

Pedagogy and Social Learning in Human Development

For J. Kiverstein (ed.) *The Routledge Handbook of the Social Mind*

The greater part of our knowledge of reality rests upon belief that we repose in things we have been taught or told. (Anscombe, 1979, p.143)

Introduction

In both ontogeny and phylogeny the act of teaching plays a foundational role in human cognitive development. Not only does it shape our worldview; it likely enabled the survival of the human lineage in evolutionary history. With respect to human phylogeny, though, a puzzle arises about when in our history teaching might have emerged. If we think of teaching in the manner in which it exists in contemporary Western classrooms, then given the sorts of cognitive and social systems that this practice requires, it could only have emerged later in phylogeny. The later teaching emerged, though, the less it could have contributed to the survival of our early ancestors.

In this chapter, I try to defuse this concern by showing that teaching can come in socio-cognitively undemanding forms. Even early in evolutionary history, these forms would have been well placed to contribute to the survival and expansion of the human race, by facilitating the emergence of cumulative culture. This is a sophisticated and perhaps uniquely human form of social learning, in which cultural technologies are not simply learned from others. Rather, high-fidelity social learning strategies and technological innovation interact (Legare & Nielsen, 2015) - leading to the development of increasingly complex technology over generations. I start by illustrating why teaching (and other forms of social learning) played an essential role in the emergence of cumulative culture, by contrasting the strengths and weaknesses of three different models of learning. I then sketch an account of the nature of teaching, and I defend an account of its cognitive prerequisites that does not presuppose sophisticated individual abilities or social mechanisms - and so is consistent with the possibility that teaching emerged early in hominin phylogeny.

Why Does Social Learning Matter?

The significance of social learning to human development can be illustrated by considering three different models of the sources of an agent's abilities to survive in and cope with its environment. The first model appeals only to inherited cognitive abilities and makes little use of the notion of learning. The second supplements the set of inherited abilities with further individual learning; and a third model explains survival via a combination of inherited abilities, and individual and social learning. While the first and second models might suffice to explain the survival of some organisms, no one would claim that they are adequate for the characterisation of humans.¹ However, considering the differences between the models will highlight the importance of social learning to human forms of life.

(i) Inheritance alone

On the first model, the cognitive abilities that allow a creature to survive in its environment are unlearned. Such abilities might consist of a set of hardwired, specialised cognitive modules or heuristics supporting essential survival skills - including (but not exhausted by) knowledge of the food types and hunting skills that would enable a creature to survive in its environment, and of the fight-or-flight and mating instincts that would enable it to avoid or overwhelm predators while reproducing often enough to ensure the survival of its lineage.

Some abilities that particularly lend themselves to survival seem to be present in this way in our nearest cousins, the non-human great apes. For example, Mountain gorillas (*Gorilla gorilla beringei*) have been shown to feed spontaneously on a type of stinging nettle, *Laportea alatifipes*, that is thought to have medicinal properties; and when they do so, they employ a skillful stripping technique to protect them from its sting (Byrne and Byrne 1993). When Tennie et al. (2008) presented similar nettles (*Urtica dioica*) to groups of captive

¹ While authors differ in the relative importance that they attribute to adaptations, and individual and social learning strategies - contrast, for example, Pinker (2010) and Boyd, Richerson & Henrich (2011) - these are largely differences of emphasis.

Western lowland gorillas (*Gorilla gorilla gorilla*), who seem not to eat nettles in the wild and who were known not to have encountered them in captivity, gorillas in each group spontaneously ate the leaves, and did so using the same elaborate processing technique as their wild cousins. By contrast, they did not use this technique for eating similar looking but harmless willow leaves; and similar techniques were not observed when the nettles were fed to other species of non-human great ape. Given the spontaneous appearance of this distinctive technique in groups of naïve individuals, it is plausibly the result of an adaptation for nettle eating in the gorilla genus.

Such adaptations likely play an important role in the survival of all species. However, without supplementation, species equipped with only innate abilities would prove particularly vulnerable to certain kinds of threat. Hardwired abilities are typically adapted to certain kinds of ecological niche, and have been honed to survive in this niche as a result of natural selection for beneficial mutations over a period of evolutionary time. Steven Pinker eloquently describes such change as “arising by random mutation and being tuned over generations by the slow feedback of differential survival and reproduction” (Pinker, 2010, p.8994). Where environmental changes occur in real time, though - over the course of individuals’ lifetimes and not generations - species who are too highly adapted to one environment may find themselves ill-equipped to cope with environmental change.

(ii) Inherited abilities supplemented by individual learning

Creatures could counter this threat if they were able to supplement innate abilities with a capacity for individual learning. This would allow them to acquire skills more suitable for a changing environment. For example, species equipped with the ability to learn might discover new causal contingencies in their environment - like the fact that certain nuts could be cracked open with the use of stone hammers, and then eaten. Alternatively, pushed into a very new environment, they might discover that fish could be caught and eaten; and that if these fish were cooked, they were easier to eat and tasted better.

So long as such technologies were fairly simple, inquisitive and moderately intelligent individuals could learn them during the course of their lifetime, and so augment their ability to survive. However, there are inevitable restrictions on what any mortal individual can learn. The sophistication of tools that they could create would be limited, leaving individuals potentially ill equipped to cope with more difficult environmental challenges. Furthermore, where agents learn not from each other but only individually, then valuable technological innovations will always be lost with the death of their inventor. Thus tools previously discovered by others would have to be re-invented by each new generation; and new learners would spend their time reinventing technologies already discovered and lost many times over, rather than refining the technologies of their forebears.

We know that as our early human ancestors moved out of Africa and came to populate what is now Europe, they overcame much greater obstacles than could be survived by individuals working alone (Wade, 2006). They were able to do this because they did not just learn individually. They also learned from each other. As Dennett has noted, “cultural evolution operates many orders of magnitude faster than genetic evolution, and this is part of its role in making our species special” (Dennett, 1996, p.339).

(iii) Inherited abilities supplemented by individual and social learning

In arguing for the claim that “culture is essential for human adaptation” Boyd, Richerson, and Henrich (2011) show that even among cultures that seem technologically unsophisticated, skills that are essential for survival turn out to exploit remarkable degrees of expertise. As such, the skills required to survive could not be learned by isolated individuals; and their existence within a community can be explained only by the existence of social learning. They give the example of the Central Inuit of Northern Canada, who live in temperatures as low as -35°C in the winter months. To survive in these temperatures, the Central Inuit rely on clothes made from carefully constructed and elaborately treated caribou skins that are lined with wolverine fur, and stitched together with fine bone needles using sinew taken from around the caribou vertebrae. The Central Inuit also live in snow igloos built on sea ice that are carefully constructed to maximise heat retention, and

which are lit with lamps carved from stone and fuelled by seal fat. In the winter they survive on meat harvested from seals hunted at breathing holes using harpoons carved from antlers and tipped with sharpened polar bear bones. However, in the summer, their primary sustenance comes from caribou that are hunted using long bows expertly crafted using a combination of driftwood, horn, antler, and sinew. Therefore, to survive, the Central Inuit must become expert tailors, hunters, weapons-makers, and architects - not to mention their need to raise and manage dogs, and engineer sledges, kayaks, and tools. On top of all of this, to be able to engage in more than rudimentary communication, and thereby coordinate their activities with others, all humans must acquire language. This requires particularly high levels of social learning, because word forms must be copied precisely from others in order to be useful in communication (Tomasello, 2008; Moore, 2013a; Fridland & Moore, 2014).

If the Central Inuit individuals had to learn each of the above survival skills for themselves and from scratch, making the same mistakes as their forefathers had done, they would die long before they could master the very substantial expertise that survival in such climates requires. They therefore survive only because each new generation learns from their older peers, and learns only the latest technological innovations. Expertise accumulates over generations, as specialists in each new generation refine the skills learned by their forebears. As these skills develop, survival in hostile climates becomes more assured.

The form of culture in which communities build upon and extend the knowledge of their forebears is known as 'cumulative culture' (Galef, 1992; Tomasello, 1999; Richerson & Boyd, 2005). While our nearest cousins, the non-human great apes, are capable of some forms of cultural learning, no other great ape species comes close to the fidelity, range, or complexity of social learning of which humans are capable, none innovate so well, and none possesses cumulative culture (Tennie, Call & Tomasello, 2009; Laland & Galef, 2009; Moore, 2013b). An early estimate comparing six chimpanzee communities identified 39 culturally variant behaviours between chimpanzee groups (Whiten et al., 1999). While subsequent research has increased this number (e.g., Luncz, Mundry & Boesch, 2012; van

Leeuwen et al., 2012), the total number of culturally variant behaviours attributable to apes will inevitably pale in comparison to countless such differences between groups of humans. In addition to there being fewer culturally variant behaviours in chimpanzees than in humans, the skills that chimpanzees learn from their peers are much simpler. The most complex toolsets seen in groups of wild chimpanzees are sets of several sticks of different sizes and lengths used to dig up and break open underground honey nests (Sanz & Morgan 2007, 2009; Boesch, Head & Robbins, 2009). By human standards, though, such toolsets are technologically unimpressive. A recent pastiche on *The Onion* website, entitled 'Chimpanzees: dumber than all humans', put this point as follows:

It is true that chimpanzees have been observed using tools, but their tools are little more than sticks. [A] hammer is an infinitely better tool than a stick, and it is not even that good relative to other human tools.²

Given the greater demands of human social learning, in comparison to our nearest relatives humans have had to develop far superior skills for social learning - including the use of transmission mechanisms that are not shared by the other great ape species.

High Fidelity Learning Mechanisms

Two social learning mechanisms have played a particularly important role in the development of cumulative culture in humans: imitation and pedagogy (Richerson & Boyd, 2005). These are thought to be significant because they are high fidelity modes of social information transmission. Fidelity is important, because when it comes to cumulative culture, if complex tool sets can be copied precisely from others, then less time will need to be spent re-inventing techniques already mastered by others, and more time can be devoted to improving these techniques. Even in humans, skillsets learned from others are rarely reproduced entirely faithfully (Sperber, 1996). However, where skills are copied inaccurately within communities, then the chances of sophisticated innovations being lost through imperfect reproduction is high (Sterelny, 2012).

².*The Onion, Horrifying Planet* episode 2, July 25th 2012. <https://www.youtube.com/watch?v=H-fC9uNyhWo>

Imitation occurs when one agent observes another's behaviour, recognises the goal with which it was performed, and then reproduces the same action in pursuit of the same goal. Specifically, in reproducing the observed action, the agent should be concerned to replicate the technique performed by the original author as precisely as possible (Tomasello 1999; Tennie, Call & Tomasello, 2009; Fridland & Moore, 2014). Imitation differs from 'lower fidelity' social learning mechanisms like emulation - in which an observer recognises a behaviour as goal directed, and tries to realise the goal of that behaviour herself, but without having a particular concern to replicate the techniques that she observes. This difference can be crucial in the copying of complex behaviours. For example, if I see you trying to make a long bow by using a combination of driftwood, horn, antler, and sinew, but do so without paying particular attention to the ways in which you combine those objects, then even if my finished product looks superficially similar to yours, important details of your craft may not have been copied adequately. With respect to language, failure to attend to and replicate the means may be even more catastrophic. Any member of a community who cannot reproduce the same arbitrary patterns of sounds as her peers may fail to acquire a functional vocabulary with which to communicate (Moore, 2013a; Fridland & Moore, 2014).

For these reasons, imitation is likely to have played a very important role in human cognitive development in both ontogeny and phylogeny - and perhaps particularly in the role of language development (Donald, 1991; Tomasello, 2008; Arbib, 2012). Nonetheless, when supplemented or even replaced by pedagogy, it becomes more powerful still. It was recently found that novices trying to recreate Oldowan stone tools produced significantly more viable tools when given verbal and non-verbal teaching instructions than when given the opportunity to learn only imitatively (Morgan et al., 2015).³ Using computational

³ In this study, imitation and emulation learners also accrued no clear advantage over those who used reverse engineering strategies. While it is often assumed that imitation evolved for the social learning of complex tools (Gergely & Csibra, 2006; Arbib, 2012), and was subsequently appropriated for use in communication, this finding suggests an alternative hypothesis. For even quite sophisticated forms of tool technology, reverse engineering may suffice to ensure faithful reproduction. The same is not true

models of cultural evolution, others have argued that cumulative culture likely emerged only after imitative forms of learning were accompanied by the emergence of expert 'assessors' who were able to provide communicative feedback on the learned behaviours of their peers (Castro & Toro, 2004).

Teaching therefore likely played a foundational role in the development of uniquely human forms of culture (Richerson & Boyd, 2005; Csibra & Gergely, 2009; Sterelny, 2012). For its emergence to be possible, though, a certain set of cognitive and social conditions would need to be in place. Characterising what these conditions and abilities are will help us to better understand where in human pre-history teaching likely emerged. Before this can be attempted, though, some preliminary characterisation of the nature of teaching is needed.

What Is Pedagogy?

For the purpose of answering the question of whether there is teaching in non-human animals, and thereby shedding light on the possible evolutionary roots of pedagogy, Caro and Hauser (1992) defined teaching as follows:

An individual actor A can be said to teach if it modifies its behavior only in the presence of a naïve observer, B, at some cost or at least without obtaining an immediate benefit for itself. A's behavior thereby encourages or punishes B's behavior, or provides B with experience, or sets an example for B. As a result B acquires knowledge or learns a skill earlier in life or more rapidly or efficiently than it might otherwise do, or that it would not learn at all. (Caro & Hauser, 1992, p.153)

In this way, they identify four conditions as necessary and co-sufficient for teaching: (1) the 'teacher' modifies its behavior, (2) the modification occurs only in the presence of naïve (or appropriately inexperienced) observers, (3) the modification does not benefit the teacher, and (4) it facilitates learning in the observer. While these criteria have been very

for arbitrary forms of communication, imperfect copies of which may fail to be usable. Evolutionary pressure for imitation may therefore have originated not for tool mastery, but for the acquisition of languages making use of arbitrary signs.

influential, and have been adopted by many animal cognition researchers (e.g., Hoppitt et al., 2008; Thornton & McAuliffe, 2012), they are imperfect for the characterisation of teaching in humans (Csibra, 2007; Byrne & Rapaport, 2011; Moore 2013b).⁴

A feature of human pedagogy that is not well captured on this definition is that teaching in humans characteristically takes the form of an intentional communicative act (Csibra, 2007; Moore, 2013b). In particular, it is a communicative act in which a teacher provides information that she intends to benefit the learner. While teaching need not always benefit the teacher, it may sometimes do so. This would be the case if by teaching you how to perform a task that I would otherwise have to do myself I can reduce my own workload. In that case, Caro and Hauser's (3) should be dropped and their (1) revised:

Teaching is (1) an act of intentional communication in which (2) a knowledgeable individual (the 'teacher') volunteers information for the benefit of one or more naïve individuals (the 'learners'), (3) with the intention of facilitating learning (e.g. the development of knowledge or skills) in the naïve individuals.

Here, of course, teachers and learners need be knowledgeable and ignorant only in respects that are relevant to the content of the teacher's message. A teacher in one context may be a learner in another. Additionally, the content of 'intending to facilitate learning' can be specified in conceptually undemanding ways. For example, it may be that the teacher has no articulate or general concepts of *skill* or *learning*; and that she intends only that her interlocutor come to grasp some fact, or perform some relevant task better.

A further feature of teaching motivates another revision. Typically we think of pedagogical acts as connected to the acquisition of lasting skillsets and general truths about the world, and not just of occasion specific items of knowledge (Csibra, 2007). For example, while the assertion that "Christopher is a cat, and therefore a carnivore" is something that could be taught, the utterance that "Christopher is in the garden" intuitively could not - despite its

⁴ Another recent attempt to characterise the evolutionary origins of teaching (Kline, 2015) is less compelling, because it lumps together behaviours supported by very different underlying abilities and which appear in only distantly related clades. See Moore and Tennie (2015) for discussion.

sometimes being consistent with (3) above. In order to distinguish between cases in which an agent *teaches* and cases in which an agent merely *tells* her interlocutor something, Csibra (2007) argues for a further modification:

(4) The information provided by the knowledgeable individual is generalisable.

While the communication of generalisable information is no doubt an important part of teaching, the above formulation is unsatisfactory. Generic semantic knowledge (“Cats are carnivores”) and general technical instructions (“To achieve *E* in situation *S*, do ϕ ”) are not the only forms of knowledge that can be taught. The details of historical events can also be taught, as can truths like “Caligula was a tyrant”. Intuitively, episodic facts like these fail condition (4). The characterisation of (4) should therefore be revised in such a way that it licenses a distinction between teaching and telling.⁵

In a recent paper, Small (2015) suggests the following:

Successful teaching [in contrast to telling] results in the learner’s initiation into a science, art, craft, or other kind of practice, the members of which are such as to become independent active principles in its maintenance and development, be it theoretical physics, the violin, cricket, or pottery. (Small, 2015, p.381)

That is, in teaching but not telling, a teacher initiates her students into a community of intergenerational knowledge that each of them becomes responsible for maintaining and expanding. This characterisation is appealing for the purposes in hand, because it suggests a conceptual link between teaching and cumulative culture.

Like Csibra, Small thinks of the contents of teaching as general, in a way that the contents of telling are not. Thus, on his account, history is not just the practice of learning historical facts: “it is part of teaching history to teach students how to deal with historical evidence in various ways” (*ibid.*, p.382). While true, this point does not answer the question of why the details of some but not all episodes can be taught. A possible answer is suggested by

⁵ Alternatively, one could opt for a more restricted characterisation of teaching that leaves behind the common usage of the word in favour of characterising a more homogenous class of acts. I see no reason to prefer this approach.

another feature of Small's view, though. If teaching is characterised as the initiation of others into a community of knowledge, then it may be that the identity of that community turns on its identification with some narratives and historical episodes but not others. Thus teaching might extend to incorporate not only generic statements and skills that form a platform for future innovations, but historical narratives relevant to the identity and history of the knowledge community.⁶ Since the boundaries of all communities are fuzzy, one could accept this point and recognise that the teaching-telling boundary is itself sometimes fuzzy.

Small's view (developing ideas sketched by Rödl (in press)) also has implications for how we think of the status of teachers, relative to their peers.

The teacher does not speak as an individual subject, but ... in a sense goes proxy for the whole science, art, or practice[.] ... Though the actuality of the epistemic community for which the teacher speaks resides in the individuals and concrete interpersonal relations it comprises, it is not merely on behalf of those individuals that the teacher speaks, but on behalf of the science, art, or craft of which they are, as it were, the present custodians. (Small, 2015, p.384)

It is often true that teachers see themselves as guardians of traditions - be they evolving scientific practices, or historical, cultural narratives. However, at least for the purposes of an account of the consequences of teaching for human survival, the requirement that teachers think of themselves as speaking on behalf of such traditions seems arbitrary; and so ought not to be a pre-requisite for teaching. Thus, one might think that content can be taught just when it contributes to the transmission of general skills, or communicates information that is important to the identity of a community; even if teachers do not think of themselves as guardians of communal traditions, or of a communal knowledge base. As a result, the fourth clause below does not fall under the scope of any thought process that the teacher must entertain. It simply serves as an external constraint on the sorts of

⁶ For a valuable discussion of the relationship between social learning and group identity, see Haun & Over (2013).

communicative act that we would class as teaching.

(4) The information provided by the knowledgeable individual is generalisable or relevant to the identity of the group of which teacher and students are members, and could serve as a platform for future insight or innovation by others.

Together, these conditions give the following preliminary analysis:

Teaching is (1) an act of intentional communication in which (2) a knowledgeable individual (the 'teacher') volunteers information for the benefit of one or more naïve individuals (the 'learners'), (3) with the intention of facilitating learning (e.g. the development of knowledge or skills) in the naïve individuals. (4) The information provided by the knowledgeable individual is generalisable, or relevant to the identity of the group to which teacher and students belong, and could serve as a platform for future insight or innovation by others.

This account is attractive because it incorporates both the cases of verbal instruction described by Morgan et al. (2015) and the cases of feedback modelled by Castro and Toro (2004). However, it excludes as pedagogical cases in which a learner learns from an expert by observation but where there is no intention to provide valuable information, and also cases in which the information that the teacher volunteers is too ephemeral. It also characterises a set of behaviours that is pervasive in humans, but seemingly absent from the behavioural repertoire of our nearest relatives, the non-human great apes (Lonsdorf, 2006; Moore, 2013b; Moore & Tennie, 2015). The emergence of this behaviour is likely to have been closely connected with the phylogenetic origins of cumulative culture, and the transition of ancestral hominin groups from possessors of a limited toolset, to possessors of a far more impressive set of technologies. It is also likely to have played a foundational role in the dispersal of our earliest human ancestors out of Africa and into new territories for which our genetic inheritance had not prepared us to survive.

Simple and Complex Forms of Teaching

A virtue of the above characterisation is that it is loose enough to incorporate a variety of functionally similar but importantly different behaviours - from simple demonstrations of

how to use a tool, to cases closer to the teaching methods used in contemporary university lecture theatres. This is important, because if we think of pedagogy in the mode in which it currently features in Western classrooms, a further set of evolutionary questions arises.

On this paradigm, a knowledgeable teacher stands at the front of a classroom and repeats for her students a series of related statements - historical narratives, scientific theories, mathematical proofs - that her own teachers previously taught to her. Here pedagogy takes the form of a set of propositions asserted as true by a pedagogue and passed down from one generation to the next. Teachers who conduct their own research may supplement inherited propositions with insights of their own. However, the teacher may herself have independently evaluated the truth of only a small subset of the propositions that she asserts, and will likely take for granted the truth of much of what she was herself taught. In turn, many of the propositions that she asserts will be taken as true by students simply because they have been asserted - either by the teacher, or in a set of texts with which the teacher supplements her teaching.

Such teaching methods have no doubt contributed a great deal to human learning. However, from an evolutionary perspective, they are both cognitively demanding and potentially unstable.

Cognitive Challenges to Teaching

A first worry is that this form of teaching could not exist in the absence of language. This would place constraints on the models of cultural evolution that could be prima facie credible, because it suggests that complex tool sets like those described by Boyd, Richerson and Heinrich (2011) could not have emerged until after language was in place. This worry dissipates if it is acknowledged that there could be forms of non-verbal or 'proto-linguistic' communication that emerged earlier than language. However, even here difficulties arise. On standard accounts of communication even non-verbal communication requires acting with and understanding communicative intentions with a 'Gricean' intentional structure (Grice, 1957). This is problematic because on traditional readings of Grice, such

communication requires very sophisticated socio-cognitive abilities - including possession of a concept of belief, the ability to make complex inferences about others' communicative goals, and the ability to entertain third and fourth orders of meta-representation (Sperber, 2000; see Moore, 2014, 2015, under resubmission for discussion). Since there is empirical evidence that even ten-year-old school children struggle to entertain fourth order meta-representations (Liddle & Nettle, 2006), then the ability of ten-year-olds to learn from teaching would seem to be inconsistent with traditional Gricean accounts of communication. Unless we think our early ancestors cleverer than educated, Western ten-year-old children, this worry would also generalise to make problems for an account of the emergence of teaching in phylogeny.

This empirical evidence is consistent with an anxiety that Grice himself raised, which was that the cognitive abilities required by the account of communication he specified were "too sophisticated a state to be found in a language-destitute creature" (Grice, 1986, p.85). In other words, while Grice's account of acting with and understanding communicative intent might serve as a foundation for the non-verbal behaviour of linguistic creatures, at least on standard accounts it looks like a poor candidate for explaining the communicative actions of creatures who have yet to evolve language.

A number of responses have been proposed to the challenges presented by accounts of Gricean communication for cognitive development. One set of responses is to argue that potentially difficult communicative interactions have been made more tractable by the existence of adaptations for teaching and learning from teaching. Adaptions provide a convenient solution to cognitive challenges because they take over and automate difficult behaviours and processes, and thereby reduce the demands that they place on the resources of cognitively limited individuals.

Sperber and Wilson (1995, 2002) accept the standard story about the meta-representational demands of Gricean communication. However, they argue that humans have inherited modular abilities for meta-representation that make the production and comprehension of

communicative intentions easy. Moreover, they argue, we also have an adaptation for processing the content of speakers' communicative intentions, based on the relevance of what they say. The Relevance detection module that they propose assigns content to speakers' utterances on the basis of what would be the most relevant interpretation, where this is calculated by the formula $Relevance = Cognitive\ Gain / Processing\ Cost$.

More recently, Gergely and Csibra have proposed a second adaptation - which they call 'Natural Pedagogy' - to explain children's facility for learning from teaching (Csibra & Gergely 2006, 2009; Csibra, 2010; Gergely & Csibra, 2006, 2013; Gergely, Egyed & Kiraly, 2007). While the details of their proposal have changed as the claim has been developed, three claims are central:

- (1) *Communicative Intention*: Human infants are hardwired to recognise certain 'ostensive' signals (including eye contact and infant-directed speech) as indicating that a speaker is acting with communicative intent (Csibra, 2010).
- (2) *Content Filling*: On the basis of (1), when infants are addressed with ostensive cues, they seek to recover the content of the speaker's message. In particular they do this by setting out to infer the object to which the speaker intended to refer (Senju & Csibra, 2008); and by considering the ways in which that object might be relevant to their on-going interaction with the speaker.
- (3) *Generalisation of the Content*: Additionally, because of the presence of ostensive cues, the addressee takes the speaker to be making a general claim about the object kind to which she is referring (Csibra & Gergely, 2009).

In principle, the Relevance and Natural Pedagogy proposals could work in unison. Thus, students might recognise that their teacher was acting with communicative intent on the basis of her addressing them with ostensive cues. The same ostensive cues would additionally trigger the operation of the audience's Relevance modules, and subsequently fill out the content of the teacher's utterance based on an interpretation of what she said. The children would then interpret this content to be a general claim about the world, and generalise it. Presented with an ostensive demonstration of how to use a magnetic tool (a 'blicket') to sweep iron filings from the surface of a desk, children would recognise that

take the teacher to be communicating to them an enduring, general claim about blickets - for example, their property of being magnetic; and not a claim about any particular blicket - like its location.⁷

There is some evidence that older children do indeed generalise taught information in the way that Gergely and Csibra predict. For example, Butler and Markman (2012) presented children with a scene in which an experimenter used a tool like the blicket detector described above, in a way that revealed its magnetic properties. The experimenter demonstrated the tool either ostensively, intentionally but non-ostensively, or accidentally (by dropping on the tool onto magnetic objects). They found that four (but not three) year-old children spent longer investigating similar looking objects that were not magnetic when they had seen the object used in the demonstration condition than in either the intentional or accidental conditions. From this, Butler and Markman inferred that the older children in that condition had acquired expectations that the object should have essential functional properties (namely magnetism) that children in other conditions did not acquire. Unlike the older subjects, however, three-year-olds did not distinguish between pedagogical and intentional conditions. In a follow-up study (Butler & Markman, 2014), the same authors found that children of four and five years sorted similar looking objects into different groups depending on their functional properties (whether or not they were magnetic) when they observed those objects demonstrated ostensively. By contrast, when they observed the same object properties through watching intentional but non-demonstrative and accidental uses of the object, they sorted on the basis of appearance, and not function.

These studies suggest that pedagogical demonstrations (i.e. those accompanied by a demonstrator's use of ostensive cues) lead at least older children to assume that they are being taught about functional properties of the class of objects to which the demonstrated object belongs. However, if Natural Pedagogy is an adaptation, it is puzzling that younger children in the first Markman and Butler study did not distinguish between intentional and

⁷ While I have argued that some forms of episodic information can be taught, the Natural Pedagogy adaptation is hypothesised to explain children's learning of generalisable knowledge only.

pedagogical conditions. Heyes (2015) argues that if Natural Pedagogy is an adaptation, its effects on learning would be expected to be present from birth; and so behavioural evidence should be present in children at the youngest testable ages - around four months old. In this direction, Yoon et al. (2008) found that children of 9 months who observed an experimenter ostensibly pointing to an object were more likely to retain information about its identity; while those who saw an experimenter reach non-ostensively for the same object were more likely to retain information about its location. However, these subjects are still much older than the four-month-olds that Heyes thinks would be evidence for the existence of an adaptation. It may be that early in life, children simply learn a heuristic that when adults are communicating with them, they often communicate information about object kinds. Evidence that Natural Pedagogy is an adaptation is therefore currently lacking.

While human children are undeniably very good at inferring communicative intentions, evidence for the existence of a Relevance detection module is also far from conclusive; and proponents of Relevance Theory make some claims that are simply inconsistent with existing empirical data. For example, Sperber and Wilson's claim that Gricean communication requires fourth order meta-representations is difficult to reconcile with evidence that ten-year-old children find communication easy but fourth-order meta-representation difficult. For these reasons, some authors (myself included) have sought to challenge the orthodoxy that claims that Gricean communication requires high orders of meta-representation (Gómez, 1994; Moore, 2014, 2015, under resubmission; Sterelny, in press). If we are right, and Gricean communication requires less complex meta-cognition than Sperber and Wilson suppose, then this worry also dissipates, and Gricean analyses of communication may be appropriate for evolutionary accounts of communication after all.

In addition to the possibility that children possess adaptations for learning from teaching, it may also be that parents possess adaptations for teaching. With respect to Natural Pedagogy, one recent study of parental teaching behaviour suggests that parents do change their behaviour when demonstrating different object properties to children. However, this

data is not obviously supportive of the Natural Pedagogy hypothesis. In observations of mothers interacting with their children, Hoicka (2015) found that parents produce more ostensive cues when they are joking or pretending with their children than when they are teaching them. That is, they behave more ostensively precisely when they intend to communicate non-generalisable information. If ostensive cues are part of an adaptation for the learning of generalisable information, such behaviour seems puzzling. In another study, Brand and colleagues (2002) found that mothers of young infants (6-8 months, and 11-13 months) spontaneously adopted 'motionese' when demonstrating object functions to their children - exaggerating, simplifying and repeating object movements in ways that would help children learn. They were less likely to use motionese when demonstrating the same tools to adults. However, the authors of this study do not claim that motionese constitutes an adaptation, since it may also be a culturally learned practice.

Given these considerations, evidence for the existence of adaptations for teaching and learning from teaching is currently suggestive but inconclusive. However, even if modern humans possess such adaptations, their postulation would not resolve all issues connected to the emergence of teaching in phylogeny. It is part of the nature of adaptations that selection pressure for them can emerge only when the abilities that they exploit are already in use. Thus, adaptations for learning from teaching can have emerged only after the establishment of teaching in communities of our ancestors. Adaptationist accounts are therefore by their nature ill equipped to explain the teaching and learning interactions of our early ancestors. While their pedagogical interactions might undergo processes of natural selection that would result in cognitive adaptations that facilitated teaching and learning from teaching in subsequent generations, still teaching in earlier generations might prove to be cognitively challenging. This is a reason to develop deflationary models of the sorts of cognition that simple forms of teaching might require.

Social Challenges to Teaching

Independently of worries about the cognitive prerequisites of teaching, there are also grounds for thinking that at least some forms of teaching presuppose robust - and perhaps

evolutionarily recent - forms of social structure. For if we think of teaching involving linguistic communication, then a possibility emerges that deceptive individuals might use teaching not to help others, but to cheat them. For example, if we are members of competing groups, I might give you false information about the whereabouts of valuable resources, or faulty instructions about how to make the tools that would ensure your survival. If, by doing this, I can bring about your demise while safeguarding my survival, my deception could be adaptively advantageous.

Where communities are small, and communicators are dependent on one another to survive, there may be little incentive for communicators to deceive one another. Furthermore, even where communicators are not co-dependent, deception may be an aversively risky strategy - if, for example, the prospect of re-encountering those one has wronged is high (Axelrod, 1984; Sterelny 2012). However, as communities grow, and others' fates are less inextricably linked, the motivation to deceive may increase. This is particularly so when social networks become large enough for interactions between strangers to be common, since this means that potential deceivers can predict that they will not encounter their victims again. In such communities, if communication is to be a stable mechanism for the transmission of valuable information, there will need to be some way of limiting the extent to which it can be used to deceive.

One way in which individuals can deal with dishonest others is to avoid them, or ignore what they say. However, if the punishment for deception is not a group-wide enterprise, then peers unaware of who is dishonest may remain vulnerable to exploitation. Where the fates of group members are bound together, a group-led response will therefore be needed. One powerful remedy against dishonesty is the existence of social norms to regulate uses of communication. For example, it is widely agreed that some sort of knowledge norm governs the use of assertion (Brandom, 1983; Goldberg, 2011). Even if a norm exists that prohibits assertion of known falsehoods, though, this norm could be flouted by unscrupulous individuals looking to benefit themselves. For norms to be effective, they must be backed up by systems that enforce adherence to them. The practice of assertion consequently

depends on a set of social practices the existence of which discourages others from violating the norm of assertion, and punishes those who do - for example, by ostracising, censoring, or discrediting liars. In the absence of such practices, those who were dishonest about the quality of the goods that they sell, or who used their own influence to undermine their competitors and gain advantages for themselves, would be allowed to thrive. In a system in which dishonest practices were not curtailed, then at least in large groups (where relative anonymity made productive lying possible), the practice of assertion - and perhaps, by extension, teaching - would break down.

There are a number of ways in which the norm of assertion might be upheld. One possibility is via a system of reputation management (Enquist & Leimar, 1993; see also Dunbar 1996, 2004; Engelmann & Zeller, this volume). If groups of individuals systematically warned others off interacting with liars, then it would pay to be honest. However, while there are ways for safeguarding the honesty of assertions within a community, policing is imperfect and expensive to maintain in terms of both effort and cognitive development. Only those who are sensitive to the possibility of being cheated or exploited could take the steps needed to protect themselves, and doing so may be hard work.⁸ As a result, the possibility of deception poses further constraints on the emergence of teaching in phylogeny: if the practice of assertion requires the existence of social networks that enforce honesty on the members of a community, then at least in large communities assertion-led teaching may have been unstable and unreliable prior to the development of appropriately complex forms of norm enforcement.

A partial remedy to the possibility of deception would be the existence of individual mechanisms for guarding against epistemic exploitation. Recently Sperber and colleagues

⁸ Dunbar (1996, 2004) also argues that high orders of mental state attribution are necessary for gossip, since such abilities are a pre-requisite of Gricean communication. I have argued at length against this view (Moore 2014, 2015, under resubmission). However, it may be that high order mental state attributions are important for tracking deceptive intentions - and so play an important role in cheater detection practices - even if not intentional communication in general.

have argued that humans do not simply accept what they are told unquestioningly, but possess “a suite of cognitive mechanisms for epistemic vigilance” (Sperber et al., 2010, p.359) that they use to evaluate the information that others communicate to them. Humans typically track both the honesty and reliability of informants; and evaluate the content of what we are told for consistency with our other beliefs. Abilities like these are found not only in adults, but also in young children (see Harris & Corriveau, 2011). Sperber and colleagues argue that while some of these mechanisms are likely cultural, others are biological adaptations for survival in a communication-dependent environment (Sperber et al., 2010). However, as in the case of cultural safeguards against deception, any dependence upon the existence of individual adaptations for epistemic vigilance would place further constraints upon the stage of human history at which teaching could emerge.

A Solution: Demonstrating the Use of Tools

If pedagogy presupposes the existence of both cognitively sophisticated individuals and socially developed communities in which norms of assertion are enforced, then it may be that teaching could emerge only relatively late in hominin phylogeny. In fact, though, there are forms of teaching that do not require this. As a result, we can posit the emergence of teaching in phylogeny earlier than might otherwise have been supposed. A cognitively simple form of teaching that is also relatively robust against the threat deception is the case of demonstration (Sterelny, 2012; Moore 2013b; Buckwalter & Turri, 2014).

Suppose that I want to teach you how to make warm clothes by lining caribou skins with wolverine fur, and stitching the materials together using bone needles and sinew. I can do this just by engaging in the activity myself while soliciting your attention, in order to encourage you to attend to what I am doing (Moore, 2013b). To make particular aspects of the performance particularly salient - for example, the alignment of certain materials in the preparation of animal skins - I could additionally exaggerate particular aspects of my activity, by performing them more slowly or deliberately (consistent with what Brand and colleagues (2002) called *motionese*). In such cases, the content of my communicative act may be nothing more than “Look!”, or “Do *this!*”, or “Do *this* like *this!*” - where the

demonstratives would pick out either action sequences, or behavioural means that could be used to achieve the goals in hand. If a knowledgeable tool-user deliberately called the attention of a naïve observer in this way, and then demonstrated the use of her tool in order to help her interlocutor learn, she would satisfy clauses (1)-(3) of the characterisation of teaching given above. Additionally, if her student acquired generalisable information from this demonstration - like improved knowledge of how to make warm clothes - then the fourth criterion would also be met. The requirement here, then, is just that the teacher be able to perform a potentially simple communicative act with some sensitivity to the knowledge (or ignorance) state of her interlocutor, and with the intention to help rectify that ignorance. While sometimes ascertaining others' knowledge states can be difficult, in other cases it will be less so. For example, when one is in the process of performing some manual task inexpertly, the failure to use the required tools properly will often be visually salient.

Sterelny has argued that even simple forms of pedagogy may be deceptively complex:

A demonstration for teaching purposes is rarely identical to a utilitarian performance. Demonstrations are slowed down and exaggerated; sometimes crucial elements are repeated. One point of demonstration is to make the constituent structure of a complex procedure obvious, for often that structure is not obvious in practiced, fluid performance. (Sterelny, 2012, p.135)

Here one might worry that even simple forms of pedagogy therefore place strong demands on teachers' ability to break down and represent the separate stages of the actions that they teach (Sutton, 2013). However, in the most basic cases of pedagogy the teacher need not break down and represent separately the parts of her activity (Moore, 2013b). Even by soliciting attention to non-stylised acts produced without any accompanying verbal or gestural commentary, teachers would facilitate knowledge transfer to their pupils, by encouraging pupils to attend to and reflect upon what they were doing. In such cases, teaching need not even require that teachers go to great lengths to facilitate their pupils' learning. Thus, while Caro and Hauser (1992) originally suggested that teachers must pay a

cost to teach, in the most basic forms of teaching, this cost need not be high. Demands on a teacher's altruistic tendencies would also then be minimal.⁹

In addition to making only simple demands on a teacher's prosocial tendencies and representational abilities, action demonstrations are honest in ways that verbal utterances need not be. While it is easy to use words to deceive, in the case of demonstration success can usually be evaluated readily (Sterelny, 2012). For example, a demonstration of how to use a hammer to crack a nut can be known to be reliable if, following the demonstration, the nut has been cracked. While deception might sometimes occur, if early forms of teaching took the form of demonstrations, teaching could have emerged even prior to the emergence of both epistemic vigilance and societal mechanisms for norm enforcement.

In such communities, technology, language, and teaching might have developed together. First, by attending to and coming to appreciate the difficulties of their students in reproducing particular aspects of a performance, teachers might have learned how to break down the processes of their activity more carefully than before, in order to better demonstrate the required skills to their students. In doing so, they might thereby have gained new insights into their behaviour that paved the way for technical refinements and further technological developments. If teachers also innovated new utterance types to better discriminate between similar processes, the emergence of such forms of language might additionally help them to better understand the details of the practices in which they were engaged. The teaching interaction would therefore constitute a learning opportunity for teachers and pupils alike, thereby enabling further technological developments.

Conclusions

⁹ For discussion of whether and to what extent communication requires pro-social tendencies, see Tomasello (2008), and Moore (in press). While Tomasello argues that human communication is fundamentally cooperative, I argue that this need not be the case.

Teaching has played a fundamental role in the survival and expansion of the human species. Furthermore, since its most basic forms can be both cognitively and socially undemanding, its earliest forms may have arisen early in hominin phylogeny. In time, selective pressures may have given rise to adaptations that improved our ancestors' abilities to teach and learn from teaching; and new socio-cultural practices for disseminating and assessing information would additionally have arisen. It is likely that such practices further advanced the role of teaching in human communities, making possible ever more sophisticated forms of cultural technology. However, we need not assume that these advanced teaching techniques were present in early human communities in order to explain how teaching contributed to the survival of the earliest human communities.

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