Mind, brain, and teaching. Some directions for future research

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Abstract: In line with Kline's taxonomy, highlighting teaching as an array of behaviors with different cognitive underpinnings, we advocate the expansion of a specific line of research on mind, brain, and teaching. This research program is devoted to the understanding of the neuro-cognitive mechanisms and the evolutionary determinants of teaching skills, with the ultimate goal of helping teachers improve teaching quality.

In cognitive science, although progress has been made in dissecting the neurocognitive mechanisms underlying learning, little is known of those supporting teaching. This has become especially untenable in the light of mounting evidence that teachers have an important, long-lasting impact on their pupils; for example, econometric studies on the "teacher effect" extending into real life indicators of socioeconomic status, including: retirement plans, salary, and house ownership (Bressoux & Bianco 2004; Bressoux et al. 2007; Chetty et al. 2011; Kane & Staiger 2008; Konstantopoulos 2007; Nye et al. 2004; Rivkin et al. 2005). Educational research and mind and brain sciences have strengthened their cooperation during the last decade, to the extent that a new field of research is developing (Brabeck 2008; Fischer et al. 2007; Pasquinelli 2011, 2013a, 2013b). In this commentary, we advocate the development of a specific line of research on mind, brain, and education, with a translational aim and an evidence-based attitude at its core, devoted

to the understanding and betterment of teaching skills (see also: Battro 2010; Rodriguez 2012; Strauss & Ziv 2012).

Kline's framework for going beyond traditional sector honed definition theories to observe teaching practices, across species and across cultures, provides a base from whence we can ask the questions that have historically driven a wedge between nonhuman and human teaching debates:

1. whether there is something like a "teaching instinct" in humans (teaching as a natural cognitive ability, as hypothesized in Csibra (2007); Csibra & Gergely (2009); and Strauss (2005), and
2. whether and how the teaching instinct relates to or interacts with other cognitive functions (Barnett 1973; Olson & Bruner 1996; Pearson 1989; Premack 1984; Tomasello, Kruger, Ratner 1993).

In order to answer these questions, we believe that a promising approach would be to use the experimental tool kit of cognitive psychology and neuroscience to implement quantitative studies. First, we should develop solid psychometric measures for evaluating teaching abilities, and then run correlational studies (based on interindividual differences), assessing whether the success of professional as well as nonprofessional individuals in complex teaching tasks is related to their skills in the cognitive domains that are classically thought to be relevant for teaching (Theory of Mind, empathy, metacognition, general intelligence). This research should also compare kin versus non-kin use of Kline's taxonomy types in adult–child interactions, and include individuals with atypical development. One interesting population would be that characterized by a nonsevere form of autism, Asperger syndrome: a neurodevelopmental disorder characterized by poor Theory of Mind and cognitive empathy, but with preserved metacognition, affective empathy, and general intelligence (Charman et al. 2011). Studying teaching abilities under different neurocognitive constraints could help refine the role of specific cognitive skills in teaching. Another method used in cognitive psychology to assess the relationship among different cognitive functions is that of training. In order to isolate the cognitive determinants of the "teaching instinct," this research program should, therefore, include training studies aiming at improving either Theory of Mind, empathy, or metacognition, and measuring to what extent a transfer can be observed to teaching skills. Finally,

comparing the data from objective studies with the subjective views of teachers, their folk theories of teaching and learning (Dekker et al. 2012; Olson & Bruner 1966; Pasquinelli 2012; Strauss 2001) and one's own self-assessment, could be key for gaining valuable insights into discrepancies between facts and intuitions about teaching.

It also seems reasonable that research on teaching should broaden its view so as to account for mechanisms that do benefit the teacher as much as the learner, by considering that teaching allows the teacher to gain cognitive advantages, and perhaps also prestige, leadership, and/or social status. Historically, the functional characterization of teaching in animal studies (Caro & Hauser 1992) explicitly excludes behaviors benefiting the teacher. However, as Kline states, "If there are costs of teaching, then there must be some benefit to the teacher, in order for teaching to evolve." Kline suggests that the benefits of teaching are indirect, the pupil being a gene carrier, protector, or mate (see also Fogarty et al. 2011; Hoppitt et al. 2008; Skerry et al. 2013). However, it is our belief that teaching also serves purposes that are advantageous to the teacher himself (beyond indirect gains and kin selection). For example, it has been observed that learning in order to teach (i.e., preparing for teaching) enhances content understanding and retention as compared with studying for pure learning (Bargh & Schul 1989), and research on peer teaching suggests that both teacher and learner show benefits (Brown & Palincsar 1989. More research that focuses specifically on the teacher's gains is required.

Furthermore a respected view in evolutionary biology characterizes communication and signaling as serving both altruistic and egoistic aims, namely: influence upon the addressee, that is, manipulation of cospecifics and prey behavior. The view predicts the coevolution of skills for persuading and for resisting persuasion when detrimental (Dawkins & Krebs 1978; Krebs & Dawkins 1984; Fernald, 1992). The prediction seems to be confirmed, in the case of humans, by the observation that persuasion skills coexist with a complex of vigilance mechanisms upon the information given aimed at the information giver (Harris & Corriveau 2011; Sperber et al. 2010). If teaching behavior also proffers advantages to the teacher, a cost-based calculus might not be enough to predict when more complex (and costly) forms of teaching will spontaneously appear. A set of questions then follows.

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1. Which are the specificities of the persuasion-related displays that teachers commonly employ, in comparison with salespersons' and leaders' techniques aimed at persuading their audience?
2. What is their impact on learning outcomes (understanding, retention)? Are there other measurable effects on the teacher's prestige, status, and position?

Answering these questions, and more generally acquiring a better understanding of the cognitive underpinnings of teaching behaviors, is a necessary condition for explaining, and taking advantage of, the "teacher effect," benefiting education by enhancing the efficacy of professional development (Harris & Sass 2011; Yoon et al. 2007) and for developing strategies and technologies that exploit and supplement "natural" teaching.

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