Teaching can teach us a lot

Alex Thornton a,*, Katherine McAuliffe b

a Department of Experimental Psychology, University of Cambridge, Cambridge, U.K.
b Human Evolutionary Biology, Harvard University, Cambridge, MA, U.S.A.

IS IT TEACHING?

A rigorous definition is necessary to distinguish teaching from other forms of behaviour. From an evolutionary perspective, much of the interest in teaching arises because it is a specialized form of cooperation, whereby knowledgeable individuals invest in helping others to learn (Thornton & Raihani 2008). Caro & Hauser’s (1992) operational definition is critical in allowing us to discriminate such active assistance from cases of inadvertent social learning, where individuals acquire information from others who are simply going about their usual business and attempting to maximize their own immediate benefits. This parallels the distinction between cooperative behaviour that involves initial investments and is selected for its beneficial effects on recipients and by-product mutualism, where the self-serving actions of one individual inadvertently benefit another (Clutton-Brock 2002; West et al. 2007). The C & H definition has been enormously productive, spurring on a previously moribund area of research and setting the scene for empirical (Hoppitt et al. 2008; Thornton & Raihani 2008) and theoretical analyses (Riboli-Sasco et al. 2008; Fogarty et al. 2011), with impacts felt in evolutionary biology, anthropology and psychology (e.g. Tehrani & Riede 2008; Thornton & Raihani 2008; Hrdy 2009; Shettleworth 2010a). Nevertheless, B & R argue that strict adherence to the definition risks neglecting certain cases and, critically, that many instances of human teaching would be excluded.

In fact, we argue that, by placing the emphasis on measurable parameters, the C & H definition does rather a good job of capturing a diverse range of teaching interactions. The definition is divided into three main criteria: a knowledgeable individual (1) changes its
behaviour in the presence of a naïve companion in a way that (2) provides no immediate benefit, or imposes short-term costs, but (3) causes the companion to learn. In fact, the two cases B & R present as examples of the definition’s failure to capture ‘unambiguous cases’ of human teaching fit the criteria perfectly. In the first example, an Aché father (1) modifies his usual behaviour when crafting a bow by calling his son over, choosing a wide seat to accommodate the son and shifting his position periodically to allow the son a better view. These subtle behavioural changes (2) provide no current benefit to the father relative to his usual bow making when alone, and may well slow down the process. Finally, (3) the son learns a skill he may not have learned otherwise. In the second example, a school teacher (1) writes cursive on the blackboard in a classroom full of children and moulds the hand of a particularly poor pupil. This behaviour (2) is time consuming and provides no immediate benefits to the teacher, but (3) the children all learn something they would not have done otherwise, with the poor pupil perhaps showing particular improvements owing to the extra attention he receives. B & R are particularly concerned that in some cases the costs of teaching may be minimal and have no measurable impact on energy budgets. However, this issue is not as damaging to the C & H approach as they imply. The critical point is that there is no current benefit: the teachers’ changes to their usual routine serve no purpose other than to help others to learn. Thus, the C & H definition may not be as restrictive as B & R assume.

Nevertheless, there will clearly be genuine cases of teaching for which it proves difficult to generate unequivocal evidence. Indeed, we have previously made the point that, because of these difficulties, we currently underestimate the prevalence of teaching (Thornton & McAuliffe 2006; Thornton & Raihani 2008), and we have provided numerous suggestions as to methodologies that might improve data collection (Thornton & Raihani 2010). With the field as it currently stands, it is important to consider how we may treat cases where the evidence is suggestive but inconclusive. B & R provide no alternative standards by which to judge whether one individual goes out of its way to help another to learn and, in a curious reversal of Occam’s razor, suggest that it may be productive to grant ambiguous cases the benefit of the doubt until teaching is disproven. We feel that moving away from a clearly delineated and testable definition risks creating confusion and eroding standards of evidence in this nascent field. Moreover, there is a serious risk of inadvertently setting up a double standard, whereby special dispensation of weak evidence is granted to certain species simply by virtue of their large brains, presumed cognitive sophistication or phylogenetic proximity to humans. For instance, given inconclusive evidence for teaching from, say, a fish and a primate, there may be a danger that the latter evidence may be treated more generously, and that the underlying mechanisms may be assumed by default to be more complex. Similar concerns have been raised by other comparative researchers (e.g. Laland & Hoppitt 2003; Chittka & Niven 2009) and may be partly assuaged by adhering to carefully defined, measurable criteria. Rather than abandoning rigour, it is more productive to present inconclusive evidence for teaching with due caution and consideration for alternative explanations. Such cases can undoubtedly contribute to our growing understanding of teaching and will help to spur further research. However, there is little to be gained from accepting equivocal evidence for teaching uncritically if simpler explanations that do not require the active participation of knowledgeable individuals cannot be ruled out.

SENSITIVE TEACHERS

As B & R rightly point out, population-level analyses, such as those employed in accepted cases of teaching in tandem-running ants, Temnothorax albipennis, pied babblers, Turdoides bicolor, and meerkats, Suricata suricatta (Franks & Richardson 2006; Raihani & Ridley 2008; Thornton & McAuliffe 2006, respectively), may not capture instances where particularly sensitive teachers act to bring slow learners up to speed. This is not, however, a reason to abandon the operational definition, but instead should lead us to consider how best to test it, and to determine the level at which to conduct our analyses. The most direct route is to withhold or increase teaching experimentally for certain pupils and measure the impacts (Thornton & Raihani 2010). Experiments may also serve not only to establish the occurrence of teaching, but also to document the extent to which teachers are sensitive to their pupils’ needs. For instance, by interrupting bouts of teaching and experimentally inhibiting the capacity of pupils to learn, researchers have shown that knowledgeable tandem-running ants evaluate the progress of their pupils and adjust their movements accordingly (Richardson et al. 2007; Franklin et al. 2011). Where experiments are unfeasible, careful analyses of observational data can also be highly informative. In population-level studies, the potential impacts of individual variability may often be accounted through the use of mixed-effects models controlling for repeated measures of individuals. Where there is strong reason to suspect that teachers show sensitivity to individual pupils’ competence, within-subjects analyses would allow us to detect improvements in individual pupils’ skills relative to teachers’ investments. Further analyses could determine the impact of putative teachers by comparing learning by poor pupils that do or do not receive extra assistance. Thus, in B & R’s schoolteacher example, population-level analyses of the C & H criteria would reveal overall improvements in the children’s cursive skills in relation to their attendance of cursive lessons, and certainly relative to children that did not attend lessons. Similarly, at an individual level, we could compare the poor pupil’s skills before and after lessons and measure his learning trajectory relative to unschooled pupils of the same age.

COGNITIVE MECHANISMS OF TEACHING

One of B & R’s principal concerns is that the focus on the function of teaching detracts from our understanding of its cognitive foundations. However, adherence to a rigorous operational definition based on evolutionary function does not preclude in any way analysis of cognitive mechanisms. Indeed, it is very difficult to understand the mechanisms by which one individual helps another to learn if, in fact, we do not know that that is indeed what it is doing.

From a psychological perspective, much of the interest in teaching stems from the fact that much (although not all) of human teaching involves recognizing that a given individual lacks knowledge or skills, allowing flexible, targeted teaching across contexts. However, it is important to note that skill monitoring may be achieved through a number of different mechanisms. In many cases, responses to physical or behavioural cues may suffice for teaching to be targeted appropriately. Adult meerkats, for instance, respond to age-related changes in pups’ begging calls, presenting dead or disabled prey to young pups and live prey to old pups. They also monitor individual pups handling prey and will intervene by recapturing or modifying prey if a pup is having difficulty (Thornton & McAuliffe 2006). Similarly, tandem-running ants use tactile cues to ensure that teachers and pupils respond sensitively to one another’s movements, thus facilitating learning (Franks & Richardson 2006; Richardson et al. 2007; Franklin et al. 2011). These findings provide a powerful illustration of the power of simple mechanisms in generating seemingly complex behaviour. Such low-level mechanisms are increasingly recognized as having great importance in both human and nonhuman behaviour.
The mechanisms employed in some forms of human teaching are already doing, we can examine the domain-general mechanisms, which are already in place, to understand how it does so. Second, as many comparative researchers through two parallel lines of research. First, we can use the C & H definition to determine whether teaching occurs in a given species and, if so, to examine the underlying mechanisms. Moreover, productive experimental studies of the mechanisms involved in human teaching can proceed in animals that are not teaching.

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