On pedagogy

György Gergely, Katalin Egyed and Ildikó Király

Institute for Psychological Research, Hungarian Academy of Sciences, Hungary

Abstract

Humans are adapted to spontaneously transfer relevant cultural knowledge to conspecifics and to fast-learn the contents of such teaching through a human-specific social learning system called 'pedagogy' (Csibra & Gergely, 2006). Pedagogical knowledge transfer is triggered by specific communicative cues (such as eye-contact, contingent reactivity, the prosodic pattern of 'mother-ese', and being addressed by one's own name). Infants show special sensitivity to such 'ostensive' cues that signal the teacher's communicative intention to manifest new and relevant knowledge about a referent object. Pedagogy offers a novel functional perspective to interpret a variety of early emerging triadic communicative interactions between adults and infants about novel objects they are jointly attending to. The currently dominant interpretation of such triadic communications (mindreading) holds that infants interpret others' object-directed manifestations in terms of subjective mental states (such as emotions, dispositions, or intentions) that they attribute to the other person's mind. We contrast the pedagogical versus the mindreading account in a new study testing 14-month-olds' interpretation of others' object-directed emotion expressions observed in a communicative cueing context. We end by discussing the far-reaching implications of the pedagogical perspective for a wide range of early social-cognitive competences, and for providing new directions for future research on child development.

Introduction: Early mindreading versus pedagogical knowledge transfer

More than 20 years have passed since the by now classical demonstrations (Wimmer & Perner, 1983) that around 4 years of age children start to exhibit explicit 'mindreading' skills. This is evidenced by their verbal ability to predict and justify others' false belief based actions by attributing causal intentional mental states to them (such as desires, intentions, and beliefs). Since then research on early social cognitive development has been preoccupied with searching for the ontogenetic origins and earliest forms of attributing mental states to others (Leslie, 1987; Perner, 1991; Repacholi & Gopnik, 1997; Trevarthen & Aitken, 2001; Carpenter, Nagell & Tomasello, 1998; Tomasello, Carpenter, Call, Behne & Moll, 2005; Moses, Baldwin, Rosicky & Tidball, 2001). This approach has led to important discoveries through the use of non-verbal violation-of-expectation looking time methodologies suggesting that already 15-month-olds may possess an implicit capacity to infer others' intentional mental states even when these represent a counterfactual state of affairs (false beliefs; Onishi & Baillargeon, 2005) or fictional (mentally stipulated imaginary) representations of reality (as in understanding pretense actions; Onishi, Baillargeon & Leslie, in press).

Recent research on social referencing[1] (Moses *et al.*, 2001; Mumme & Fernald, 2003), 'proto-declarative' pointing[2] (Carpenter *et al.*, 1998; Liszkowski, 2006) or predicting others' object-directed actions (Phillips, Wellman & Spelke, 2002; Sodian & Thoermer, 2004) has converged on the mentalistic view that by 12 to 14 months of age, based on others' emotion expressions directed at objects identified by referential cues (such as direction of gaze, or pointing), infants attribute intentional mental states to others such as emotional attitudes, desires, or dispositions about referent objects. It has been argued that infants can 'recognize the central role that such internal states play in others' behavior' (Moses *et al.*, 2001, p. 733) and rely on them to predict others' object-directed actions (Phillips *et al.*, 2002), to 'share' their own mental attitudes towards the referent with those of others (Tomasello *et al.*, 2005), or to modulate their own object-directed behaviours based on the other's emotional attitude toward the object (Mumme & Fernald, 2003).

---

[1] One-year-olds' ability to seek out and rely on others' object-directed emotion expressions to modulate their own behaviour towards novel objects.

[2] Infants' pointing to direct an adult's attention to novel objects and elicit commentary and joint communicative interactions from them about it.

Address for correspondence: György Gergely, Institute for Psychological Research, Hungarian Academy of Sciences, 18–22 Victor Hugo Street, H-1132. Budapest, Hungary; e-mail: gergelyg@mtapi.hu

Arguably, however, the enthusiastic search for early forms of intersubjective understanding of minds had an additional undesirable effect of sometimes too hastily embracing mentalistic interpretations for early social cognitive phenomena (including social referencing, imitative learning, facial and vocal interactions that have a turn-taking 'proto-conversational' structural organization, proto-declarative pointing, or predicting others' object-directed actions) at the expense of exploring alternative functional explanations that do not necessarily involve or rely on infants' capacity to attribute mental states (Gergely, 2002; Csibra & Gergely, 2006). Elsewhere we have proposed such alternatives – namely, the infant's 'teleological stance'[3] (Gergely & Csibra, 2003) or the system of human 'pedagogy' (Csibra & Gergely, 2006) – that, in our view, represent a novel perspective on the functional nature and underlying mechanisms of several early social cognitive capacities that are currently standardly considered as involving early forms of mindreading.

In particular, the theory of *human pedagogy* (Csibra & Gergely, 2006; Gergely & Csibra, 2005, 2006) proposes that many types of early emerging triadic communications about referent objects are best conceived as serving the primarily *epistemic* function of actively seeking out and cooperatively providing reliable, new and relevant information by knowledgeable adults to ignorant infants about the generalizable properties of referent objects and their kinds that constitute universally shared cultural knowledge to be fast-learned by infants (such as the object's name, proper function, manner of use, or valence qualities). There is evidence (see Csibra & Gergely, 2006, for a review) that human infants actively seek out and show early sensitivity, orientation, and preference for specific types of communicative cues (such as eye-contact, eyebrow raising, turn-taking contingent reactivity, motherese, or being addressed by their name) that typically accompany triadic interactions about referents. According to pedagogy theory, infants are adapted to automatically interpret such cues as 'ostensive' signals (cf. Sperber & Wilson, 1986) indicating the other's overt communicative intention to manifest new and relevant information 'for' them to acquire about the object that is identified by non-verbal referential cues (such as gaze-direction or pointing). We hypothesize that ostensive

cues constrain and direct infants' interpretation of adults' object-directed behavioural manifestations (such as their object-referential emotion expressions, verbal labelling, demonstrations of the functional properties of objects, or specific manners of artifact use) as conveying to them new and relevant knowledge about the referent that they need to extract and bind to its representation as its essential property.

Furthermore, such pedagogical manifestations are interpreted to convey information that is generalizable to the object class that the referent belongs to and is assumed to be part of universally shared cultural knowledge about the object kind. Therefore, pedagogy theory predicts that when another person's object-directed behavioural manifestations are observed in an ostensive cuing context, infants will *not* interpret the content of such manifestations as expressing the specific subjective mental states that the other holds about the referent, but rather they will use such communicative displays as the basis to infer the new information about the relevant properties of the referent object that they are being taught about.

Learning 'about' versus learning 'from' other minds: the role of ostensive cuing in triggering pedagogical information transfer

Below we shall directly contrast the alternative explanatory perspectives of the pedagogical versus the standard mindreading account by comparing their differential predictions about how young infants interpret others' object-directed emotion displays in *social referencing* situations, i.e. when infants seek out and use others' emotion expressions to modulate their own behaviour towards novel and ambiguous objects. The mindreading account assumes three crucial steps. First, from the other's object-directed emotion display (say, fear or interest/joy) infants infer what specific emotional or dispositional mental state the other holds towards the object (being afraid vs. liking). Second, the infant predicts from this attributed mental state the type of action the other could be expected to perform toward the referent (approaching or avoiding it). Third, infants rely on the mental attitude attributed to the other and/or the action prediction derived from it to modulate their *own* behaviour towards the object.

A potential problem for this interpretation stems from its under-determination by the observable evidence, as others' object-referential emotion expressions can be compatible with qualitatively different interpretations. One possibility is, of course, the '*person-centred*' *interpretation* assumed by the mindreading account, namely, that infants indeed interpret the other's emotion display

---

[3] Young infants' capacity to represent actions as goal-directed and agents as rational who are expected to pursue their goals in the most efficient manner available under the physical constraints of the situation. The existence of this teleological system specialized for action interpretation in terms of goals and efficiency is based on non-verbal violation-of-expectation looking time studies (e.g. Csibra *et al.*, 2003; Gergely *et al.*, 1995) showing that 1-year-olds can productively infer and attribute goals to agents and interpret their behaviour as goal-directed actions on condition that their goal approach satisfies the assumption of efficiency.

as expressing the individual's person-specific subjective mental attitude toward the referent (e.g. that 'Alison *likes* broccoli'). Note, however, that the same emotion expression could be equally compatible with an *'object-centred' interpretation* as it could convey new information about some relevant property of the referenced object (e.g. that 'broccoli is *good*'). If infants adopted such an object-centred interpretation by construing the other's emotion manifestation as communicating relevant information about the valence qualities of the object, they could directly encode this new information by binding it to their representation of the referent. They could then access the relevant contents of their newly formed representation (that would now include information about the object's positive valence) to modulate their behaviour towards it (e.g. to approach rather than avoid it). Clearly, this way infants could succeed in social referencing without necessarily attributing or relying on the other's subjective mental attitude towards the referent.

This raises two questions: 1. Do infants interpret others' object-directed emotion displays by setting up 'person-centred' or 'object-centred' representations? 2. Do infants predict others' object-directed behaviours from their representation of the individual's person-specific subjective mental attitude towards the referent, or do they base their action predictions on the objective valence qualities of the referent that they have come to represent through their 'object-centred' interpretation of others' referential emotion displays?

The pedagogical approach proposes that during social referencing infants set up and rely on 'object-centred' interpretations of others' referential emotion expressions. This should be so because social referencing interactions involve salient ostensive and referential cues of triadic communication (such as eye-contact, turn-taking looking back and forth between the object and the infant, using motherese to address the infant and while commenting about the object, etc.). As hypothesized above (Csibra & Gergely, 2006), such ostensive cues identify the situation as a case of pedagogical knowledge transfer for the infants, triggering the interpretation that the other exhibits a communicative intention addressed to them to manifest new and relevant information for them to fast-learn about the referent.

Pedagogy theory also assumes (Csibra & Gergely, 2006; Gergely & Csibra, 2006) that ostensive cues trigger in-built assumptions in infants about the *generalizability* and *universality* of the epistemic information that the other's communicative manifestations convey about the referent. For social referencing this predicts that infants assume that the other's object-directed emotion manifestations convey universally shared information about the referent that is available to *all* individuals. We hypothesize,

therefore, that infants rely on their 'object-centred' interpretations to form generalized expectations that all others (and not only the specific person manifesting the emotion to them) will perform the same kind of object-directed actions that are appropriate and rational given the objective valence quality of the referent that the infant's newly formed object representation contains.

Below we report a study with 14-month-olds designed to test the contrastive predictions of the pedagogical vs. mindreading account using a violation-of-expectation looking time procedure. Two subject groups watched different series of familiarization events in which two demonstrators repeatedly presented ostensively cued object-directed emotion manifestations of different valence towards two novel objects. Both demonstrators were *consistent* in manifesting over trials the same (positive vs. negative) emotions towards the referents, but they always expressed the *opposite* emotion towards the same target than the other demonstrator.

The familiarization series presented to the two subject groups differed in the relative frequency with which the demonstrators appeared across trials, and in the overall number of events. In the *'Symmetric' condition* both demonstrators appeared with equal frequency. In the *'Asymmetric' condition* the 'frequent' demonstrator appeared three times more often than the 'infrequent' demonstrator.

These familiarization series were followed by four 'object-directed action' test trials in which each demonstrator appeared twice, choosing alternately one or the other target to act on. Thus, both demonstrators performed one *'attitude-consistent' object-choice* (acting on the object towards which they consistently expressed positive emotion during familiarization), and one *'attitude-inconsistent' object-choice* (choosing the object towards which they had expressed a negative emotion).

We can derive differential predictions for the two conditions from the mindreading vs. pedagogical account. According to the mindreading account, during familiarization infants attribute to each demonstrator different (in fact, opposite) person-specific mental attitudes of 'liking' vs. 'disliking' the two targets. From these, infants are assumed to generate opposite expectations as to which referent the demonstrators will choose during test trials: expecting both to make person-specific 'attitude-consistent' object-choices. Thus, longer looking times are predicted for the (unexpected) 'attitude-*in*consistent' object-choices for *both* conditions.

In contrast, the pedagogical account generates different predictions for the two conditions. In the Symmetric condition both targets are manifested to have positive vs. negative valence equally often by the two demonstrators. Therefore, binding the valence value of each emotion manifestation to the 'object-centred' representation of

its referent should not change the perceived valence of the two objects (that were initially novel and equally neutral for the infants). Since according to the universality assumption, infants assume *all* individuals (including both demonstrators) to have access to the objective valence information manifested for them about the referents, they will expect all others' object-directed choices and actions to be similarly determined by the objects' valence qualities. Therefore, no differential looking times are predicted for alternative object-choices in this condition (irrespective of whether the object-choices are 'attitude-consistent' or 'attitude-inconsistent').

In the 'Asymmetric' condition, however, infants' valence representations of the referents should be differentially modified during familiarization trials due to the unequal frequency of the two demonstrators' opposite-valued valence manifestations. The referent manifested to have positive valence more frequently across trials will become represented as 'good or better' than the other object that was manifested more frequently to have negative valence. Therefore, the pedagogical account predicts a valence-based object-choice (of the 'better' object) for *both* demonstrators (irrespective of whether their object-choice is 'attitude-consistent' or 'attitude-inconsistent').

Method

Participants

Sixty-four 14-month-olds participated in the experiment. Thirty-two were assigned to the Symmetric (21 male, 11 female, mean age: 422 days, range: 406–440 days) and 32 to the Asymmetric condition (17 male, 15 female, mean age: 423 days, range: 409–437 days). An additional 41 infants were excluded due to technical problems (2), fussiness (26), or maternal interference (12).

Stimuli

All familiarization and test events were videotaped. In each event one (of two) female demonstrators appeared in the middle of the screen facing the infant. The demonstrator sat behind a table with two different objects placed in front of her on the left vs. right sides of the table. Demonstrator 1 was a long-haired brunette, Demonstrator 2 was short-haired and blond. The targets were two wooden objects of equal size (about 5 cm high) but they differed in shape and colour (Object A: red ball; Object B: yellow cube). Both objects were unfamiliar to the infants who showed no differential preference for either. In all events Object A was on the left, while object B was on the right side of the table.

Familiarization events

Each event contained the same action sequence: First, the demonstrator 'greeted' the infant manifesting ostensive-communicative cues (slightly tilting her head forward, looking and smiling at the baby while 'knowingly' raising her eyebrows). Then she turned to the left to gaze at Object A, displaying always the same (either positive: 'interest/joy' or negative: 'disgust') emotion towards it. She then turned back to the middle and looked at the infant again. Then she turned to the right to look at Object B, displaying always the other emotion of opposite valence than what she expressed towards Object A. Finally, she turned back to the middle looking at the infant again.

Across all familiarization trials Demonstrator 1 (the long-haired brunette) always displayed 'interest/joy' towards Object A and 'disgust' towards Object B, while Demonstrator 2 (the short-haired blond) always expressed 'disgust' towards Object A and 'interest/joy' towards Object B.

The familiarization series presented in the Symmetric vs. Asymmetric conditions differed in three respects: in the relative frequency and relative order of the two demonstrators' appearances across trials, and in the overall number of events. The 'Symmetric' condition consisted of six events in which the demonstrators appeared with equal frequency (three times each) across trials. These were presented in an ABABAB order for half of the subjects, while the other half saw the opposite BABABA sequence. The 'Asymmetric' condition consisted of 12 events across which Demonstrator 1 ('frequent person': FP) appeared nine times, while Demonstrator 2 ('infrequent person': IP) appeared only three times. Each of the 32 series started with FP. In half of them IP appeared in the 2nd, 7th, and 11th position. In the other 16 series IP appeared in the 2nd, 7th, and the final 12th position. Thus, across subjects FP and IP appeared equally often in the last position to control for possible recency effects.

Test phase

For both groups the familiarization phase was followed by four 'object-choice and object-directed action' test trials. Each demonstrator appeared twice across these events, always presenting first the same ostensive cues of 'greeting' as during familiarization. Then she turned to and chose either Object A or B to 'play with' fixating it with a neutral facial expression throughout. She grasped the chosen object, moved it to a new position (10 cm away), and then moved it back. This 'playing' action was repeated as long as the subject watched it. Across trials both demonstrators performed one *'attitude-consistent'*

and one *'attitude-inconsistent' object-choice* (relative to their object-specific emotional attitude manifested during familiarization). The order of test events was counterbalanced across subjects.

Procedure

Infants sat on their parent's lap, 80 cm from a 21″ monitor. They were presented with the familiarization events in one block followed by the four test events. Their visual behaviour was recorded by a video-camera hidden above the monitor. An experimenter watched their looking behaviour on a monitor in an adjacent room and registered through a computer program the length of their visual fixations to each test event by pressing a key on a keyboard. Each test event lasted until the infant looked away for more than 2 seconds. A sound cue oriented the infant's attention back to the display before the next event started.

Results

We used the looking times during test trials as the sole dependent measure. A second experimenter re-coded off-line 25% of the video-records measuring subjects' looking times for the test events. The two coders' measurements showed significantly high correlation (Pearson: $r = .99$), indicating the reliability of the looking time data.

Figure 1 depicts the mean looking times to the different types of object-choices during test events for the
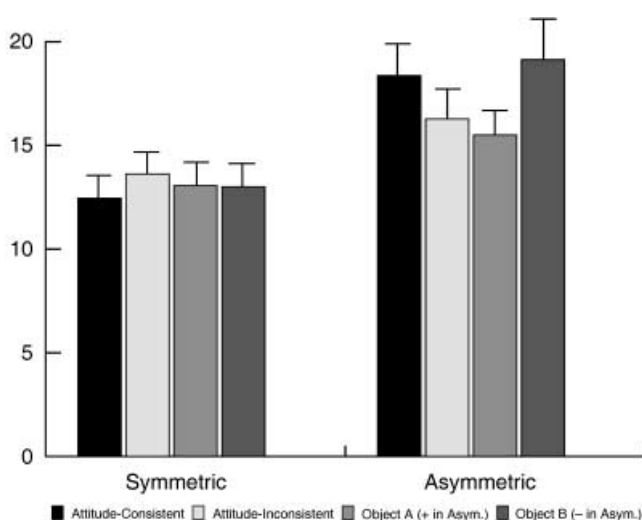

Figure 1 *Mean looking times to 'attitude-consistent' vs. 'attitude-inconsistent' object-choices and to choosing Object A vs. B in the Symmetric and Asymmetric familiarization conditions.*

Symmetric vs. Asymmetric conditions. To analyze the looking times, first we performed a repeated measures mixed ANOVA with Object (A vs. B) and Attitude-Consistency (Consistent vs. Inconsistent object-choice) as within-subject factors, and Condition (Symmetric vs. Asymmetric) as the between-subjects factor. This analysis yielded a significant main effect of Condition ($F(1, 62) = 7.243$, $p < .01$), which reflects the longer overall looking times for the test trials in the Asymmetric condition (Figure 1). We found a tendential main effect of Object ($F(1, 62) = 3.514$, $p < .07$) and a nearly significant Object × Condition interaction ($F(1, 62) = 3.685$, $p = .06$). The analysis also yielded a significant Attitude-Consistency × Condition interaction ($F(1, 62) = 4.30$, $p < .05$). Note that no main effect of Attitude-Consistency ($p = .555$) was present.

To resolve the interactions, we ran separate repeated measures ANOVAs for the two conditions. In the Symmetric condition neither the effect of Object ($p = .971$) nor that of Attitude-Consistency ($p = .315$) approached significance and there was no Object × Attitude-Consistency interaction ($p = .935$) either. In contrast, a similar ANOVA for the Asymmetric condition yielded a significant main effect of Object ($F(1, 31) = 5.903$, $p = .021$). The main effect of Consistency did not reach significance ($F(1, 31) = 3.751$, $p < .07$), and the direction of difference was actually opposite (longer looking at the consistent events, Figure 1) to what the mindreading account would have predicted. We found no interaction between Object and Attitude-Consistency ($p = .521$). A non-parametric Sign test also confirmed the Object valence effect for the Asymmetric condition yielding a close to significant result ($z = -1.945$, $p = .052$).

Finally, we checked for any effect of (a) Person (Demonstrator 1 vs. 2) or (b) Order of test trials separately for the two conditions. While there was no Person effect in either the Symmetric ($p = .935$) or Asymmetric ($p = .521$) condition, the Symmetric condition yielded a significant Order effect ($F(3, 93) = 10.432$, $p < .001$), showing a continuous decrease in looking times from the first to the last test event (1st: 17.89 sec; 2nd: 12.14 sec; 3rd: 11.80 sec; 4th: 10.33 sec). No Order effect was present in the Asymmetric condition ($F(3, 93) = 1.978$, $p = .123$).

Discussion

First, as Figure 1 shows, the main prediction of the mindreading account that attitude-inconsistent object-choices, which violate infants' person-specific attitude-based expectations, should result in longer looking times in both conditions is clearly not supported by the results.

In accordance with the lack of an Attitude-Consistency main effect, there was no significant difference in looking times to attitude-consistent vs. attitude-inconsistent object-choices in either condition. In fact, the significant Attitude-Consistency × Condition interaction is, in part, dependent on a looking time difference in the Asymmetric condition that is in the opposite direction of that predicted by the mindreading perspective (Figure 1). In contrast, these findings are in line with the pedagogical account that predicted no difference for attitude-consistent vs. attitude-inconsistent object-choices for either condition.

The Object effects provide further support for the pedagogical approach. As shown in Figure 1, the tendential main effect of Object together with the nearly significant Object × Condition interaction stems entirely from the longer looking times for choosing Object B over A in the *Asymmetric condition only*.[4] This is exactly what was predicted by the pedagogical approach, according to which the 'object-centred' valence representation of Object B should have become more negative (while Object A was more positive) during familiarization in the Asymmetric but not in the Symmetric condition. Based on the universality assumption, the pedagogical approach predicted that infants in the Asymmetric condition will develop a generalized expectation that all others (including both demonstrators) should choose the more positive-valenced Object A: an expectation whose violation led to longer looking times when the more negative-valenced Object B was chosen in the Asymmetric condition.

The significant Object-Valence main effect ($p = .021$) in the Asymmetric condition provides further support for this interpretation showing that, as predicted, choosing the more negative-valenced Object B ($M = 19.15$ sec) led to significantly longer looking times than choosing the more positive-valenced Object A ($M = 15.50$ sec) (Figure 1). Note that this valence-based effect cannot be accounted for by the mindreading account that predicts longer looking times only for the attitude-inconsistent object-choices.

The significant Order effect present only in the Symmetric condition is also in line with the pedagogical interpretation that infants develop no specific expectations in this condition as to the type of object-choices either on the basis of object-valence (that remains equal for the two objects), or on the basis of person-specific referential attitude (which was either not attributed, or not used to predict the person's object-choice). Thus,

following their initial recovery of attention upon seeing the novel action in the first test event, lacking any specific expectations concerning the type of object-choice, infants showed a steady decrease of interest during the repeated presentations of the same action type.

Some important questions, however, remain unanswered by these results. For example, how should one interpret the apparent lack of infants' attributing person-specific mental attitudes from observing others' object-directed emotion expressions? According to the 'theory-theory' view (Perner, 1991; Gopnik & Wellman, 1994), this may indicate that 14-month-olds have not yet acquired the representational concept of 'desire' or cannot yet attribute such a mental state to others from observing their referential emotion expressions (Repacholi & Gopnik, 1997). We find this view implausible in light of recent evidence showing implicit false-belief attribution (Onishi & Baillargeon, 2005) and understanding violations of mentally stipulated fictional pretence scenarios (Onishi *et al.*, in press) already at 15 months.

In this regard, we emphasize that our theory of pedagogical knowledge transfer (Csibra & Gergely, 2006) does not propose that 14-month-olds are unable to attribute mental states to others. Rather, our proposal is that whether they do so or not may be directed by the presence of ostensive cues that trigger object-centred interpretations for communicative manifestations. We hypothesize that ostensive cues can act as an 'interpretation switch' directing infants to construe others' referential knowledge manifestations as pedagogical 'teaching' events. Accordingly, we suggest that in the present study it was the ostensive cuing context that biased infants to encode the manifested emotions as conveying information about the objective valence qualities of the referents, and not about the other's person-specific subjective attitude towards them.

Clearly, our results are compatible with but, in themselves, not sufficient to prove our 'interpretation switching' hypothesis as we did not directly manipulate the presence of ostensive cues in our familiarization conditions. We are currently running experiments with 14-month-olds to see if the withdrawal of ostensive cues would result in 'switching' infants' interpretive stance to set up person-centred mentalistic representations for others' object-directed emotion expressions. We do have, however, new and promising preliminary results from a modified 'object-requesting' paradigm (cf. Repacholi & Gopnik, 1997), suggesting that the hypothesized 'interpretation switching' role of ostensive cuing is, indeed, present in 18-month-olds (Egyed, Király & Gergely, in preparation). Finally, we can refer to further evidence supporting the hypothesized interpretation-modulating role of ostensive cuing that comes from our recent studies on imitative

---

[4] The nearly identical mean looking times for Objects A vs. B in the Symmetric condition also indicate that the infants had no inherent preference for either of the novel objects on which they could have based egocentrically determined expectations about others' likely object-choices (cf. Repacholi & Gopnik, 1997).

learning. These show that selective relevance-guided imitation of novel means (Gergely, Bekkering & Király, 2002) is triggered in 14-month-olds *only* in the presence of an ostensive cuing context (Gergely & Csibra, 2005).

General implications of pedagogy theory for future directions of research on child development

The human social and cultural environment represents two major and species-unique challenges for infants. On the one hand, young children must develop an understanding of others' minds to be able to predict and interpret their actions in terms of causal mental states attributed to them. On the other hand, infants must adapt to and acquire an immense amount of cultural knowledge that is – at least partially – cognitively 'opaque' to them as they involve arbitrary, conventional, and often apparently nonadaptive features of social belief systems and representational devices, and highly complex cultural artifacts with often hidden mechanistic and functional design properties. Recent theories of social cognitive development mainly focused on the first, challenge advancing alternative models to explain the ontogenetic development of young children's explicit representational understanding of others' minds and their mindreading skills to infer the specific intentional mental states that drive others' actions.

We believe that the theory of human pedagogy provides a new perspective for approaching both of the major challenges of social-cultural development outlined above. The primary focus of the theory is on how humans meet the second type of challenge that the need to learn cognitively opaque social and technological knowledge represents for the young learner who, arguably, could not acquire such knowledge through classical mechanisms of observational learning such as associative learning or 'blind' imitative copying (see Gergely & Csibra, 2006, for arguments). Human pedagogy is a species-specific social learning system that has evolved as a specialized adaptation to solve the learnability problem that the cognitive opacity of human cultural forms represents for the individual observational learner (Csibra & Gergely, 2006). This social learning mechanism of mutual design allows infants to seek out and rely on the communicative manifestations of relevant knowledge that knowledgeable conspecifics are spontaneously inclined to provide and tailor to meet the receptive requirements that the juvenile learner's often inadequate existing knowledge base and limited cognitive interpretive skills represent.

There are two built-in design features of pedagogy that, in our view, also shed new light on how to approach the first challenge that the development of understanding other minds presents. Fast and efficient cultural knowledge transfer is ensured by two implicit assumptions about communicating agents that human infants must possess. On the one hand, the ostensive cues of others that infants are biased to interpret as indicating their communicative intention to transfer relevant knowledge for them to fast-learn must also trigger a built-in assumption of '*basic epistemic trust*' in the other as a benevolent, cooperative, and reliable source of cultural information. This activates a 'presumption of relevance' about the contents of manifested knowledge as a result of which the young apprentice can fast-learn it without the need to test or critically scrutinize its validity or relevance any further.

The second built-in functional assumption concerns the presumption that the pedagogically manifested knowledge is generalizable (semantic) information about referent kinds that is universally shared by other (equivalently knowledgeable) members of the cultural community. This default assumption about communicative agents as sources of universally shared cultural knowledge amounts to an implicit construal of *others as equally 'omniscient' sources of shared knowledge*. This assumption of communicating others as possessing functionally equivalent omniscient minds with identical and universally shared knowledge contents may, in fact, constitute the biological basis of the epistemic illusion (sometimes referred to as 'the curse of knowledge'; Birch & Bloom, 2004) whereby young children – and to a lesser extent adults – are biased to believe that their own knowledge about the world is universally shared by all others (leading to a difficulty in conceptualizing other minds as having different knowledge contents).

In short, pedagogy theory suggests that much of early social-cognitive development establishing a realistic understanding of other minds involves learning about the specific conditions under which the built-in default assumption of universal knowledge and omniscient other minds must be suspended or inhibited. This gradual and experience-driven learning process eventually leads to the ability to draw correct inferences to attribute and represent the differential knowledge contents of separate and individual minds of others. A further developmental task is to acquire the specific conditions under which the other default assumption of pedagogy, the generalized 'epistemic trust' in communicating others, needs to be suspended or inhibited. Young children have to learn the hard way (that is, through accumulating experience) to differentiate trustworthy, benevolent, and reliable communicative sources of information from communicators who are unreliable, uninformed, or downright bad-intentioned providers of useless or deceiving information. At the same time, children must develop differentiated knowledge about the social division of epistemic labour

in their culture to identify domain-specific experts and trustworthy institutionalized information outlets (such as professional rather than intuitive educators). They also have to learn to modulate their belief fixation mechanisms as a function of their developing understanding of the relative reliability of different sources of information. In summary, while previous research on social-cognitive development considered as its central task the need to account for how children come to understand that other people *have* minds, the new theoretical perspective offered by pedagogy theory turns this question upside-down, identifying as the central task for children's early development the need to come to understand that others have *separate minds with different knowledge contents*.

Acknowledgements

References

Birch, S.A.J., & Bloom, P. (2004). Understanding children's and adults' limitations in mental state reasoning. *Trends in Cognitive Sciences*, **8** (6), 255–260.

Carpenter, M., Nagell, K., & Tomasello, M. (1998). Social cognition, joint attention, and communicative competence from 9 to 15 months of age. *Monographs of the Society for Research in Child Development*, **63** (4), Serial No. 255.

Csibra, G., Bíró, S., Koós, O., & Gergely, G. (2003). One-year-old infants use teleological representations of actions productively. *Cognitive Science*, **27** (1), 111–133.

Csibra, G., & Gergely, G. (2006). Social learning and social cognition: the case for pedagogy. In Y. Munakata & M.H. Johnson (Eds.), *Processes of change in brain and cognitive development. Attention and performance* XXI (pp. 249–274). Oxford: Oxford University Press.

Egyed, K., Király, I., & Gergely, G. (in preparation). The role of ostensive cues in triggering 'object-centred' vs. 'person-centred' interpretations of referential emotion expressions of others.

Gergely, G. (2002). The development of an understanding of self and agency. In U. Goswami (Ed.), *Blackwell's handbook of childhood cognitive development* (pp. 26–46). Oxford: Blackwell.

Gergely, G., & Csibra, G. (2003). Teleological reasoning about actions: the naïve theory of rational action. *Trends in Cognitive Sciences*, **7**, 287–292.

Gergely, G., & Csibra, G. (2005). The social construction of the cultural mind: imitative learning as a mechanism of human pedagogy. *Interaction Studies*, **6**, 463–481.

Gergely, G., & Csibra, G. (2006). Sylvia's recipe: the role of imitation and pedagogy in the transmission of human culture. In N.J. Enfield & S.C. Levinson (Eds.), *Roots of human sociality: Culture, cognition, and human interaction* (pp. 229–255). Oxford: Berg Publishers.

Gergely, G., Bekkering, H., & Király, I. (2002). Rational imitation in preverbal infants. *Nature*, **415**, 755.

Gergely, G., Nádasdy, Z., Csibra, G., & Bíró, S. (1995). Taking the intentional stance at 12 months of age. *Cognition*, **56** (2), 165–193.

Gopnik, A., & Wellman, H.M. (1994). The theory theory. In L.A. Hirschfeld & S.A. Gelman (Eds.), *Mapping the mind: Domain specificity in cognition and culture* (pp. 257–293). New York: Cambridge University Press.

Leslie, A. (1987). Pretense and representation: the origins of a theory of mind. *Psychological Review*, **94**, 417–426.

Liszkowski, U. (2006). Infant pointing at twelve months: communicative goals, motives, and social-cognitive abilities. In N. Enfield & S. Levinson (Eds.), *Roots of human sociality: Culture, cognition, and interaction.* Oxford: Berg.

Moses, L.J., Baldwin, D.A., Rosicky, J.G., & Tidball, G. (2001). Evidence for referential understanding in the emotions domain at twelve and eighteen months. *Child Development*, **72** (3), 718–735.

Mumme, D.L., & Fernald, A. (2003). The infant as onlooker: learning from emotional reactions observed in a television scenario. *Child Development*, **74** (1), 221–237.

Onishi, K.H., & Baillargeon, R. (2005). 15-month-old infants understand false beliefs. *Science*, **308** (5719), 255–258.

Onishi, K.H., Baillargeon, R., & Leslie, A.M. (in press). 15-month-old infants detect violations in pretend scenarios. *Acta Psychologica*.

Perner, J. (1991). *Understanding the representational mind*. Cambridge, MA: MIT Press.

Phillips, A.T., Wellman, H.M., & Spelke, E.S. (2002). Infants' ability to connect gaze and emotional expression to intentional action. *Cognition*, **85**, 53–78.

Repacholi, B., & Gopnik, A. (1997). Early reasoning about desires: evidence from 14- and 18-month-olds. *Developmental Psychology*, **33** (1), 12–21.

Sodian, B., & Thoermer, C. (2004). Infants' understanding of looking, pointing, and reaching as cues to goal-directed action. *Journal of Cognition and Development*, **5** (3), 289–316.

Sperber, D., & Wilson, D. (1986). *Relevance: Communication and cognition*. Oxford: Blackwell.

Tomasello, M., Carpenter, M., Call, J., Behne, T., & Moll, H. (2005). Understanding and sharing intentions: the origins of cultural cognition. *Behavioral and Brain Sciences*, **28**, 675–691.

Trevarthen, C., & Aitken, K.J. (2001). Infant intersubjectivity: research, theory, and clinical applications. *Journal of Child Psychology and Psychiatry*, **42** (1), 3–48.

Wimmer, H., & Perner, J. (1983). Beliefs about beliefs: representation and constraining function of wrong beliefs in young children's understanding of deception. *Cognition*, **13**, 103–128.