

Kline commentary

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Potential subjectivity in the framework's application in comparative contexts

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We welcome Kline's attempt to develop an overarching framework to allow much needed collaboration between fields in the study of teaching. While we see much utility in this enterprise, we are concerned that there is too much focus on the behaviour of the teacher, without examining results or costs, and the categories within the framework are not sufficiently distinct.

Kline provides us with a comprehensive and thought-provoking review of our current understanding of teaching. We particularly welcome the focus on increasing dialogue between researchers in different disciplines studying the topic. The comparative study of teaching is still in relative infancy, with few cases of teaching in non-human animals having been identified (Fogarty, Strimling, &

Laland, 2011; Hoppitt et al., 2008; Thornton & Raihani, 2010). Increased dialogue between fields can only assist the furtherance of research in this area. By proposing a unified framework for the study of teaching, Kline aims to encourage better formalised and more constructive dialogue.

We agree with Kline that there are different mechanisms by which teaching can occur, however, we are concerned over the implementation of the framework as it currently stands. Thornton and Raihani (2010) propose a functional approach to identifying teaching, arguing that researchers need to examine the behaviour of learners as well as teachers, focus on the learning outcomes and examine the costs for teachers. By an increased focus on the behaviour of teachers during a teaching event, we fear that operationalizing Kline's framework in non-humans may depend too much on inference by the researcher about the purpose of the behaviour.

Let us take as an example the category *teaching by social tolerance*. Kline proposes that adults may be tolerant of other individuals in the population, particularly juveniles, specifically in order to facilitate learning in those individuals. If 'teachers' are deliberately creating a learning environment for 'pupils', this clearly goes beyond inadvertent social learning and may qualify as a teaching event – 'opportunity teaching' in Caro and Hauser's (1992) classification or 'teaching by local enhancement' in Hoppitt et al. (2008). However, the reason for social tolerance between individuals is an empirical question itself. Tolerance varies between species (de Waal & Luttrell, 1989) and within species (Burkart & van Schaik, 2010), and may be influenced by the culture of the group (Sapolsky, 2006). There may also be many different reasons why animals are differentially tolerant towards other individuals, including kinship bonds (Sueur et al., 2011) and strategic allegiances (Byrne & Whiten, 1988) without active teaching occurring. This differential social tolerance may increase the likelihood of inadvertent social learning as those animals that are more tolerant of one another may produce more opportunities for social learning to occur, a phenomenon known as 'directed social learning' (Coussi-Korbel & Fragaszy, 1995).

Care should, therefore, be taken to ensure that the behaviour that is identified is due to active teaching and not inadvertent social learning, driven by the learner. Such a distinction may be relatively easy to make in human populations, where individuals may be asked why they are acting in a particular manner, but in non-human species there remains a need to rule out alternatives through empirical methods (Thornton & Raihani, 2010). Functional approaches to the study of teaching, with a focus on teaching costs, learning opportunities and learning outcomes should reduce the need for inference and subjective judgement on the part of researchers. For example, without considering these things would Kline et al. describe the tolerance of nut-cracking tufted capuchins for the presence of scrounging juveniles (Ottoni, Dogo de Resende, & Izar, 2005) as teaching? In reality it may be of direct benefit to individuals (and thus not 'costly' teaching) to tolerate scrounging if (1) there is a chance the juveniles are their own offspring, and (2) the loss of nut-meat is less than the opportunity cost of fending off juveniles. An alternative reason why this would not qualify as teaching may be seen from the juvenile (or potential pupil's) point of view: there is conflicting evidence regarding the utility of scrounging in learning outcomes (Caldwell & Whiten, 2003; Giraldeau & Lefebvre, 1987). Thus, even were it to be documented that adults are more tolerant of juveniles during nut-cracking than at other times, this evidence alone is not sufficient to classify it as teaching.

The framework proposed has the advantage that it has few categories, allowing initial comparison between species, and research fields, to be more straightforward. We are concerned, however, that in studies with non-human species, categories may not be as intuitive as Kline has proposed. To illustrate, consider an example given by Kline et al. for *teaching by stimulus or local enhancement*. Otters and sea lions drag their offspring into the water to ensure that they learn to swim. It is far from clear that this corresponds to stimulus enhancement, as described in the social learning literature, in which attention is drawn to an object or part of an object (Whiten & Ham, 1992). While pupils will have their attention drawn to the water, placing an animal in water to ensure that it swims would equally appear to fit within Kline's *teaching by opportunity*

provisioning category. In this category, teachers create the opportunities for pupils to practice, using asocial learning, that would not otherwise exist. By placing a pupil into water, it could be equally argued that the teacher is creating an opportunity that the pupil would not otherwise encounter. We propose that this represents a broader deficiency with the framework, in which categories are not exclusive and independent. The strength of a comprehensive framework is that it can provide researchers with an objective means of categorising these mechanisms, even if multiple mechanisms are occurring in one teaching event. The framework's utility may be reduced due to the issue of the proposed mechanisms being judged differently by different researchers.

There is much to commend Kline's attempt to construct a framework that would allow a comparative and collaborative approach to the study of teaching. However, the merit of any interdisciplinary approach must be in how applicable it is to all fields involved. We have concerns that, particularly for comparative researchers, the framework as currently proposed may prove to be overly reliant on subjective judgement and inference, reducing the comparative and collaborative utility of the exercise.

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