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Natural Pedagogy and Social Interaction

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Abstract

I briefly review several debates between standard cognitivist theories and more embodied (and enactive) theories in the area of social cognition, especially in the context of developmental studies and recent false-belief experiments with young infants. I suggest that the concept of natural pedagogy (Csibra & Gergely, 2009) fits best with the more embodied and enactive accounts of social cognition, and that it provides a good model for an embodied learning processes.

Keywords: *Natural Pedagogy – Social Cognition – Interaction – False-belief Tasks – Ostensive Communication*

Pedagogia naturale e interazione sociale
Rivisito brevemente vari dibattiti che intercorrono tra le teorie cognitive standard e le teorie embodied *(e* enactive*) all'interno dell'area della* social cognition*, specialmente nel contesto dei* developmental studies *e dei recenti* false-belief experiments *effettuati con bambini piccoli. Suggerisco che il concetto di* natural pedagogy *(Csibra & Gergely, 2009) funziona meglio con una teoria* embodied *e enactive della cognizione sociale e che esso fornisce un buon modello per un processo di apprendimento* embodied learning*.*

Parole chiave: *Pedagogia naturale – Cognizione sociale – Interazione – Compito della falsa credenza – Comunicazione ostensiva*

Introduction

In many, and perhaps most cases, we learn from others. That makes learning a highly intersubjective phenomenon, and suggests that a good understanding of the learning process, and how pedagogical practice should happen, can benefit from a better understanding of intersubjectivity. Studies of intersubjectivity and social cognition have been advanced in recent years in

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approaches that have integrated phenomenology with developmental psychology and cognitive neuroscience. This integration has occurred around the concept of embodied cognition (EC), and can be found in the work of phenomenologists who draw from the insights of Husserl, Heidegger, and Merleau-Ponty (e.g., Varela, Thompson & Rosch, 1991; Gallagher, 2005; Ratcliffe, 2007). This turn to a phenomenologically-inspired EC, however, has been controversial from the perspective of standard cognitive science which understands cognition in terms of computational models, internal representations, and subpersonal processes that all occur "*in the head*" of the individual cognizer. In contrast, embodied approaches champion the constitutive role of non-representational, extra-neural bodily and environmental (physical, social, and cultural) factors. The cognizer is an embodied agent rather than a central processor, and cognition is enacted in the movements and actions the agent *in-the-world* is capable of performing (Thompson, 2007; Hutto & Myin, 2013). For some theorists, cognition is an extensive event – incorporating tools, technologies, and even institutions in the processes that constitute perception, memory, thinking, and problem solving (Clark & Chalmers, 1998; Clark, 2008; Menary, 2009; Gallagher, 2013).

It's important to note, however, that the now common mantra that cognition is embodied, environmentally embedded, enactive, and extended hides a number of important disagreements among EC theorists that concern just these terms. What does embodiment mean, and how essential is the body itself (rather than just the brain, or possible prosthetic enhancements or replacements)? Is cognition entirely non-representational (as the enactivists claim), or does it depend on some minimal, action-oriented representations (as some extended mind theorists tend to claim)? Precisely how should we define the role of the environment and what is the nature of the coupling between body and environment? All of these issues remain unsettled and are the topics of ongoing debates (see, e.g., Kiverstein & Clark, 2009). Apart from the often fascinating empirical discoveries, part of what makes cognitive science an exciting theoretical field is that in almost every corner there is ongoing debate among orthodox cognitivists, embodied theorists, enactivists, extended minders, etc., and these debates range in an interdisciplinary way across disciplines such as psychology, neuroscience, linguistics, philosophy of mind, AI and robotics, and phenomenology.

My focus in this paper is on the topic of social cognition, and specifically

as it relates to questions of pedagogy. My own view is that research on EC should inform theories of social cognition, and that this has practical implications for pedagogy. In the following sections I defend a phenomenologically-informed theory of embodied social cognition (although without offering the full account that this topic deserves), and relate it to the concept of natural pedagogy (Csibra & Gergely, 2009). I also want to emphasize, however, that intersubjectivity itself is just as basic as embodiment when it comes to explaining cognition and learning. Any attempt to explain cognition purely in terms of factors (embodied or otherwise) that do not include social or intersubjective factors remains philosophically autistic (Gallagher, 2009). In this respect, the topic of *social* cognition is not simply a sub-topic within the topic of cognition; rather, it holds a central place in any full account of the mind.

The social cognition debates

In the midst of the debates about EC one finds an ongoing, and equally contentious discussion of social cognition and intersubjectivity. EC approaches to questions about how we understand others come into conflict with more standard and cognitivist views of "theory of mind" (ToM), which include so-called "theory theory" (TT) and simulation theory (ST). TT and ST have their own debates, but these ToM approaches also find themselves pitted against more recently developed EC approaches. One such, phenomenologically-inspired EC approach is sometimes referred to as *interaction theory* (IT). In brief, the differences between these approaches can be summarized as follows.

TT: our understanding of others is based on our ability to mindread, that is, to attribute mental states to others by making theoretical inferences guided by folk (or common-sense) psychology. That is, by appealing to the various rules or platitudes of folk psychology, we can explain and predict the other person's behavior by attributing to her certain beliefs and desires. We can think of this as a *third-person* process since our use of theoretical inference is based on a third-person observation of the other.

ST: our understanding of others depends on a form of mindreading based, not on folk-psychological inferences, but on our ability to use our own mind as a model to simulate the mind of the other. We put ourselves "in the shoes" of the other, ask what we would believe or desire in that

situation, and then we explain or predict her behavior by projecting such mental states to her. Although this process is usually characterized as beginning with a third-person observation of the other's behavior, we can think of simulation as involving a *first-person* perspective since our understanding is based primarily on using our own mental processes as a model.

IT: our understanding of others, in most of our everyday encounters, is based on embodied interactions with them in shared contexts. In our interactions with others we perceive their bodily postures and movements, their gestures, facial expressions, vocal intonations, and actions in highly contextualized pragmatic and social situations, and we respond to them in similar action-oriented ways. In most of our everyday encounters the information we gain from these interactions is sufficient for understanding others, and no further processes of mindreading are required. If in some circumstances we do need a more sophisticated understanding of their motives or reasons for acting as they do, we draw on a rich narrative background rather than a theory or a simulation routine. According to IT, we can think of the processes involved in intersubjectivity as *second-person* processes since they depend not simply on one individual's internal mechanisms, but require the dynamic interaction of more than one person.

IT draws from phenomenological, developmental, and neuroscientific evidence to argue against TT and ST, and to substantiate its own claims. TT and ST tend to reject phenomenology as a good guide to the processes in question, since, for both TT and ST, most, if not all, of the important processing happens sub-personally, in functional theory-of-mind mechanisms (ToMMs) or mirror neurons. Accordingly, whatever "seems" to be happening at the conscious or personal level is simply beside the point (e.g., Spaulding, 2010; Jacob, 2011). For their part, phenomenologists, without denying that the brain is dynamically involved in intersubjective processes, defend the idea that intersubjectivity is something that happens at a personal (or inter-personal) level, and understanding such personal-level processes is required to explain whatever is happening on the subpersonal level (Gallagher, 2013). I won't try to resolve this aspect of the debate here. Rather, I'll focus on the developmental and neuroscientific evidence. In this respect there is some agreement about what the important data actually are; the disagreement concerns how to interpret the data.

For example, there is general agreement that mirror neurons have something to do with social cognition. Mirror neurons activate under two con-

ditions: when I, as an agent, perform an intentional action, and when I, as an observer, perceive you perform that same action. Almost everyone agrees on the neuroscience of mirror neurons. ST has argued that these neurons play a central role in the simulation process – mirror neurons in the motor system are simulating (Gallese, 2001; Goldman, 2006), and thereby helping us to understand the actions of others and to mindread their intentions. TT, while not denying that the mirror system is involved in some low-level action understanding, nonetheless contends that the real action takes place in other areas of the brain (medial prefrontal cortex, precuneus, among others) activated for mindreading mental states such as beliefs and desires (e.g., Saxe & Kanwisher, 2003). IT, while not denying that the mirror system is involved, disputes the idea that mirror neurons are simulating, and instead argues that mirror neuron activation is part of or preparatory for an enactive (action-oriented) response to the other person's actions (Gallagher, 2007; Gallagher & Zahavi, 2012). In addition to debates about how to interpret mirror neuron activation there are also debates about the ontogenetic status of mirror neurons. Either they are genetically innate, the product of long-term evolutionary processes (indeed, mirror neurons were first discovered in macaque monkeys), or they owe their specific function to processes that involve learned associations (e.g., Catmur, Walsh & Heye, 2007). This aspect of the debate suggests that developmental issues are important to consider.

Developmental studies over the past 40 years have made it clear that our traditional understanding of infant development has been woefully inadequate – and this includes some aspects of the Piagetian tradition, which has had a significant impact on the field of educational theory and practice. In developmental studies of social cognition there is also general agreement on important data, but again there is controversy concerning their interpretation. Looking closely at one of these disagreements will get us closer to issues that relate more directly to pedagogy.

The new false belief experiments

Standard false-belief tests point to the ages of 3-4 years as significant since on average, at around 4 years, children begin to be able to recognize when another person has a false belief about a particular situation. One interpretation is that children around 4 years attain a theory of mind (ToM), which allows them to "mindread" the other person's mental states. TT conceives

of the child at this age gaining ability in using folk psychology to make inferences about the other person's mental states. Despite claims made by theory theorists about the implicit (or even subpersonal) nature of the theoretical inference involved (e.g., Lavelle, 2012; Spaulding, 2010), the standard false belief tests that are cited as evidence for such inferential processes are completely explicit. The child is asked to observe a situation and to make a conscious judgment about where some third person (or usually puppet, doll, or cartoon character) will look for a toy that has been moved, unbeknownst to that person. Accordingly, such tests involve 3rd person, observational strategies, and are designed to require a personal-level inference. On average, the three-year-old fails the test and the four-year-old passes it. What is tested in such experiments (namely, the child's ability to mindread the third person with whom they are not interacting), and the explanations of how this happens completely ignore the successful second-person interaction that happens between child (including the three-year old child) and experimenter. As we'll see, this is an important point if we are to explain why the three-year old fails the test, while younger infants seemingly pass false belief tests.

In regard to the latter, recent experiments (Onishi & Baillargeon, 2005; Baillargeon, Scott, & He, 2010) purportedly show that 13- and 15-month-old infants pass more implicit false belief tests. The infant witnesses an agent place a toy in location A and then either leave the room or turn away. Unbeknownst to the agent, the toy is then shifted to location B. The agent then returns to look for the toy. The information the agent has should lead her to look in location A, where she falsely believes the toy to be. The agent (one of the experimenters), however, looks in location B. The infant indicates a violation of expectations (VOE) by looking longer at unexpected behavior (Onishi & Baillargeon, 2005; Song et al., 2008; Surian et al., 2007). In this case the infant looks longer at the situation when the agent goes to the B location than when the agent goes to the A location. In other experiments (e.g., Southgate et al., 2007) infants show anticipated looking (AL) at targets where they expect the agent to look for the toy. The experimental results are surprising precisely because the TT consensus had been that infants this young (13-15 months) were thought not to have a concept of belief, and certainly not to be capable of representing (or engaging in the kind of metarepresentational process necessary to grasp) false belief. Despite that, theory theorists interpret the results in terms of TT: the infant is able

to attribute a false belief to the agent. Carruthers (2009, p. 166), for example, sees this performance as "evidence of very early metarepresentational competence in infants, embracing false-belief understanding." Baillargeon, Scott, & He (2010) conclude that the infant not only *infers* that the agent's mental state consists of a false belief, but that the child can reason about a complex set of mental states. Simulation theorists, of course, argue that the infant uses simulation skills to understand the situation. Herschbach, for example, argues that simulation may account for the infant's ability in this regard. Using simulation, the infant uses "information about the other's beliefs gained from pretending to have those beliefs (where 'pretending' is not necessarily a conscious or person-level notion)' (2007, 15). It's questionable, however, whether one can characterize subpersonal processes in terms of pretense, a person-level concept essential to the traditional account of simulation (Gallagher, 2007). Accordingly, Herschbach (2008) changes route and follows Goldman in shifting to a minimal concept of simulation defined by the 'matching hypothesis'. In this regard, however, there is some confusion about what 'matching' actually means. The Parma group who originally discovered mirror neurons understand the match to be an intra-cranial one, internal to one individual's brain (the action function of the mirror neuron, when I engage in intentional action, is matched by the observational function, when I see the action of the other person). Matching means "mapping the visual representation of the observed action onto the motor representation of the same action" in the observer's brain (Rizzolatti et al., 2001, 661). In contrast, Goldman (2006) characterizes the match as happening inter-cranially between brains (my mirror system matches your mirror system). "Applied to mindreading, a minimally necessary condition is that the state ascribed to the target is ascribed as a result of the attributor's instantiating, undergoing, or experiencing, that very state. In the case of successful simulation, the experienced state matches that of the target. This minimal condition for simulation is satisfied [in the neural simulation model]" (Goldman & Sripada, 2005, p. 208; also see Jacob, 2011). Regardless of how one conceives matching, this form of simulation looks like a good explanation of imitative responses, but it's difficult to see how it can explain how young infants are able to understand the actions of the other agent.

An alternative, behavioral interpretation is simply that the infant expects the agent's action to be guided by what the agent has done or seen rather

than by what the agent has not seen. The infant expects a certain action; that expectation is formed by recognizing that the agent sees or does not see something. The infant knows, for example, that the agent has not seen the toy being moved, anticipates that the agent will look one place, but is surprised that the agent looks in a different location. The infant, according to Ruffman and Perner (2005; Perner & Ruffman, 2005) follows a set of *behavioral rules* (e.g. 'people look for objects where they last saw them') gained via statistical learning abilities.[1] This account still requires some kind of inference on the part of the infant. Moreover, Baillargeon, Scott, & He (2010) suggest that the behavioral rules explanation fails because of the large number of rules that would be needed in a variety of situations involving false beliefs. It is not clear, however, why infants should not be able to apply more general perception and action principles, specifically along enactive lines (i.e., in terms of their own action capabilities), especially if infants spend their entire first year interacting with others and begin to engage in joint attention and joint actions starting around 9-12 months. Note that the TT, ST, and behavioral accounts are methodologically individualistic. Both TT and ST require some kind of monological mental or brain mechanism to function within the infant. Behavioral interpretations require a mechanistic, causal process of abstraction to general rules, and then inference from rule to predicted action. Such approaches ignore the contribution of, or the potential for, interaction. What is significant, on the IT approach, is that, since birth, the infant has been dialogically interacting with others in strongly embodied and enactive ways, and in ways that attune them to perception-action principles. On the IT enactive view, infants understand others in terms of *how they can interact with them*, or in terms of the infant's engagement in what the other is doing or expressing or feeling. This may apply even in cases where the infant is simply observing rather than actually interacting with the agent. The agent's involvement in the world, which the infant sees, can influence her expectations in terms of the possible or potential interactions she can have with that person.

Experiments that involve dialogical interaction rather than just observation offer some insight into this idea. Buttelmann, Carpenter and Tomasello (2009) show that 18-month-olds attempt to help an agent retrieve a toy while taking into account the fact that the agent hasn't seen a switch of location (the false belief situation). In that situation, when the agent focuses on the wrong location (A), the infant is ready to lead him to the correct lo-

cation (B), but not in the situation when the agent knows about the switch, i.e., the true belief situation, and still goes to A. In the latter case the infant goes to assist the agent at A. The infant sees exactly the same thing in the case of true belief (when the agent knows there has been a shift from A to B) as in the case of false belief (when the agent does not know about the shift). The fact that the infant sees either that the agent has seen the switch or not, plus the agent's behavior with respect to A (e.g., moving to the container at A and attempting to open it), is enough to specify the difference in the agent's intention – an intention that is built into the agent's movements within the situation. The intention signals a difference in affordance, i.e., a difference in how the infant can act, and thereby interact with the agent. The infant does not have to make inferences to mental states since all of the information needed to understand the other and to interact is already available in what the infant has seen of the situation.[2]

The enactive approach to social cognition emphasizes embodied dialogical interaction (De Jaegher et al., 2010). On this view, the capacity for understanding social situations complicated by an agent's lack of information is closely intertwined with the infant's ability to deploy social competences that engage with those situations. Even in cases where the infant is allowed only to observe, the violation of expectations may be a violation of affordance expectation – the fact that the agent goes to B rather than A does not present the expected affordance for the infant's own potential action. Even in the case of observation, the agent's involvement in the world, which I see, can influence my expectations in terms of the possible or potential interactions I can have with that person.

How can we explain why 13-18-month-old infants seemingly pass false belief tests while 3-year-old children fail the standard variety of such tests? As Pierre Jacob (2013) has pointed out, the tasks are quite different, and the difference between explicit requirements (in the standard tests) and implicit opportunities (in the young infant tests) puts the infants in a different situation. To be more precise, on Jacob's account, differences in the number of perspectives involved in the two kinds of tests are important. In the standard test, the infant is required to deal with two perspectives – the third-person perspective required to make a judgment about the other person (or puppet, etc.) with whom the child is *not* interacting, and the second-person perspective required to interactively engage with the experimenter. In the young infant tests, the infant is required only to observe the agent in a

third-person perspective (or, alternatively, in some experiments, engage in a second-person perspective with the agent). For Jacob it is the number of perspectives that makes for the complicating difference – a child dealing with only one perspective is less likely to become confused about what is required than a child (even at three years) who is required to deal with two perspectives at once. The task is complicated. A similar point is made by Rubio-Fernández and Geurts (2013).

Let me offer a slightly different explanation. Rather than the number of perspectives, or the complexity of the task, *per se*, I suggest that in the case of the standard test, the second-person interaction (with the experimenter) has a saliency that takes precedence over the third-person task and biases the child's answer. Both the child and the experimenter have a common knowledge of where the toy really is, and in their real interaction with each other, this shared knowledge becomes the salient feature and motivates the (wrong) answer to the third-person task. In the standard experiment, the three-year-old more consistently provides the answer that is facilitated by the second-person interaction with the experimenter. If one rearranges the task in a way that makes the interaction with the experimenter support (rather than distract from) the child's ability to track the perspective of the agent (see Rubio-Fernández & Geurts, 2013), the child does much better.

Natural pedagogy

It may be clear by now that I prefer IT to TT or ST as a way to explain social cognition, in young infants, as well as in adults. I haven't provided all of the evidence here; rather, I've focused on some ongoing debates. The full story would involve a detailed developmental account in terms of primary and secondary intersubjectivity (Trevarthen, 1979; Trevarthen and Aitken, 2001; Reddy, 2008). Primary intersubjectivity focuses on just those sensory-motor, embodied capacities, operative from birth or very early in the first year, that allow the infant to track and interact with others in terms of their movements, postures, facial expressions, gestures, actions, etc. Secondary intersubjectivity, which begins sometime during the first year of life, involves joint attention in richly contextualized pragmatic and social situations. These are not *precursors* to *real* social cognition; they constitute a kind of social cognition from the very beginning, and continue to characterize our adult interactions with others. To this we can add narrative

competency and the rich hermeneutical background that narrative practices provide (Gallagher & Hutto, 2008). Even if we say that in most of our everyday encounters, interactive and narrative practices, rather than mind-reading, account for our understanding of others, we can also be pluralists about social cognition and say that in some specific (and perhaps unusual) circumstances we may need to employ theoretical inference or simulation routines to make sense out of someone's behavior.

I now want to suggest the importance of embodied interaction (primary and secondary intersubjective practices) for learning processes. Specifically, I want to suggest that the notion of natural pedagogy (Csibra & Gergely, 2009) fits closely with the IT approach to social cognition, and provides a way to explain how we can move from very basic, non-representational, non-conceptual EC, to an account of how we gain generalizable, conceptual knowledge. One might think that for the latter one clearly needs language, as some philosophers argue (Brandom, 1994, Davidson, 1975, Dummett, 1993). Davidson, for example, argues that a child does not have a concept of belief (or any concept) until she is capable of speech or the interpretation of speech (1975, 170). So whatever the 13-month-old infant is doing, she is not detecting false beliefs. Piaget, in contrast, argues that concepts may be acquired prior to language ability (Piaget & Inhelder, 1969), and a number of philosophers agree, conceptualizing concepts in terms of representations (Bermudez, 2003; Fodor, 1975; Pinker, 1994). I want to argue that it is neither language nor mental representations that initiates conceptual abilities (i.e., abilities to acquire and use concepts), even if at some point language and external representations may facilitate concept acquisition and use, but rather something very specific in intersubjective interaction. To see this, consider the following experiment, again involving the so-called "false-belief" task, in a circumstance that involves language.

Southgate, Chevallier and Csibra (2010) conducted an experiment with 18-month-olds. An agent hides two toys in separate boxes, and then leaves. Infants then watch as another person switches the contents of the two boxes. When the agent returns she (the agent) points to one of the boxes (A), announcing that the toy hidden inside is a 'sefo'. When the infants are then asked to retrieve the 'sefo' most of them approach the other box (B), indicating that they must have understood that the agent intended to name the toy that was now in B, unaware of the toy's changed location. The infant sees the agent's original action and sees the switch that the agent does not

see. This is another experiment that allows the child to interact. There is interaction when the agent communicates with the child in this situation and when the infant is invited to act. IT argues that the infant does not have to engage in mindreading since all of the information relevant for the infant's response is available in the behavioral situation, and is sufficient to inform the infant's action.

The child learns something in this experiment. She learns that the toy is called a 'sefo'. Seemingly she learns this from hearing the word 'sefo' used to indicate the toy presumably in a certain location. Does having this word allow the child to generalize – that is to grasp a concept under which she would be able to categorize other things? If, for example, someone else walked into the room carrying the same kind of toy, would the child think that this too was a sefo? Csibra and Gergely's (2009) notion of *natural pedagogy* addresses this question and suggests that it is not the word, or language, *per se* (or language alone) that allows for this conceptual ability. In the remainder of this section I summarize their theory of natural pedagogy, highlighting its relevance to embodied, intersubjective learning.

For Csibra and Gergely (2009, p. 148), "Learning involves acquiring new information and using it later when necessary." In other words learning is a conceptual accomplishment. It requires generalizing information to new situations – learning not just individual facts that apply only to the one immediate situation in which they are learned, but learning to apply learned concepts to different objects, locations, or contexts. How is it possible to do this when in the learning process we are actually located in only one particular situation – how do we know that the information we gain about X in this situation applies to X in other situations (the *problem of induction*)? One explanation is children learn by association. They hear the word 'sefo' a number of times, always in association with the particular toy X. After a number of instances they learn to associate the word with the thing. Some kind of statistical learning mechanism in their brain establishes the association (firing together – wiring together). Passive observations are sufficient on this theory. Infants, however, tend to learn faster than can be accounted for in this way. In some cases, they can learn generalizable knowledge from a single instance. How does that work?

Csibra and Gergely (2009) argue that certain interactive aspects of communicative practices are the key. Infants are not simply passively assimilating and processing knowledge; they are more proactively receptive to

communications because they are sensitive to ostensive signals that indicate they are being addressed. In contexts of ostensive communicative interaction infants develop referential expectations and are biased to interpret such communications as conveying information that is generalizable.

They provide some examples. If I show the infant two airplanes and say that 'airplanes fly', the infant learns not just that these two airplanes fly, they learn generic knowledge about airplanes: the information "is generalizable to other members of the category and to variable contexts" (Ibid). Importantly, the communication of knowledge in this way is not limited to linguistic communication.

> If I show you by manual demonstration how to open a milk carton, what you will learn is how to open that kind of container (i.e. you acquire kind-generalizable knowledge from a single manifestation). In such cases, the observer does not need to rely on statistical procedures to extract the relevant information to be generalized because this is selectively manifested to her by the communicative demonstration. (2009, p. 148).

It is essential that the communication be interactive, in the sense that it is ostensively directed at the learner, or that the learner is being actively guided. The pattern of learning is fundamentally different between situations where the learner is passively observing or overhearing (call this the *osmosis method*), and situations where the learner is ostensively directed or guided. Ostensive communication means that (1) there is some indication or sign that the communication or demonstration is meant to be communicative (and not just an accidental happening), and (2) there is some sign that specifies the addressee so that the infant knows she is being addressed. In this regard, as Csibra and Gergely show, the most ostensive cues involve direct gaze towards the addressee, and mutual eye contact. Infants have an innate tendency to look to the eyes and to join in mutual gaze. Auditory cues (e.g., motherese intonation) also can capture the infant's attention.

The attention of the infant must be directed to the referent, the thing about which the infant is learning. Besides linguistic aspects of reference, one can use eye direction ("young infants tend to follow gaze shifts only when these are preceded by an ostensive signal such as eye contact or infant-directed greeting" [2009, p. 151], and infants expect to find a referent when they follow gaze), pointing, or manipulation/demonstration.

Perhaps most importantly, "children expect to learn something gener-

alizable in ostensive-referential contexts rather than just become informed about particular episodic facts that obtain only in the 'here-and-now'" (2009, p. 151). This differs from the osmosis method where the learning usually does not generalize. For example, when an agent looks at a particular object and expresses a certain emotion on his face (joy, disgust, fear etc.), 14-month-olds interpret this "as conveying valence information about the referent [rather] than expressing the subjective attitude state of the communicator towards the object" and 18-month-olds apply this to other people, i.e., they generalize to the idea that other people will also like or dislike or fear the object, respectively (Gergely et al., 2007). But this happens only when this is communicated to them in an ostensive manner (in contrast to the osmosis method) (Egyed et al., 2007).

Csibra and Gergely (2009) also cite evidence of another difference between osmosis and ostensive situations. In the latter situation, but not the former one, the 9-month-old focuses and learns about the permanent features of an object (e.g., its visible features), which can be referenced and re-identified later in different situations. She ignores information about current location of a moveable object, information that is irrelevant for its future recognition or the identification of other members of its kind. In the non-communicative osmosis situation, in contrast, the infant is more likely to detect changes in an object's location than its appearance (Yoon et al., 2008).[3],[4]

Conclusion

There are some important lessons to be learned from these developmental studies of natural pedagogy and the wider debates about social cognition. These studies demonstrate that natural pedagogy depends on embodied intersubjective interactions – processes that are best described as occurring *in the world* (oriented towards action in highly contextualized pragmatic and social environments) rather than in any individual's head. Getting another person's attention is not a matter of directing her mental state – it's a matter of putting to use the various embodied processes that fall under the headings of primary and secondary intersubjectivity, in dynamic situations where things are not only named, but demonstrated in an ostensive communicative manner. This kind of communication is a kind of interaction where the learner is not simply an observer.

On this basis, I want to suggest one prescriptive generalization: natural

pedagogy ought to be considered an important factor in most learning situations, and not just in the contexts of working with infants. In contrast to an osmosis method, ostensive, interactive engagement with the student(s) should be the rule. Perhaps we have known this since the time of Comenius; we now certainly have good science to support it. Yet it is a lesson that is easily lost in the overabundance of educational methodologies.

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Notes

[1] This view is similar to the behavioral abstraction hypothesis (e.g., Povinelli and Vonk, 2003), which states that infants are able to represent observed behavior in terms of a more abstract interpretation.

[2] Similar considerations apply to the interactive study by Southgate, Chevallier and Csibra, 2010.

[3] Csibra and Gergely (2009) suggest that this may explain the results of the classic A-not-B test, where infants who are engaged ostensively when they are shown an object, lose track of the object, looking for it in position A where they were first shown it, rather than in position B, where they have just recently seen it hidden. We can extend this suggestion to the contrasting instance of infants who are passive observers in the early false-belief tasks, who easily keep track of the toy, and do so even in the 'sefo' task where interactive communication occurs only after they learn about the toy's location via passive observation. I suggest this may also be relevant to why 3-year-olds tend to fail the standard false-belief tasks. In the standard tasks, as noted above, they are engaged by the experimenter in an ostensive second-person interaction which biases their attention to what the experimenter references (which is specifically the new location of the toy). They have no problem following the changing location of the toy, registering the original position passively since the observed agent (puppet, doll, etc.) is not offering any ostensive cues, and then registering the new position because that (changed location) is what the experimenter ostensively references. Is it possible that the child then generalizes this knowledge about the new location to others (including the returning agent), and therefore answers the key question ("Where will the agent look?") incorrectly? The interesting question becomes: why does the 4-year-old, on average, give the correct answer? In this regard a developing narrative competency may play an important role.

[4] Returning briefly to Davidson's view that concepts depend on language, he offers a perspective that, nonetheless, in light of this analysis of natural pedagogy seems incom-

plete: "Ostensive learning depends on triangulation, and ostensive learning is crucial to the existence of objective thought and language; this is the line of thinking that persuades me that triangulation is a necessary condition of thought and language" (Davidson 2003, 694). One need only think that the notion of triangulation can be pushed back to pre-linguistic joint attention and joint action to get a more balanced perspective on what is possible in the embodied learning and behavior of infants, and from that a more basic account of the mind.

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