogy to the components of 'shared intentionality' (Tomasello 2014), including social motivation and normative thinking, which have the potential to support recurrent fidelity. Social motivation is a good example because, in the last decade, the idea that human infants and children find it rewarding to behave in the same way as those around them—that they are socially motivated—has been revived by evidence of 'overimitation' (Over and Carpenter 2013). Studies of overimitation suggest that children copy the behaviour of adults even when, from an instrumental perspective, it is inefficient to do so. For example, when retrieving a toy from a puzzle box, three- and four-year-old children do not only release the latches and open the doors impeding their access to the prize. They also copy the model's extraneous actions—such as tapping the box with a wand—and engage in this overimitation even when they are

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apparently able to discriminate the 'silly', extraneous actions from the actions necessary to get the job done (Lyons et al. 2007).

Whether or not they call it social motivation, contemporary researchers typically assume that the impulse to overimitate is a genetic adaptation or 'evolved heuristic' (Whiten et al. 2009)—that human children have an inborn tendency or pre-disposition to overimitate. But evidence published predominantly in the 1970s and 1980s—when overimitation was called 'generalized imitation'—suggests that this assumption is not sound. In these studies, children from pre-school age up to 14 years were tested for imitation of a set of novel actions at baseline—i.e. before imitation of any action in the set had been rewarded—and after selective reward—i.e. when imitation of some, but not all, actions in the set had begun to be rewarded. The frequency of imitation increased substantially from baseline when the reward, typically praise, was introduced (Baer and Sherman 1964), and the children showed generalization (overimitation): once the reward had been introduced, the children were apt to imitate not only the actions for which imitation was rewarded, but also other actions of the same type (Baer and Sherman 1964; Garcia et al. 1971; Young et al. 1994).

At the time, these findings were interpreted within a behaviourist framework (Baer and Deguchi 1985), but one does not need to subscribe to any particular theory of learning to feel the impact of these studies. They show that experiences of social reward are a powerful determinant of imitation in childhood, and thereby encourage research that investigates rather than assumes that the impulse to overimitate is inborn. One alternative possibility is that in humans, genetic evolution has simply increased the reward value of response-contingent stimulation. Since imitation delivers response-contingent stimulation (what the imitator does depends on what the imitatee has just done), this would produce a positive feedback loop: Being imitated by a child (or anyone else) makes an adult feel good, and consequently likely to react in a positive way—to move towards the child, smile, or say something nice (Grusec and Abramovitch 1982). The child finds the adult's reaction rewarding—partly because the reaction was positive, but also just because it was response-contingent—making the child more likely to imitate the same and similar behaviour now and in the future. It doesn't matter whether the behaviour is 'silly' in the sense that it plays no role in securing an asocial reward. Research on generalized imitation suggests that as long as imitation of similar behaviour has secured social rewards in the past, the impulse to 'overimitate' will be there.

This alternative hypothesis suggests that genetic evolution has tweaked rather than reconstructed social motivation in the hominid line. Rather than giving us a specific new desire—to act like others in our social group—Mother Nature may have simply amplified the rewarding power of response-contingent stimulation.

In summary: I have suggested that the theory of natural pedagogy embodies three insights that it would be wise to pursue in future research on cultural learning: imitation is not enough; the extra comes from blind trust; and tweaks are a powerful source of cognitive change. In discussing each of these insights, I have argued that imitation is not enough primarily because it does not, by itself, promote recurrent fidelity; that the

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extra comes from processes, such as social motivation and normative thinking, that promote blind retention, as well as from processes that promote blind acquisition; and that genetic tweaks are a powerful source of cognitive change because their effects can be amplified massively by domain-general processes of learning operating in a sociocultural context (Heyes 2018).

4.6 Evolutionary Causal Essentialism

As far as I am aware, Csibra and Gergely have never said that natural pedagogy is part of 'human nature'. However, their inclusion of 'natural' in the name of the theory, defence of the view that pedagogy occurs in all cultures (Csibra and Gergely 2011), and emphasis on the evolutionary origins of natural pedagogy make natural pedagogy an interesting test case for theories of human nature. In particular, it seems that two recent accounts of human nature—Machery's (Chapter 1 this volume) nomological account and Samuels's (2012) causal essentialist theory—should embrace natural pedagogy. According to both Machery and Samuels, an important function of a theory of human nature is to explicate the practices of cognitive scientists engaged in just the kind of project represented by the theory of natural pedagogy. Therefore, the nomological account and the causal essentialist theory should each characterize human nature such that if the claims of the theory of natural pedagogy were true, natural pedagogy would be a component of human nature.

In practice, both accounts capture natural pedagogy, but not very firmly. The nomological account says: 'Human nature is the set of properties that humans tend to possess as a result of the evolution of their species', combining 'the universality proposal'—that traits belonging to human nature must be typical of human beings—and 'the evolution proposal'—that they must be evolved traits (Machery, Chapter 1 this volume). This certainly encompasses Csibra and Gergely's claims that natural pedagogy is found in all cultures, and that it is a set of specific genetic adaptations. However, because the nomological account allows that *all* traits we possess as a result of the evolution of our species are part of human nature—e.g. morphological, physiological, behavioural, and cognitive traits—Machery's account does not have a firm grasp on Csibra and Gergely's preoccupation with generative mechanisms. Like much of evolutionary psychology, broadly construed (Heyes 2003), the theory of natural pedagogy is concerned not so much with the manifest characteristics of our species—with how adult humans could be distinguished from other species by a newly arrived Martian—but with the underlying mechanisms that make us different; specifically, with the ways in which we learn from others in infancy and childhood.

On the causal essentialist view, 'human nature is a suite of mechanisms that underlie the manifestation of species-typical cognitive and behavioural regularities'. Thus, in contrast with the nomological account, the causal essentialist view captures exactly Csibra and Gergely's concern with generative mechanisms. It stipulates that components of human nature are 'species-typical', and is therefore also consistent with the claim that natural pedagogy occurs in all cultures. However, the causal essentialist account does not confine human nature to mechanisms that have particular origins, and so does not make sense of Csibra and Gergely's dominant concern with the evolutionary origins of natural pedagogy.

Here is a simple suggestion: why not cross the nomological account with causal essentialism? This hybrid would make human nature the set of mechanisms that underlie the manifestation of species-typical cognitive and behavioural regularities, which humans tend to possess as a result of the evolution of their species. In addition to providing a snug fit for natural pedagogy, this hybrid account, which we can call 'evolutionary causal essentialism', inherits some significant assets from its parents. Like the nomological view, it is evolutionary, but it does not commit the essentialist sins found by evolutionists in older theories of human nature (Hull 1986). For example, it does not offer necessary and sufficient conditions for being human, nor imply that human nature is either normative or fixed. Similarly, evolutionary causal essentialism, like causal essentialism, preserves the causal-explanatory function of human nature; following Aristotle, Locke, and Hume, it casts the components of human nature as underlying or 'hidden' entities that explain obvious differences between humans and other creatures (Samuels 2012). Evolutionary causal essentialism may also escape some of the problems encountered by its parents. For example, the nomological view has been accused of excessive liberalism, because it allows that Sikhism and skiing are components of human nature (Lewens 2015). In contrast, evolutionary causal essentialism, like plain causal essentialism, would not admit Sikhism and skiing, however widespread they became, because they are sets of manifest characteristics (behaviours, beliefs, values), rather than generative mechanisms of the kind studied by cognitive science.

A more serious charge against the nomological view is that it makes the arbitrary assumption that a characteristic can be a component of human nature if it is a product of the genetic evolution of our species, but not if it results from social learning (Lewens 2015) or cultural evolution (in this volume, Laland and Brown, Chapter 7, and Richerson, Chapter 8). To overcome this problem, and on independent grounds (e.g. Heyes 2012, 2016, 2018; Heyes and Frith 2014), I favour a version of evolutionary causal essentialism in which 'the evolution of our species' is understood to encompass not only genetic processes but cultural and epigenetic inheritance systems.[3] On this reading, evolutionary causal essentialism would have a firm hold on natural pedagogy—it would fulfil the rationalizing and scientific project-defining functions of a theory of human nature (in this volume, Kronfeldner, Chapter 10, Machery, Chapter 1, and Sterelny, Chapter 6;

[3] My instinct (pun intended) would be to count as contributing to 'the evolution of our species' only processes that are based on variation-and-selective-retention (Campbell 1974). Whatever the merits of that particular approach, evolutionary causal essentialism certainly needs some well-founded constraints on what it takes to be an evolutionary process.

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Samuels 2012)—even if Mother Culture plays a more significant role than Mother Nature in preparing humans to be taught.

4.7 Conclusion

The theory of natural pedagogy proposes that Mother Nature has played a major role in making human infants and children receptive to teaching signals. With this specific 'purpose', genetic evolution has introduced at early stages in development small but crucial changes in the way that human infants process information from other people. The evidence reviewed in Heyes (2016) and summarized at the beginning of this chapter, combined with the arguments presented here, suggest that Mother Nature may have had less specific purposes when she did her tweaking, and that Mother Culture does a lot of the hard work in preparing children to be taught.

Less specific purposes are suggested by the fact that where there is evidence that a component of natural pedagogy has been shaped by genetic evolution, there is also evidence that it was adapted not for teaching, but for social bonding or to promote attention to other agents. A more important role for Mother Culture is suggested by evidence that some components of the pedagogy package (infant-directed speech, gaze cuing, rational imitation), and other psychological attributes (social motivation, overimitation), become adapted for teaching through the operation of domain-general processes of learning in social contexts. For example, the evidence suggests that motion cuing becomes gaze cuing, and possibly modulated by communicative cues, through reinforcement learning in contexts where the eye movements of others predict the locations of interesting objects and events. Similarly, research on generalized imitation suggests that children may become overimitators through reinforcement learning in contexts where adults deliver rewards for imitation because they, the adults, judge the behaviour to be similar to their own, or simply because, without recognizing that it is imitative, the adults are pleased by the response-contingent character of the children's imitative behaviour.

In these examples, learning that makes a child more teachable is guided by the actions of adults. If the adults' guiding actions, such as gaze shifting and rewarding imitative behaviour, are intended to support learning by the child, then children are taught to be teachable. But even when adults do not intend to influence a child—when they are going about their normal business, looking at events that interest them, and reacting warmly to behaviour simply because they find it pleasing—the effect of their actions is to promote the development of psychological tendencies that make children teachable; natural pedagogy, or 'teachability', is culturally inherited. According to the nomological account, this disqualifies natural pedagogy from the realm of human nature. In contrast, evolutionary causal essentialism recognizes cultural inheritance as part of 'the evolution of our species', and therefore admits natural pedagogy to the warm embrace of human nature.

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