

“Teaching as a natural cognitive ability: Implications for ways to think about educational research on teaching” (versión en inglés)

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Teaching Is A Natural Cognitive Ability Among Humans: A Research Agenda

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Talk Outline

- **Teaching is a natural cognitive ability among humans**
 - **What is teaching?**
 - **Multidisciplinary agenda**
 - **What is a natural cognitive ability?**
 - **Developmentally reliable**
 - **Teaching follows 2 developmental courses**
 - **3 missing pieces: research directions**
 - **how we learn**
 - **how teaching causes learning**
 - **connections to actual teaching**
-

Teaching Among Humans Is A Natural Cognitive Ability

- **I will give a broad panoramic overview**
 - **Some details towards the end**
-

Human Teaching

- Remarkable human achievement
 - Allows efficient transfer of information between conspecifics
 - Allows cumulative human culture to exist: Tomasello ratchet wrench analogy
 - Other side of learning coin
 - Under the radar in cognitive and neurosciences
-

Questions About Teaching

Questions about teaching:

Ancient Greek philosophers asked: what is good teaching?

Some people from education ask: how can we improve it?

My questions:

why do we teach in the first place?
what has to be in place cognitively for teaching?

My claim:

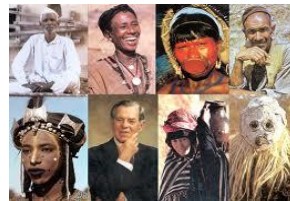
**Teaching among humans is a
natural cognitive ability**

Multidisciplinary Challenge

- **Human ontogenesis** (Davis-Unger & Carlson, 2008 a, b; Strauss & Ziv, 2012; Strauss et al., 2002)



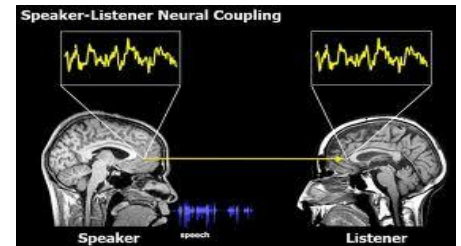
- **Anthropology** (Greenfield, 2004; Hewlett, Fouts, Boyette, & Hewlett, 2011)



- **Cultural evolution** (Mesoudi, Whiten & Laland, 2006)
- **Cognitive evolution** (Shultz, Nelson & Dunbar, 2012)
- **Nonhuman animal teaching** (Thornton & Raihani, 2008, 2010)



- **Brain sciences (Battro, 2007, 2010; Rodriguez, 2012)**



- **Artificial intelligence (Dessus, Mandin, & Zampa, 2008)**
- **Cognitive archeology from prehistoric periods (Chazan, 2012)**



- **Psycholinguistics (Bartsch, Wright, & Estes, 2010)**
- **Philosophy (Scheffler, 1965)**
- **Intelligent tutoring systems (Kopp, Britt, Millis, & Graesser, 2012)**
- **Computer-human interface systems**
- **silicon-biology interfaces**

Multidisciplinary Challenge

- **Teaching often studied as a way to understand phenomena**
 - **What separates human culture from non-human culture (traditions)**
 - **It is teaching that needs to be understood (and described)**
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Multidisciplinary Challenge

- **We may be on the cusp of a paradigm shift in understanding teaching**
 - **Scientific view**
 - **Based on cognitive sciences**
 - **enormous strides in recent past**
-

What is a Natural Cognitive Ability?

- ❑ **Species unique**
 - Biological evolution (phylogeny)
- ❑ **Universal (species typical)**
 - Anthropology
 - ❑ Cultural co-evolution
 - Archeology
 - ❑ Prehistoric artifacts
- ❑ **Ontogeny: Developmentally Reliable**
 - Learned without instruction
 - Young children master it at an early age
 - Young children master it effortlessly

Sometimes so easy and natural that we usually don't think about it

Language is a classic example.

Teaching may be, too.

Right under our noses.

What is Human Teaching, Anyway?

Psychological definition

“When faced with the question of determining whether an action is a teaching action, as opposed to some other action such as reciting, talking or acting in a play, it is the *intention* of bringing about learning that is the basis for distinguishing teaching from other activities. The *intention* the activity serves, then, is a part of the meaning of the concept...” (italics added)

Pearson, A. T. (1989). The teacher: Theory and practice in teacher education. New York: Routledge



What is Teaching, Anyway?

The psychological view involves:

- **Intentionality**

- **Intention to cause learning in other's mind**

- **Knowledge (gap)**

- **Close the gap in knowledge, understanding, etc.**

“Mind the gap”!

Ontogenetic Developmental Claim

Two developmental courses

Separate yet intertwining



- **Understandings of learning**
- **Understandings of teaching**
 - **From birth through adulthood**

- **Actual and proto-teaching**
 - **Emerges around age 1**

Ontogenesis of Teaching:

Cognitive *Understandings* Enable Teaching

Age

Cognitive Templates

Authors

Birth

Natural receptive pedagogy

Gergely,
Csibra



9 month

Person-object-person
Triadic revolution

Tomasello
(1993);
Ando (2009)



Ontogenesis of Teaching:

Understanding Cognitive Prerequisites

- ❑ **Knowledge gap**
 - **Who do you teach?**
 - ❑ An ignorant or knowledgeable person?

 - ❑ **Sources of Knowledge**
 - **Perceptual access**
 - ❑ Visual (demonstration)
 - ❑ Auditory (telling)

 - ❑ **Intentionality**
 - ❑ Intention versus outcome
-

Ontogenesis of Teaching:

Understanding Cognitive Prerequisites

<u>Age</u>	<u>Prerequisites</u>	<u>Authors (incomplete)</u>
3 years	Knowledge gap	Strauss et al. (2002)
	Sources of knowledge	Strauss et al. (in preparation)
5 years	Intentionality	Ziv, Solomon, & Frye (2008)

Ontogenesis of Teaching: Development of Proto and Actual Teaching

<u>Age</u>	<u>Teaching Abilities</u>	<u>Authors</u>
1 year	Proto-teaching Episodic (non-teaching)	Ando (2009); Agaki (2004) Liszkowski et al. (2006, 2008)
1½ years	Request teaching, e.g., asking for names	Strauss & Ziv (2001)
3½ years	Teaching appears generalizeability (teaching)	Strauss et al. (2002); Ziv, Solomon, Strauss, (in preparation); Davis & Carlson (2009a,b)



Ontogenesis of Teaching: Development of Proto and Actual Teaching

<u>Age</u>	<u>Teaching Abilities</u>	<u>Authors</u>
5 years	Explanations ToM knowledge states	Strauss et al. (2002)
7 years	Contingent teaching (on-line ToM)	Wood et al. (1995); Ziv, Solomon & Strauss (submitted)
??	Socratic teaching	Bar Tikva (2010); Battro et al (2011)
Adults	Mental models of direct transmission	Strauss (2001; 2012); Strauss & Shilony (1994)

Ontogenesis of Teaching: Development of Proto and Actual Teaching

- **Children ages 3 and 5 teaching a game**
 - **Let's see a video clip**
-

Interim Summary about Ontogenesis: Knowing About Teaching and Teaching

Long and complex ontogenetic course

- Birth: Template (receptivity to teaching)
- 9 months: Triadic revolution
- Age 1: Proto-teaching
- Age 1½: Request teaching
- Age 3: Actual teaching (demonstration)
- Age 3: Understanding of knowledge gap & sources of knowledge
- Age 5: ToM classic and teaching
- Age 5: Actual teaching (explanation)
- Age 7: Contingent teaching
 - On-line ToM
- ~~Mental models among adults~~



A Brief Return To My Question

What has to be in place cognitively for teaching to take place?

- **Understanding of:**
 - **How learning occurs**
 - **How teaching causes learning**
 - **Their relations to actual teaching**
-

How Do Understanding of Teaching (ToM) and Actual Teaching Intertwine?

- **Conventional wisdom**
- **The two are connected**
 - **Premack & Premack (1996): “To teach effectively, one individual must understand what another *sees, knows, wants, and is trying to achieve*” (italics in original, p. 308).
 - In other words, actual teaching relies on ToM**
- **OK, but doesn't go far enough**



What We Know About Children's Understanding of Teaching (ToM)

- **Knowledge gap: who do you teach?**
(Strauss, Ziv & Stein, 2002)
 - **Miriam is a teacher. She knows how to tie shoe laces. Tom doesn't know how to tie his shoelaces. Vera knows how to tie her shoe laces. Who will the teacher teach? Tom or Vera?**
 - **Children at age 3,6 know that the teacher will teach Tom, where there is a knowledge gap.**
-

What We Know About Children's Understanding of Teaching (ToM)

- **Intentionality** (Frye & Ziv, 2005; Ziv, Solomon & Frye, 2008)
 - **Story 1: intends to teach someone**
 - **Story 2: doesn't intend to teach someone**
 - **Both stories, outcome is learning or its lack**
 - **Children age 3,6 judge on learning outcomes: no learning, no teaching even if teaching is intended**
 - **Children age 5,6 judge on intention even if no learning**
-

What We Know About Children's Understanding of Teaching (ToM)

- **False belief** (Strauss et al., 2002; Davis-Unger & Carlson, 2008 a, b)
 - **Underestimation**
 - Child knows how to ride a bike
 - Teacher thinks child does not know that
 - Teach child to ride a bike?
 - **Children age 3,6: no (no ToM)**
 - **Children age 5,6: yes (ToM)**
-

Summary of What We Know About Children's Understanding Teaching (ToM)

■ Knowledge gap

- Children age 3,6 understand

■ Intentionality

- Children age 3,6 learning outcomes
- Children age 5,6 intentionality

■ False belief

- Children age 3,6 no ToM
 - Children age 5,6 ToM
-

Children's Teaching Strategies when Actual Teaching

- **Children's developing teaching strategies**
(Strauss & Ziv, 2012)
 - **Very rich strategies**
 - **Demonstration age 3**
 - Exaggerate
 - Slow down
 - Break up task into parts
 - **Explanation age 5**
 - **Contingent teaching age 7**
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Empirical Relations Between ToM about Teaching and Teaching Strategies

- **Hypothesized but rarely tested** (Strauss et al., 2002; Davis-Unger & Carlson, 2008 a, b)
 - **Found correlations between understanding of teaching (ToM) and actual teaching.**
 - **Seems to be in accord with conventional wisdom assumptions that the two are related.**
 - **Looks good. But is it?**
-

Two Problems With These Findings

■ **First problem**

- ❑ **Correlations do not mean that they are related conceptually**
 - ❑ **Perhaps two systems that develop independently**
 - ❑ **Theory needed to show why they should be interdependent developing systems**
-

Two Problems With These Findings

- **Second problem**
 - **Deeper than first**
 - **How we go from beliefs about something to actually doing it?**
 - **Teaching is a case in point about the problem**
-

Second Problem: Going from Knowing to Acting on that Knowledge

- **Unclear why current conceptions of ToM are related to how children actually teach**
 - **A child understands**
 - **Knowledge gap (a more knowledgeable person teaches a less knowledgeable one)**
 - **Intentionality (the intention to teach is a defining characteristic of teaching)**
 - **False belief (teaching is based on what the teacher believes the learner's knowledge state is)**
 - **None of these suggest *how* she could actually teach**
 - **Demonstration**
 - **Explanation**
 - **Contingent teaching**
-

Houston, We Have A Problem

- **So how do we get out of the problem?**
 - **Gergely & Jacob (2012)**
 - **Two belief systems**
 - **Theoretical rationality**
 - **Practical rationality**
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A Potential Solution to the Problems

- **Theoretical rationality**
 - **Property of a person's belief system**
 - **Example: teacher believes that pupils have information processing constraints on their learning**
 - **Theoretical belief is rational if consistent with other beliefs held by that person.**
-

A Potential Solution to the Problems

- **Practical rationality**



- **Property of a person's decision system**

- **Example: a teacher demonstrates how to assemble a carburetor; pupil doesn't learn; the teacher now breaks down the assembling into small incremental steps**

- **A decision system is rational if it selects an action likely to maximize the person's desire or preference**

- **In the case of teaching, the desired goal is to cause learning in the pupil's mind.**

A Potential Solution to the Problems

- **How can these two kinds of rationality be connected?**
 - **Main idea: the decision made by the decision system (practical rationality) draws on the belief system (theoretical rationality) held by the person.**
 - **Case presented above: theoretical rationality holds that pupils have information processing constraints**
 - **The teaching decision (practical rationality) to break the assembling of the carburetor into small parts is based on that belief**
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Another Brief Return To My Question

What has to be in place cognitively for teaching to take place?

- **Understanding of:**
 - **How learning occurs**
 - **How teaching causes learning**
 - **Their relations to actual teaching**
-

How Learning Occurs

- **Research that comes close to what I am discussing**
 - **children's learning of school subject matter (such as science, math, history)**
 - **what children understand about the mind and representations (false beliefs, deception, desires).**
 - **what people understand about motivation and learning (Dweck, 1986, 2002; Elliot & Dweck, 1988)**
 - **what people understand intelligence is (Stipek & Gralinski, 1996).**
-

How Learning Occurs

- **Even closer**
 - **children's understandings of absence (ignorance) and the presence (knowing) of knowledge.**
 - **what children know about *when* they learned. For example, a child is told something she didn't know and afterwards was asked when she learned that new knowledge.**
-

How Learning Occurs

- **Closest (?)**
 - children's understanding of *how* they learn.
 - children asked if they can know the contents of a drawer when they see the contents, are told about them or infer them from clues given (Gopnik & Graf, 1998).
 - not what I have in mind; *don't* test children's understanding of *how* they learn
 - Do test understanding of *conditions under which learning occurs*.
 - when we see, when we hear, when we infer

How Learning Occurs

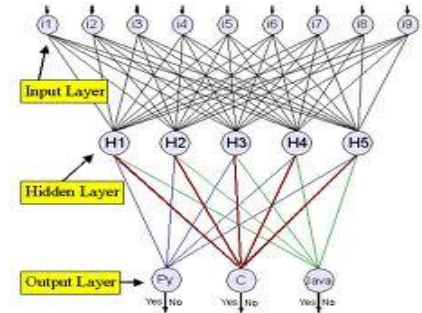
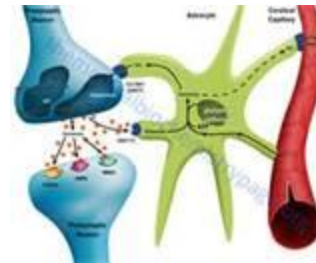
- **So, one missing piece of theoretical rationality**
 - **We don't know about children's developing understanding of *how* we learn**
 - **Research project**
-

How Teaching Causes Learning

- **A second missing theoretical rationality piece**
 - **Children's developing *understanding of teaching***
 - How teaching causes learning
 - **Epistemological assumptions about knowledge change**
 - **Action-at-a-distance**
 - **Knowledge already in mind**
 - **Connect new to old knowledge**
 - analogy
 - disequilibrium
 - **If not in mind, drive it in through repetition**
-

How Teaching Causes Learning

- **Don't expect hearing about**
 - Biochemistry of neurons
 - Neural networks
- **Do expect to hear metaphors about**
 - Connecting new knowledge to old
 - Repetition drives new knowledge into memory
- **Adult teachers have a mental model about these**
- **Research Project:**
 - What is the developmental trajectory of understanding of how teaching causes learning?



Research Agendas

$$2 + 1 = 3$$

- **2 research agendas about children's developing understanding of**
 - *how we learn*
 - **how teaching causes learning**
 - **1 missing piece and research agenda**
 - **How these theoretical rationality understandings are related to practical rationality**
 - **Relations between understanding learning and teaching and how we actually teach**
-

Summary about Theoretical and Practical Rationality

- **Two strands intertwine**
- **Practical draws on theoretical**
- **3 missing pieces: understanding how**
 - 1. learning occurs
 - 2. teaching causes learning
 - 3. both are related to actual teaching
- **Three research programs**
- **Could enhance a scientific modern view of teaching**



Talk Summary

- **Teaching is a natural cognitive ability among humans**
 - **What is teaching?**
 - **Multidisciplinary agenda**
 - **What is a natural cognitive ability?**
 - **Developmentally reliable**
 - **Teaching follows 2 developmental courses**
 - **3 missing pieces: research directions**
 - **how we learn**
 - **how teaching causes learning**
 - **connections to actual teaching**
-