

Doktori (PhD) értekezés

The Role of Marked Forms of Caregiver-Infant
Interactions in Children's Conceptual Development and
the Formation of their Representational Abilities

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"Én, Futó Judit teljes felelősségem tudatában kijelentem, hogy a benyújtott értekezés a szerzői jog nemzetközi normáinak tiszteletben tartásával készült. Jelen értekezést korábban más intézményben nem nyújtottam be és azt nem utasították el."

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A BRIEF SUMMARY

This dissertation is centered around the question of how the ‘markedness’ of early caregiver-child interactions might foster the conceptual and representational development of young children.

In the first section, I will summarize the most important characteristics of infant-directed communication that turned out to be a much broader phenomenon than it was originally believed. Following a brief introduction to the Theory of Natural Pedagogy (see Csibra & Gergely, 2009), I will conclude that ‘markedness’ seems to be a central characteristic of infant-directed communication in general. Marking, as an ostensive cue informs the addressee about the communicative and referential goal of the communicator, and marked forms of referential knowledge manifestations emphasize new and relevant aspects of the communicated information.

The first series of experiments will then be described. In these object individuation studies we tried to explore if and how a marked form of ostensive communicative cue, namely infant-directed speech might foster infants’ conceptual development by facilitating the establishment of kind representations.

The second study presented was aimed to shed light on how early marked forms of referential knowledge manifestations might support the establishment of second order representations and their manifestation in emotion regulation and pretend play. At the end of this section I will discuss in what ways early caregiver-infant interactions might shape other developing representational systems, such as infants’ autobiographical memory.

The results are discussed within the framework of Natural Pedagogy with a special emphasis on the attention attenuating effects of marked communicative expressions.

INTRODUCTION

INFANT-DIRECTED COMMUNICATION

Humans can receive information about the intentional actions of others in two qualitatively different ways: either in a non-communicative observational context (someone opens the tap) or in a human-specific communicative demonstration context (someone demonstrates or teaches how to open the tap). When learning through observation, how are we capable of inducing general knowledge from the pieces of episodic information that we acquire from time to time? In these instances, learners usually have to rely on statistical procedures to extract the part of the observed information to be generalized. When, however knowledge is transmitted through human communication, the relevant information to be generalized is selectively demonstrated to the addressee, which makes it possible for him to acquire generic knowledge from a single communicative demonstration (Csibra & Gergely, 2009).

During regular interactions, adults offer some guidance to infants in the processing and interpreting of actions, in acquiring language, and in the conceptual construction of the world. Several decades ago Stern (1977), for example noted that a number of specific changes can be observed in the behavior of adults when they interact with infants. Some of the modifications specific to these, so called ‘infant-elicited social behaviors’ include changes in speech and emotional displays, unusual movement of the head and the body and general changes that characterize the timing of different behavioral manifestations. According to Stern, these behavioral modifications emphasize specific parts of the communicative act against the background of less relevant displays. ‘Infant-elicited social behaviors’ therefore help the infant find the most important and most relevant aspect of the information that is being transmitted.

By now, considerable evidence shows that when adults interact with infants, they modify their behavior across a wide range of domains, including speech (Fernald & Mazzie, 1991; Fernald, 1992; Grieser & Kuhl, 1988; Snow, 1972), facial expressions (Chong, Werker, Russell & Carroll, 2003; Stern, 1977), gestures (Iverson, Capirci, Longobardi & Caselli, 1999; Masataka, 1996; O'Neill, Bard, Linnell & Fluck, 2005) and actions (Brand, Baldwin & Ashburn, 2002). Below I shall describe some of the specific changes that characterize infant-directed communication. Some of these changes are in conjunction with the communicative characteristics of the ‘teaching context’ (see below), in general.

‘Motherese’ and the extension of its concept

It is a well-known phenomenon, that when adults interact with infants, they modify their speech in ways that facilitate infants’ meaningful processing of the speech stream (e.g. Fernald, Taeschner, Dunn & Papousek, 1989; Grieser & Kuhl, 1988; Jusczyk, 1997; Morgan & Demuth, 1996; Shatz & Gelman, 1973; Snow & Ferguson, 1977). When talking to infants, the speech of adults is specifically characterized by heightened pitch, broader pitch range, exaggerated pitch excursions, longer pauses (Fernald, 1985; Fernald & Simon, 1984), increased repetition (Jusczyk & Hohne, 1997), short utterance length, content simplification and limitation to shared experiences (e.g., Snow, 1991; Stern, Spieker, MacKain, 1982) and special placement of new words (Fernald & Mazzie, 1991; Kemler Nelson, Hirsh-Pasek, Jusczyk & Wright Cassidy, 1989; Jusczyk, Hirsh-Pasek, Kemler Nelson, Kennedy, Woodwazd & Piwoz, 1992; Golinkoff & Alioto, 1995). This special language register - defined by its modifications unique to infant (relative to adult-) directed interactions - is called ‘infant-directed speech’, or ‘motherese’, and it has been observed in many cultures around the world. The phenomena of ‘motherese’ turned out to be more general than originally expected.

The communicator

Infant-directed language does not only characterize mothers: it has been observed in most adults regardless of age, gender or parental status (e.g. Fernald, 1992; Grieser & Kuhl, 1988; Jacobson, Boersma, Fields & Olson, 1983; Shatz & Gelman, 1973). To be more specific, it is not even restricted to adults.

Substantial evidence exists of children's use of the prosodic characteristics of infant-directed speech as well (Barton & Tomasello, 1994; Fernald, 1992; Lieven, 1994; Shatz & Gelman, 1973). For example, some results indicate that 4-year-old children speak slower when talking to infants than when speaking with adults. They also show a slight trend towards lowering their fundamental frequency, and they seem to make some changes to amplitude variability as well (see Weppelman, Bostow, Schiffer, Elbert-Perez, Newman, 2003).

The addressee

Further, characteristics of motherese do not seem to be strictly tied to communicating with infants. Specific characteristics of infant-directed speech is present in speech to

foreigners (Wesche, 1994) and close friends or lovers (Trainor, Austin & Desjardins, 2000), suggesting that motherese-type language may be elicited by (a) novice language users, and (b) emotionally intimate companions (Bahrack & Lickliter, 2000).

The modality

Moreover, motherese is not even modality specific, it seems to extend well beyond the language domain. Infant-directed modifications have been found to characterize sign language (manual modality) as well: when caregivers communicate with infants through sign language, their signing tends to be more repetitive and significantly exaggerated (slower and larger) than when signing to adults. These characteristics are strikingly similar to those observed in infant-directed speech (Masataka, 1992, 1996).

Besides speech and sign language, caregivers have also been found to modify their gestures when communicating with infants. Mothers, when interacting with their infants as compared to adults used gestures less frequently, and when gestures were used, they were more likely to co-occur with speech to reinforce or disambiguate the verbal message rather than supplement with new information the content expressed in speech (Iverson, Capirci, Longobardi & Caselli, 1999).

Early communication to infants is multimodal and contains much redundant information across the senses. This phenomenon is called “multimodal motherese.” (Gogate, Bahrack & Watson, 2000). These redundancies include the temporal characteristics and intensity shifts of facial and vocal expressions during speech, and the temporal synchrony of auditory, visual, and tactile communicative components (such as naming or showing an object, while touching the infant at the same time). For example, when teaching word-referent relation, mothers often name an object while simultaneously using gestures such as pointing or showing the object to the infant or touching the infant. Mothers seem to “synchronize” their verbal references and nonverbal gestures for infants in the first 2 years of life: results indicate that 73%–95% of all maternal verbal references to toys were simultaneous with manipulations of the toys for 11- to 24-month-old infants (Messer, 1978). Gogate et al. (2000) studied ‘multimodal motherese’ involving vocal, gestural, and tactile stimuli. Mothers were asked to teach the names of four novel target words (two nouns and two verbs) to their prelexical (5–8 months), early lexical (9–17 months), and advanced-lexical (21–30 months) infants by using distinct objects during a semi-structured play episode. The results indicated that mothers used target words more often than non-target words in synchrony with moving the target object and touching their infants with them. “Multimodal motherese”, therefore is likely to highlight target word-referent relations for infants. Further, mothers tailored their communication to infants’ level of lexical-mapping development: with prelexical infants mothers used target

words in synchrony with object motion more often than with early- and advanced-lexical infants. Mothers' decreasing use of synchrony across age parallels infants' decreasing reliance on temporal synchrony and their increased ability to detect word-referent relations on the basis of object motion alone. 'Multimodal motherese' therefore seems to be adjusted to the environment-organism relation in a dynamical and reciprocal manner (Gogate, Bahrick & Watson, 2000).

Recently, evidence for caregiver behavioral modification has been provided for a new domain: caregivers have been found to modify their actions when demonstrating objects to infants, as compared to adults. Such modifications have been called infant-directed actions (IDAs) or motionese (Brand, Baldwin, & Ashburn, 2002). Motionese, like motherese is not limited to mothers: as compared to adult-directed actions, siblings also seem to tailor their actions when interacting with infants (Lockman, 2001).

Brand, Baldwin, and Ashburn (2002) investigated the properties of actions produced by caregivers while demonstrating the action properties of five novel objects either to their infant (6–8 months or 11–13 months) or to a familiar adult. The interactions with these two groups were balanced in both content and intimacy.

The results of the experiment indicated that caregivers specifically modify their object-related actions when interacting with infants. Relative to adult-directed actions, caregivers demonstrated new objects to infants in closer proximity, with more enthusiasm (conveyed via facial expressions and body movements), higher interactiveness (seeking eye contact and joint attention, offering objects and touching objects jointly) and greater repetitiveness. Further, when demonstrating to infants caregivers used movements that were simpler (presenting shorter sequences and less complex combinations of actions), but were increased in their amplitude (range of motion). These changes have been identified as the action parameters of motionese.

Further studies showed that mothers' behavioral characteristics related to the motionese features of interactiveness (eye gaze and object exchanges) and simplification (number of action types per turn) differ depending on the age of the infant (6- to 8-month-olds compared to 11- to 13-month-olds). Caregivers' gaze was divided into more frequent, shorter gaze bouts for older infants and longer, uninterrupted looks for younger infants. Further, mothers offered less object exchanges per minute to younger as compared to older infants. It was hypothesized that the mothers' tendency for more transition in terms of both gazes and object exchanges when interacting with older infants may reflect sensitivity to the child's increased abilities in attention switching (Brand, Shallcross Sabatos & Massie, 2007).

The function of infant-directed communicative modifications

We have seen that infant-directed modification of communication is a widely observed phenomenon that appears in a wide range of communicative contexts and in different modalities. What is the function of these ‘distortions’ of the normal characteristics of everyday communication?

Infant-directed modifications have been found to have benefits to infants' processing within and across domains (Booth, McGregor & Rohlfing, 2005; Iverson & Goldin-Meadow, 2005). Infant-directed communication seems to be characterized by features that the infant's sensory system is best tuned to (such as elevated pitch or performing actions in close proximity to the infant) (Fernald, 1984). These features have the effect of gaining and holding the infants' attention (Fernald & Simon, 1984; Masataka, 1992), of marking unit boundaries within the flow of communication (Kemler Nelson, Hirsh-Pasek, Jusczyk & Wright Cassidy, 1989; Jusczyk, Hirsh-Pasek, Kemler Nelson, Kennedy, Woodward & Piwoz, 1992; Golinkoff & Alioto, 1995; Brand, Baldwin, Ashburn, 2002) and helping language acquisition and the understanding of intentional actions. Further, by highlighting new information (Fisher & Tokura, 1995) and enhancing the relative salience of important information, ID communication help out the limited information processing and memory resources of infants and might support learning in different domains.

Attention attenuation

One benefit common to all infant-directed communicative modifications is enhancement of infant's attention to the communicative input. The ‘vocal exaggerations’ of motherese, for example has the capacity to elicit and maintain the attention of the infant by accommodating to his or her immature auditory system and cognitive limitations (Fernald, 1992a, b). Infants as early as 1 month of age show a preference to infant-directed speech as compared to adult-directed speech (e.g., Cooper, Abraham, Berman & Staska, 1997; Fernald, 1985) and their attention to visual displays are also enhanced in the presence of infant-directed versus adult-directed speech (Werker, Pegg & McLeod, 1994). Similarly, using sign language in an infant-directed manner resulted in longer accruing times both in case of deaf and hearing infants with no previous exposure to sign language (Masataka, 1996, 1998). When offered the opportunity to experience ID versus AD input, infants consistently pay more attention to ID input in speech-action synchrony (Gogate, Bolzani & Betancourt, 2006) as well.

The attention attenuating effect of infant-directed communication is also observable in the domain of actions: infants prefer to view infant-directed actions as compared to adult-directed actions. In a split-screen preferential looking paradigm (Brand & Shellcross, 2007), for example 6- to 8-month-old and 11- to 13-month-old infants were shown to have a systematic preference for infant-directed action over adult-directed action. Infants' preference for motionese persisted even when action demonstrations were presented with blurred faces. These results indicate that infant-directed modifications involving hands, arms, bodies, and/or objects can sufficiently engage infants' attention even without the presence of corresponding communicative facial expressions and eye-gaze.

Motionese is likely to facilitate infants' attention to action, per se, as well as to the objects upon which the caregiver is acting. Infants might attend longer to objects presented via motionese and/or they might be more likely to attend to certain object properties rather than to others. Since object properties are known to impact infants' manipulation of objects (e.g., Lockman & McHale, 1989; Ruff, 1984), variations in infant attention to objects as function of caregivers' manipulation of the objects in the context of motionese may also influence infants' subsequent object manipulation. Results of a study (Koterba & Iverson, 2009) comparing two groups of infants presented with either high or low levels of motionese parameters (amplitude and repetition) support the hypothesis that motionese might have an effect on infant's object manipulation. In this study, infants looked longer at the objects during presentation when at least one of the action parameters was modified. Further, levels of motionese were found to be linked to variation in (the time, see Lockman & McHale, 1989) and the means of infants' object exploration.

What are the specific features of infant-directed communication that capture infants' attention?

The increased contingent gaze-checking typical to caregivers' infant-directed actions, has been shown to be recognized and preferred by infants relative to characteristics of adult-directed interactions (Hains & Muir, 1996). The higher level of 'enthusiasm' (conveyed via facial expressions and amplified body movements among others) and interactiveness (seeking eye contact, gaze-checking, joint attention, offering objects and touching objects jointly, holding the object closer to the partner) on adults' part for example may also elicit greater attention in infants (Brand et al, 2002). The attention-focusing quality of ID inputs are likely to facilitate the processing of relevant stimuli, to reduce distractions and further, it may communicate to the infant to that the information that is being conveyed to them in an infant-directed manner is highly relevant for them (Csibra & Gergely, 2006).

Functions within the attachment system

Infant-directed speech is believed to have important functions in the attachment relation (Fernald, 1992b) as well.

In early stages of development, infant-directed speech is an effective tool for modulating the infant's internal affective states and reactions by conveying important affective cues and information (Bowlby, 1969/1982; Fernald, 1992b), which can clearly be differentiated depending on whether the caregiver is encouraging the infant, attempting to elicit the infant's attention, soothing the infant, or attempting to inhibit an action (Fernald, 1992b). Speech that is intended to encourage the infant is characterized by consistently rising–falling contours (Fernald, 1992b); when the caregiver tries to sooth the infant, the speech is characterized by falling contours (Papousek, Bornstein, Nuzzo, Papousek, Symmes, 2000); attention eliciting motherese has rising contours (Fernald, 1992b); and, when the caregiver is prohibiting the infant, the speech is characterized by faster rising contours. Infants have been shown to be able to differentiate some of these patterns and to react accordingly (Kearsley, 1973).

Language acquisition

The affective salience of motherese may also have the function of scaffolding the early stages of language acquisition in preverbal infants (Clark, 2003). Other characteristics of infant-directed speech also support language acquisition. Fernald (1992) has suggested that the exaggerated acoustic patterns of motherese, similar to rocking and nursing, have evolved to elicit and sustain infants' attention to speech and to highlight the important parts of the speech stream. Infant-directed language appears to promote infants' analysis of phonology, syntax, semantics and pragmatics.

Dean Falk (2004) goes even further, when analyzing the relation between motherese and language. He believes that language acquisition is not only scaffolded onto motherese in ontogeny. Falk (2004) argues that the same is true in phylogeny. The enlarging of the brains of babies in late australopithecines/early Homo increased the difficulty of parturition, therefore females that gave birth to undeveloped neonates had a selective advantage. The ability of babies to cling to their mothers was, however lost due to their relative underdevelopment at birth. The inability of babies to cling to their mothers resulted in foraging-related changes in maternal care. Mothers had to put down their babies periodically, for example, when going after food. As a result of the reduction in mother-infant physical

contact, prosodic vocalizations and distal mother-infant gestural communication (that entailed maternal silencing, reassuring, and controlling of the behaviors of physically removed infants) appeared and increased in frequency (Tomasello & Camaioni, 1997). Such vocalizing and gestural communication would have had strong selective value. Falk (2004) speculates, that it was by the conventionalizing of certain utterances of the prelinguistic (mainly affective) vocalizations and gestures that protolanguage emerged from. Today's motherese, therefore is believed to be a 'signature' of this evolutionary process.

Multimodal motherese also seems to be effective in facilitating lexical learning in infants. Research suggests that redundant information, such as synchrony, facilitates the detection of arbitrary syllable-object relations or mapping of syllables onto objects by preverbal infants (Gogate, 1999; Gogate & Bahrck, 1998). 7-month-old infants, for example were only able to learn and remember the arbitrary syllable-object relations if there was temporal synchrony between vocalic syllables and the motions of objects. (Gogate & Bahrck, 1998). Further, Gogate et al (2000; Gogate, Bolzani & Betancourt, 2006) found that infants learn novel word-sounds better when objects and utterances are presented in temporal synchrony.

Unit-highlighting, segmentation of information

Another route by which infant-directed communication supports language acquisition (and the understanding of actions) is by helping the segmentation of the complex stream of information into meaningful units (Myers, Jusczyk, Kemler Nelson, Charles-Luce, Woodward & Hirsh-Pasek, 1996).

Specific features of infant-directed speech, such as elevated pitch has been shown to aid in the segmentation of speech by 'articulating' the boundaries between completed communicative acts (Kemler Nelson, Hirsh-Pasek, Jusczyk & Cassidy, 1989; Thiessen, Hill & Saffran, 2005). Motionese is also believed to help infants detect structure and meaningful units within the motion stream (Brand et al, 2002). Typical aspects of ID communication, such as performing communicative acts in a slower and simplified way and with repetitions, for example increase the infant's opportunity to recognize and isolate relevant units of a sequence (Avrahami & Kareev, 1994). Increased interactiveness of mothers, for example in terms of offering and retrieving objects more frequently also highlights the boundaries between action units.

According to Baldwin and Baird (1999), such ‘action parsing’ is necessary for infants to construct representations of meaningful action categories and ultimately to infer the intentions behind the action.

Understanding the intention of actions

The modifications that characterize infant-directed actions are likely to support infants’ learning about intentional human movement. Exaggerating or enhancing relevant features of infant-directed actions help infants process actions appropriately. The enhanced levels of enthusiasm and interactiveness that mothers display during infant-directed demonstrations, the exaggerated smiles and cheers that accompany completed actions may help infants recognize goal achievement. Unintended consequences are also markedly expressed during infant-directed communicative acts. The presence of such amplified intentional cues during infant-directed demonstrations may help infants interpret others’ action in intentional terms (Brand, Baldwin, Ashburn, 2002).

Supporting evidence comes from a study of Lillard, Witherington and Robinette (2001), who asked the question of why children are not puzzled when seeing nonsense actions within a pretence context. According to Lillard, children are able to ‘read’ the intention to pretend from certain characteristics of the pretender’s actions. These characteristics include more talk about the pretence behavior than the real one, more looks to the child, more smiles and sound effect (Lillard et al, 2001; Lillard & Witherington, 2004). These results suggest that certain characteristics of infant-directed actions do help children in identifying the intention behind an action, and therefore help the interpretation of the action.

Summary

In sum, we have seen that infant-directed communicative modifications seem to have a wide effect on infants’ development: they play a special role within the attachment system as a means of infants’ state regulation, they support the understanding and the processing of incoming information (attention attenuation, segmentation, understanding of intention) and therefore support learning in many different domains (action understanding, language etc.).

In the section below, I shall introduce the Theory of Natural Pedagogy and the concept of ‘markedness’, a specific feature that identifies communicative action manifestations and

that characterizes motherese, motionese and all other infant-directed communicative modifications discussed so far. Within the theoretical framework of Natural Pedagogy, specific forms of infant-directed communicative modifications are understood to have two major functions. First, they cue the addressee about the communicative and referential goal of the communicator. Second, they emphasize new and relevant aspects of the communicated information that are to be ‘anchored’ to the representation of the referent (see Gergely, 2007b, for details). Thus, the Theory of Natural Pedagogy considers infant-directed modifications as cues of communicative intentions and ‘magnifiers’ of information to be learnt.

MARKEDNESS AND THE THEORY OF NATURAL PEDAGOGY

We have seen that specific communicative modifications that have first been described as infant-directed have been identified in several different domains and have been found to extend to communicative contexts other than infant-directed interactions.

Communicative action manifestations, in general seem to be identified by their special ‘marked’ forms of motor execution. In this section, I will first define ‘markedness’ and then I will continue with describing Natural Pedagogy, the theoretical framework within which the concept of ‘marking’ has been identified. Finally, I will introduce the reader to the specific ways ‘marking’ can be employed in ostensive referential communication.

The definition of ‘markedness’

‘Markedness’ is a human-specific feature that identifies communicative action manifestations in general. ‘Marking’ is the modified and saliently transformed (exaggerated, slowed down, schematic, and sometimes only partially executed) motor execution of primary procedural motor schemes of intentional actions or emotional expressions. It involves the selective activation of certain components of the primary motor schemes and the transformation of their spatial and temporal patterns which is made possible by the meta-access that humans possess over their primary motor schemes (Csibra & Gergely, 2006).

Humans are naturally inclined to produce such ‘marked’ forms of communicative manifestations when demonstrating to naïve conspecific learners. Motherese, motionese and all kinds of infant-directed communicative modifications discussed so far fit the criteria of ‘markedness’.

“Markedness” has a specific role in the communication system of Natural Pedagogy, which has specifically been adapted to allow the transmission of generic knowledge between individuals (Csibra & Gergely, 2009).

Natural Pedagogy

’Pedagogy’ is hypothesized to be a human-specific adaptation of mutual design whose evolutionary function is the facilitation of fast and efficient intergenerational transfer of relevant cultural information from knowledgeable conspecifics to ignorant juveniles (Csibra & Gergely, 2006; Gergely & Csibra, 2005, 2006) in the knowledge domains of – for example - words, gestural symbols, artifact functions and novel means actions, valence properties of object kinds, social habits, rituals, etc. (Gergely, 2007a; Gergely & Csibra, 2005, 2006; Gergely, Bekkering & Kiraly, 2002; Gergely, Egyed & Király, 2007; Csibra & Gergely, 2006).

The built-in mutual design structure of natural pedagogy involves biological preparedness for providing and receiving relevant cultural information among humans. Caregivers communicate new and relevant information in a ‘recipient design’, ‘tailored’ to the infant’s current knowledge and inferential capacities, whereas infants have a built-in ‘pedagogical stance’ whereby they conceive the ‘teacher’ as a repository of relevant cultural knowledge who can be expected to exhibit cooperative benevolence in communicating only new and relevant information to them. This ‘basic epistemic trust’ makes it possible for the infant to faithfully and quickly learn from the adult the content of the knowledge or skill even when it is cognitively ‘opaque’ to him/her.

How is knowledge transferred within the ‘setting’ of natural pedagogy? Knowledgeable caregivers show a natural inclination to express their ‘communicative intention’ (cf. Sperber & Wilson, 1986) to transfer new and relevant knowledge to ignorant juveniles by addressing them through specific ‘ostensive’ communicative cues. Such ostensive cues include eye-contact, eye-brow flashing, contingent reactivity, or the specific type of marked speech intonation pattern of motherese) to which infants show pre-wired sensitivity and preferential orientation (Csibra & Gergely, 2006). Ostensive cues do not encode information about the content of the relevant knowledge to be transmitted. They purely inform the infant that the person producing the ostensive communicative cue has an ‘overt communicative intent’ that is specifically directed to them (the addressee).

The content of the adult’s ‘referential intention’ (cf. Sperber & Wilson, 1986) is

demonstrated by ‘marked’ cues of ‘referential knowledge manifestations’.¹ The manifested information, the new and relevant knowledge is encoded by the infant as a property of the referent kind and has to be mapped to the representation of the referent.

How is the referent identified? As we have seen, the addressee will start searching for the referent of the information to be transmitted as a result of perceiving the ostensive communicative cues, and therefore ‘reading’ the ‘communicative intention’ of the other. Ostensive cues, such as direct eye-contact (Farroni, Csibra, Simion & Johnson, 2002; Senju & Csibra, 2008), being addressed in motherese (Senju & Csibra, 2008), and turn-taking contingent reactivity (Deligiani, Senju, Gergely, & Csibra, submitted) are necessary to invoke referential expectation in infants. This is indicated by the finding that the referential gestures of gaze-shift and pointing induce gaze-following in infants only if the referential cues were preceded by infant-directed ostensive cues. Once the referent is identified, the new and relevant knowledge is mapped to the representation of the referent kind.

The role of ‘marked’ forms of intentional motor displays in ostensive-referential communication

The cue of ‘markedness’ is employed in two different ways in early ostensive referential communication (Csibra & Gergely, 2009).

Marking as an ostensive-communicative cue

First, marking, as a pure ostensive addressing cue functions to signal to the addressee that the communicator has the intention to engage him in referential communication. Further, marking, as an ostensive cue informs the addressee that the content of the knowledge manifestation that follows the ostensive cue conveys relevant and culturally shared information about some essential property of the referent and its kind Csibra & Gergely, 2009; Gergely & Csibra, 2005, 2006).

An example of marked ostensive cues is being addressed in infant directed speech, where the normative version of a verbal display (adult directed speech) is transformed in a marked manner. Motherese is a ‘purely’ ostensive cue in so far as (in preverbal infants) the communicative content it conveys has no referential content at all.

¹ Importantly, these selective manifestations of relevant knowledge have are ‘tailored’ to the specific learning needs of the addressee. In order to be able to create such ‘recipient-tailored’ knowledge manifestations, the ‘teacher’ needs to monitor the knowledge state of the addressee. This can be considered as a significant cognitive cost for the ‘teacher’.

Marked forms of referential knowledge manifestations

The second way that ‘markedness’ is employed in ostensive referential communication is in the form of marked referential knowledge manifestations. In this case, the behavioral manifestations used to express the information to be conveyed are presented in a perceptually ‘marked’ transformed motor format. Take for example, the difference between the non-communicative motor execution of a stereotypic motor skill (such as ‘opening the window’) and the ‘marked’ manner of transformed motor execution of the same skill when it is performed with the purpose to demonstrate to a naive learner ‘HOW to open the window’. Such ‘manifestatively’ transformed versions of the motor demonstration of the target skill involve schematized, partial, slowed-down, repeated, or selectively exaggerated production of certain aspects of the motor routine that are relevant for the learner to acquire. Such transformations of the primary functional use of the motor skill serve to foreground relevant and background non-relevant parts of the behavior to be learnt.

In the first series of studies presented in my dissertation, I will try to explore if and how a marked form of ostensive communicative cue, namely infant-directed speech might facilitate the establishment of kind representations in infants. In the study to be presented I used an object individuation paradigm that is well suited to and widely used for the studying of infants’ conceptual development.

In the second part of my dissertation, I will present a study which was aimed to shed light on how early marked forms of referential knowledge manifestation might support the establishment of second order representations and their manifestation in emotion regulation and pretend play. In this section, I will argue that natural pedagogy can also be employed in the domain of emotion socialization to identify, sensitize to, and transfer relevant knowledge about those categorical emotions to the infant that are culturally universal and shared among humans. In this view, early infant-caregiver affective interactions (involving ostensively cued ‘marked’ forms of contingent emotion-mirroring) constitute a special case of pedagogical knowledge transfer whereby sensitive caregivers establish second-order representation in infants that identify and encode categorical emotions. At the end of this section I will discuss in what ways early caregiver-infant interactions might shape other developing representational systems, such as infants’ autobiographical memory.

**MARKEDNESS AND INFANTS' CONCEPTUAL DEVELOPMENT:
THE ROLE OF MARKED OSTENSIVE-COMMUNICATIVE CUES IN THE
ESTABLISHMENT OF ARTIFACT KIND REPRESENTATIONS IN PREVERBAL
INFANTS**

In the section below I will argue, that markedness, as an ostensive cue plays a significant role in infants' conceptual development, since it triggers a 'generic encoding bias' in infants resulting in an expectation that the upcoming knowledge manifestation will convey kind-relevant and generalizable semantic information about the referent and its kind. I will investigate this question within the domain of artifacts.

CONCEPTS AND CATEGORIES

Concepts and categories are crucial components of everyday cognition: they reduce the load on our limited memory and perceptual processes, they allow us to make inductive inferences about members of a given category and they are strongly linked to language (Oakes and Rakison, 2003).

The study of concepts has long been a central theme of both philosophy and psychology. Scholars of both disciplines have proposed theories of concepts and concept acquisition. However, the discussion between these two groups of scholars has often been counterproductive because the specific questions that were asked and the nomenclature that was used often did not overlap. During the past decade, the study of sortal concepts and object individuation has attempted to bridge the two communities.

In the following section, I will first try to define the rich set of concepts used in the literature of the field we are about to explore. Following the definitions, I will try to show why object individuation is a useful tool for studying conceptual development. I will then summarize the relevant results of the objects individuation studies that were conducted during the last decade and I will introduce our own studies and will try to describe how they contributed to this field of research.

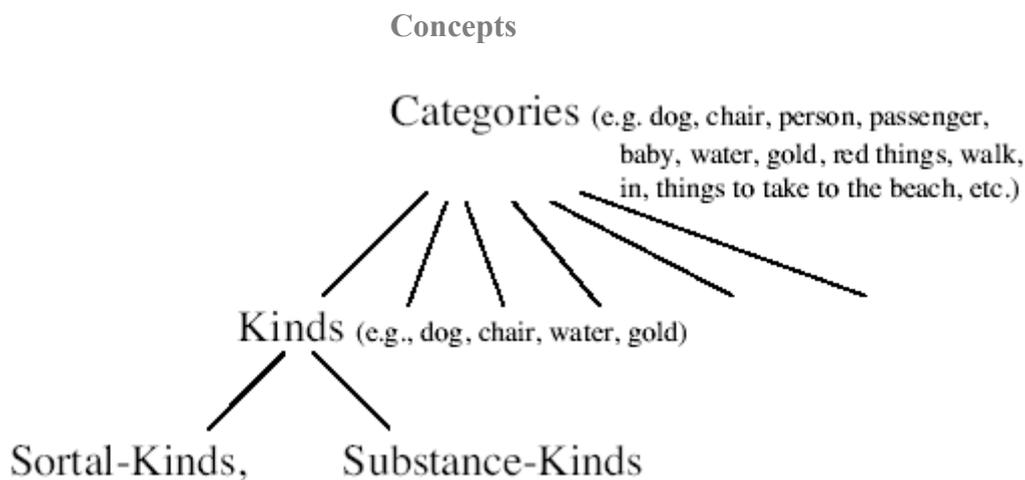
Definitions

What is the difference between a category and a concept?

The notions of ‘category’ and ‘concept’ are closely linked. The meaning of categorization is to ‘render discriminably different things equivalent, to group objects and events and people around us into classes, and to respond to them in terms of their class membership rather than their uniqueness (Bruner, Goodnow & Austin, 1956, p231).

Concepts are ‘mental representations that support categorization behavior’ (Smith & Medin, 1981). They encapsulate the structure and the commonalities that exist among items within categories (Oakes & Rakison, 2003). In this sense ‘categories are collections of things in the world and concepts are the internal mental depiction of those collections’ (Margolis, 1994).

Subsets of concepts: kinds and sortals



All concepts provide criteria for categorization and identity. Those subset of categories that have rich inductive potential are called ‘kinds’. Xu differentiates two subgroups of kinds: ‘sortal-kinds’ (such as table or car), that provide criteria for both identity and individuation (where one object ends and another one begins) (Xu, 2002, 2007) and ‘substance-kinds’ (such as sand and carbon) that do not provide criteria for individuation.

WHAT IS OBJECT INDIVIDUATION?

Object individuation is the process by which we establish the number of distinct objects in an event. In other words, it is the process for establishing numerically distinct individuals that can be tracked through time and space, e.g., objects, people, events (Xu & Carey, 1996; Xu, 2002; 2007). For example, when an object is seen twice at different times, it is of question whether the same object was seen on two different occasions or whether two distinct objects were present in the scenario.

It is important to differentiate object individuation from object identification. Within the object-indexing framework (Leslie, Xu, Tremoulet & Scholl, 1998) one can conceptualize object individuation as the process of establishing object representations regardless to the content of these representations. The result of object individuation can thus be – for example – two empty object files. Object identification, however always involves feature-binding, e.g. the binding of featural/property information to an existing object file, which allows for re-identification at another time. In other words, object individuation answers the question ‘how many’, whereas object identification answers the question ‘which one’.

Why is it useful to study object individuation when investigating conceptual development?

According to Fei Xu (2005), a theory of concepts should account for both categorization and individuation. Studies of categorization usually are concerned with how specific instances are grouped and identified, avoiding the question whether it was the same object that is categorized each time. The study of individuation, in contrast focuses on the problem of persistence of objects, people, and events. In this sense, the study of individuation is an important complementary to the study of categorization.

Studying object individuation is a useful tool for investigating conceptual development, since the criteria by which children individuate objects can serve as a means for investigating how children cognitively segment the world around them. The criterion that is used by a child to individuate objects informs us about the sortal concepts that children use at different ages and how the relative importance of such sortal kind concepts might change over the course of children’s development.

What types of information can be used for object individuation in infants?

At least three sources of information can potentially be used for object individuation: spatiotemporal information, property (featural) information, and sortal-kind information (Hirsh, 1982; Xu, 1997). In the section below, I will briefly summarize how these three types of information are used by infants for object individuation.

Spatiotemporal information

Spatiotemporal information and knowledge of core principles constraining the motion of solid, physical objects (objects travel on spatiotemporally connected paths, two objects cannot occupy the same space at the same time, and one object cannot be in two places at the same time) can be used for object individuation from the earliest months of life (Spelke, Kenstenbaum, Simons & Wein, 1995). These core principles are applicable for all objects, regardless of their kind.

In order to test whether 4-month-old infants can use spatiotemporal information for object individuation, Spelke et al. (1995) seated 4-month-olds in front of a puppet stage with two opaque screens on it. The two screens were separated by some space. Infants first saw a rod emerge from behind the right screen, move towards the right edge of the stage, change direction and return behind the right screen. After a short pause, an identical-looking rod appeared from behind the other screen, moved towards the other edge of the stage, and returned behind the screen. On the test trials, the screens were removed to reveal either an event in which a single rod moved back and forth, or an event in which two identical rods moved back and forth (see Figure 1).

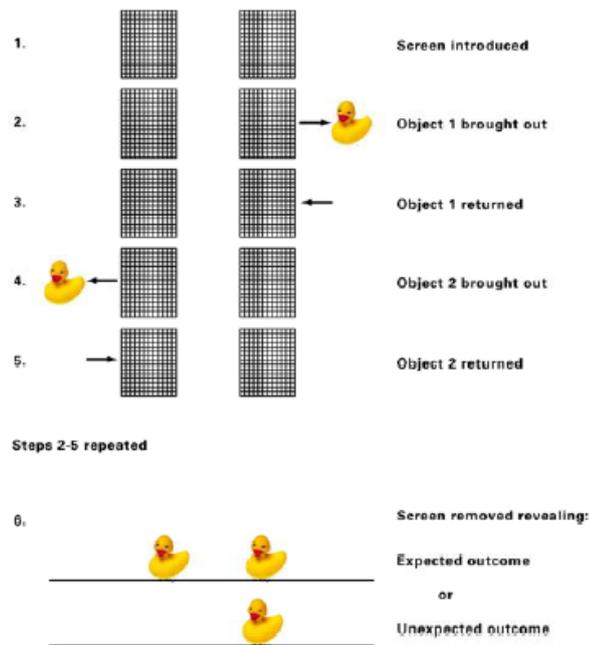


Figure 1.

Spelke et al., 1995; Discontinuous Condition

4-month-olds looked longer at the single rod event on the test trials. The results of this experiment indicated that infants as young as 4 months of age are capable of using the spatiotemporal information embedded in this experimental event. Namely, since objects travel on spatiotemporal continuous paths, it is impossible for objects to go from point A to point B without traveling through the space in between them. Since- in this experiment – no objects were visible between point A and B, infants drew the conclusion that 2 object must have participated in the event.

This finding was replicated and extended with 10-month-old infants (Xu & Carey, 1996). In case of 10-month-olds (1) spatiotemporal discontinuity (objects did not appear between the two screens during the event) lead to the representation of two objects and (2) spatiotemporal continuity (the object traveled through between the spaces separating the two objects) leads to the representation of a single object in the event.

The results discussed above indicate that even very young, 4-month-old infants are capable of using spatiotemporal information for object individuation. Further, the way spatiotemporal information is used for object individuation becomes more sophisticated over time.

Property information

Perceptual property information (such as size, texture, color) is also a useful source for object individuation. Objects usually do not change their shape or color, this information, therefore is a relatively reliable criterion of object individuation. Relatively, since property information is weighted differently when considering different kinds of objects. For example, a light bulb that is turned off is replaced by a light bulb that is on and shines in bright red color. These two objects might well be the same. However, in case a white bag is replaced by a red bag, one finds it highly unlikely that he saw the same object twice.

Wilcox and Baillargeon (1998) found evidence that infants as young as 9 months of age are capable of using property information for object individuation. In one of the conditions, infants saw a box move behind an occluder, then a ball came out from the other side of the occluder. In the other condition, a ball moved behind the occluder and a ball came out from behind the occluder on the other side. Following the events, in both conditions the occluder was removed and there was no object behind it. In case infants were sensitive to property information, they would expect to find the box behind the occluder in the box/ball condition, and therefore would look longer to the unexpected, 'no object' outcome than infants in the box/box condition. This is exactly the looking pattern that was observed.

Young infants' sensitivity to object property information in object individuation tasks was corroborated by a study conducted by Xu and Baker (2003). They used a manual search paradigm: infants saw a cup removed from a box and then replaced into the box. Following this initial presentation, infants were allowed to retrieve something from the box. In the 'no-switch trials', the object that the infants retrieved from the box was the same cup that they saw during the presentation. In the 'switch-trials', however, infants retrieved a different object, a toy duck from the box. After the infants retrieved the object from the box, it was taken away from them and infants searching behavior was monitored. In case infants were sensitive to the property information of the objects, they would be expected to search longer and more persistently inside the box on the 'switch-trials' than on the 'no-switch trials'. This pattern of search behavior was observed with 10-month-old infants.

These results clearly indicate that infants as young as 10 months of age are able to use property information for object individuation.

When the experimental procedure is simplified, even 4.5-months-old infants can use shape and size information, 7.5 months-olds can use pattern, and 11.5 months-olds are able to use color and luminance information for object individuation (Wilcox, 1999; Woods &

Wilcox, 2006). Regardless of the experimental procedure used, the developmental progression of the use of perceptual dimensions for object individuation seems to be relatively constant.

Contrasting spatiotemporal and property information

Can strong spatiotemporal evidence for a single object override property information that is suggestive of the presence of two objects?

In their classical study, Xu and Carey (1996) compared reliance on property versus spatial-temporal information for object individuation in 10 and 12 month-old infants. In this experiment (see Figure 2.) a screen was placed on a puppet stage. Infants first saw an object (i.e. a duck) emerge from behind the left side of the screen, the toy then moved towards the edge of the stage, changed direction and returned behind the screen. After a short pause a different object (i.e. a ball) emerged from the other side of the screen, moved towards the edge of the stage and returned behind the screen again. Infants were familiarized to this event: the whole sequence was repeated 7 times, thus presenting the infants with multiple alternations of the objects: duck, ball, duck, ball, duck, ball, etc. After the familiarization trials the screen was removed revealing either both objects (the ‘expected outcome’) or just one of them (the ‘unexpected outcome’). Infants’ looking time was then recorded and compared to their baseline preference for the one vs. the two-object outcomes. Baseline preference was measured by showing infants the removal of the screen and the two outcomes without the preceding familiarization. In the baseline condition, infants of both age groups looked longer at two-object outcome.

Results of the experiment showed that 12-month-old infants looked longer at the unexpected outcome, suggesting that they used property information (and possibly even sortal-kinds) to represent two numerically distinct objects, whereas 10-month-olds failed to show looking times that were consistent with correct numerical expectations. Their looking time pattern for the one- vs. the two-object outcomes did not differ from their baseline preference. 10-month-old infants therefore failed to draw the inference that there should be two objects behind the screen, whereas 12-month-old infants succeeded in doing so.

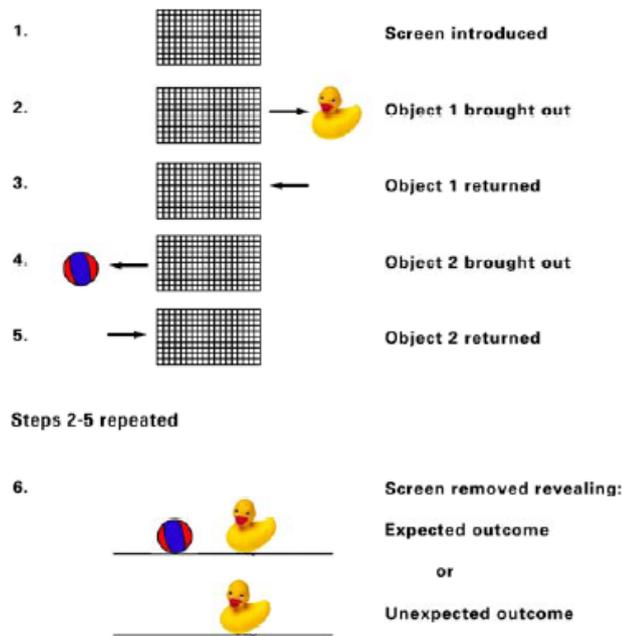


Figure 2.

The experimental setting used in the study of Xu and Carey (1996).

The sensitivity of the method applied was tested by two conditions.

First of all, it was important to know if the failure of the 10-month-old infants in this study was due to their difficulty in encoding the perceptual property differences between the objects, or whether it was a consequence of their inability to take the perceptual property differences (or information on object kind) into account when drawing a conclusion about the number of objects in the event.

Taking into consideration the results of categorization studies conducted with 3- or 4-month-old, that show that infants of this age are able to distinguish dogs from cats (e.g., Eimas & Quinn, 1994), one would expect 10-month-olds to be sensitive to the perceptual differences of the two objects in the Xu and Carey (1996) paradigm as well.

To test the question above, two groups of infants were shown two different familiarization trials (Xu & Carey, 1996). The infants in the first group were shown the two objects alternating (e.g., duck, ball, duck, ball), the other group of infants were shown one object repeatedly. Looking times were recorded. Results showed that infants in the first group habituated slower than infants in the second group, which indicates that 10-month-olds are actually sensitive to the perceptual difference between the two objects.

The second condition tested if strong spatiotemporal evidence could support individuation in 10-month-olds using the same paradigm. Infants were provided spatiotemporal evidence by having the two objects shown to them simultaneously for 2 or 3

seconds at the beginning of the trials. In this case, even 10-month-olds managed to overcome their baseline preference for two objects: they looked longer at the unexpected (one object) outcome. These results indicate that, when provided with clear spatiotemporal evidence, even 10-month-olds are capable of establishing a representation of two distinct objects behind the screen when tested in this paradigm.

Further research using the original Xu and Carey (1996) paradigm shows, that 10-months-old infants are unable to use property information and fail to individuate objects even when more simple objects are used (Bonatti, Frot, Zangl, and Mehler, 2002), or when they are presented with objects of personal significance that were brought from home (e.g., the child's own rattle) (Krojgaard, 2001).

We have, thus seen (see Wilcox and Baillargeon, 1998; Expt. 7 & 8; Xu and Baker, 2003) that infants at the age of 10 months are sensitive to property information and can use this information to individuate objects. Infants of the same age, however failed the tasks of Xu and Carey (1996) (as seen in Krojgaard, 2000, and Bonatti et al., 2002). What is the explanation of the difference in the performance of 10-month-olds when comparing these two sets of studies?

According to Xu (2007), studies conducted using the Xu and Carey paradigm (1996) - where 10-month-olds failed to individuate the objects in the event - provided stronger spatiotemporal evidence (multiple alternations of objects as opposed to one single alternation of objects) suggestive of the presence of a single object and this strong spatiotemporal evidence could override perceptual property information. Purely feature-based object individuation is therefore aggravated in the original Xu and Carey (1996) paradigm, because it contains ambiguous featural and strong spatiotemporal information (multiple alternations of objects as opposed to one single alternation of the objects) that contradicts the expected two-object outcome and places excessive demands on short-term memory (Xu & Carey, 2000).

12-months-olds, however did not fail even the more complex task. What accounts for the difference found in the performance of these two age groups?

The role of kind representations in object individuation

One of the possibilities, that could potentially account for the difference observed between the performance of 10 – and 12-month-old infants in the more complex object individuation task (Xu & Carey, 1996) is that by 12 months, strong spatiotemporal evidence can no longer override perceptual property information. Another possibility is that it is not

property information per se, but the representation of the sortal-kinds that the objects belong to that facilitates object individuation in these tasks.

In a series of experiments (see Figure 3.), information about object kind (conveyed by shape) was compared to information about perceptual properties irrelevant to the sortal-kind that the object belonged to (e.g. color, size and a combination of color, size, and surface pattern (Xu, Carey & Quint, 2004).

Infants were tested in the original Xu and Carey (1996) paradigm. When the objects emerging at the two sides of the screen were of the same kind and differed only in non-kind-relevant properties, such as color (red ball, green ball) or size (small red ball, big red ball), 12-month-old infants did not look longer at the unexpected one-object outcome, suggesting that (even though they encoded them) they could not use the color and size differences to establish a representation of two distinct objects. The same results were found when 12-month-olds were shown perceptual property differences involving a combination of size, color and surface pattern (e.g., a small green and purple tennis ball glittery and a large glittery red ball) (Xu, Carey & Quint, 2004).

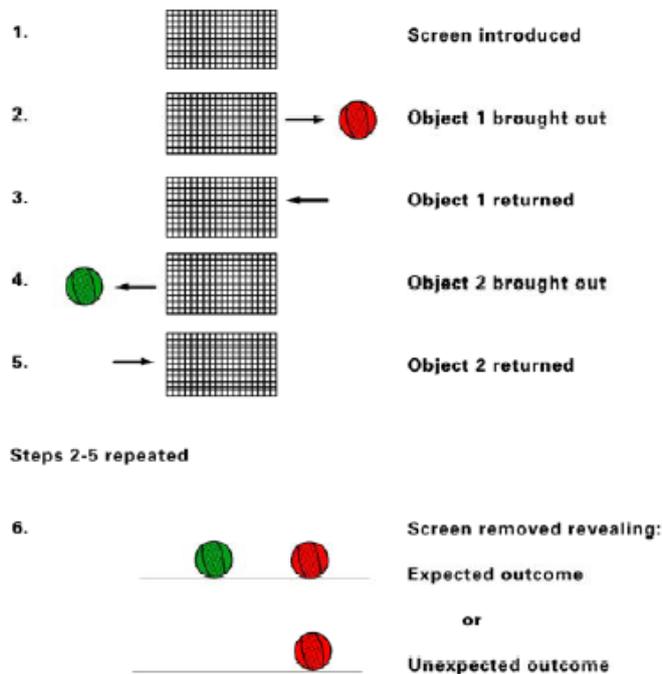


Figure 3.

Testing the role of color in object individuation.

What happens in case the property information of shape is manipulated within the same experimental paradigm? Infants were shown two types of shape contrasts: either a

within-kind (e.g., a sippy cup with two handles and a top vs. a regular cup with one handle) or a cross-kind shape contrast (e.g., a regular cup and a bottle). Infants were found to be perceptually equally sensitive to both types of shape difference. At the end of the familiarization trials, when the screen was removed, only the infants who saw the cross-kind shape contrast expected to see two objects. Infants in the other group, who saw the within-kind shape contrast, did not look longer at the unexpected, one-object outcome.

These findings clearly indicate that only properties that are indicative of a sortal-kind distinction (cup and bottle vs. cup with one and two handles) (Xu, Carey & Quint, 2004) are useful cues for object individuation at 12 months of age suggesting, that kind representations (and not just perceptual property representations) underlie the success in object individuation tasks at 12 months. It was not the assumption of enduring object properties, but the assumption that an object cannot belong to two different kinds, that allowed infants to infer the presence of at least two objects behind the screen when they belonged to two different kinds.

The availability of kind representations in these tasks can also be used for simplifying the scenario. Representing the objects as kinds during these tasks substantially reduce the load that paying attention to property information would require and help to override the strong spatiotemporal evidence. Kind representation will also allow us to store an object directly in short term memory without preserving its idiosyncratic features. Although such a memory trace does not enable definite re-identification of an object (in the sense of ‘this is the same individual as the one I saw before’), it contains sufficient information to conclude that an object of a different kind cannot be the same as the one already stored in the memory. In other words, kind representation provides criteria for object individuation (Xu & Carey, 1996, 2000).

The development of sortal-kind representations

The Spelke et al. (1995) study described above indicates that infants as young as 4 months represent the sortal-kind ‘object’, and can use information on the spatiotemporal constraint that are characteristic to objects (objects travel on spatiotemporally connected paths, two objects cannot occupy the same space at the same time, and one object cannot be in two places at the same time) for object individuation. Many laboratories have replicated

and extended these findings (Aguiar & Baillargeon, 1999; Wynn, 1992) even with younger infants, but the use of spatiotemporal discontinuity in infants younger than 4 months, though observable, is still quite fragile (Aguiar & Baillargeon, 2002; Luo & Baillargeon, 2005).

Representations of other sortal concepts develop towards the end of the first year. By 10 months, infants seem to be able to represent the sortal ‘person’. Bonatti et al. (2002) used the more complex procedure of Xu and Carey (1996) with 10-month-olds. When the objects used were a doll’s head vs. an inanimate object, 10-month-olds expected to see two objects after the removal of the screen, however they failed the object individuation task when presented with a male doll’s head and a female doll’s head, or with two different toy dog-heads in the same event. These findings indicate that, in addition to the sortal concept object, infants represent ‘person’ as a sortal by 10 months of age.

According to Xu and Carey (1996), it is not until 12 months of age that infants represent sortal kind concepts that correspond to ‘basic-level categories’ (such as table or dog)². What developmental process enables 12- but not 10-month-olds to use kind information in object individuation tasks?

In their classical experiment, Xu and Carey (1996) showed that 12, but not 10-month-olds were capable of using property information for object individuation. However, later it was found that only features that are indicative of a sortal-kind distinction (cup and bottle vs. cup with one and two handles) (Xu et al., 2004) proved to be useful cues for object individuation at 12 months of age. Additionally, Xu and Carey observed that those infants who could individuate objects were the ones who – according to their parents – knew the

² According to the results of the object individuation studies, infants do not represent basic-level kind concepts before 9-12 months-of-age (Bonatti, 2002; Wilcox and Baillargeon, 1998; Xu and Carey, 1996). Still, studies on infant categorization often conclude that infants as young as 3-4 months of age are capable of using basic-level kind concepts (e.g., Quinn, Eimas, & Rosenkrantz, 1993; Eimas & Quinn, 1994).

In categorization studies, infants are usually familiarized with different pairs of exemplars from a given category. In the test trial, infants are shown two pictures: one of them is a new exemplar of the old category and the other one is a member of a different category. In these tasks infants as young as 3-4 months of age look longer at the exemplar of the new category. These results seemingly contradict the results of the object individuation studies. But do these results really indicate that 3-4 month-olds represent basic-level kind concepts?

According to Mandler (2003), infants have two distinct systems for categorizing: one for forming categories based on perceptual similarity (perceptual categorization) and another for forming conceptual categories based on similarity in kind (conceptual categorization). Strong conclusion about the presence of kind concept representations can only be concluded when infants represent distinct individuals. Based on the categorization studies mentioned above no such conclusion can firmly be drawn. The categories that these experiments probably reveal are perceptual categories, while it is the conceptual categories that infant possess that we explore when applying object individuation tasks.

name of the objects used in their experiment. On these grounds, Xu and Carey hypothesized that language might play a specific causal role in the development of sortal kind categories.

The 'linguistic labeling hypotheses'

According to Xu (2002, 2007), 12-month-olds may be able to store kind information about objects, like a duck or a ball, because they can retrieve the linguistic label that sorts these objects under certain kinds. According to Xu (2007) the development of sortal kind concepts that correspond to basic level categories goes hand in hand with count noun acquisition.

The 'linguistic labeling hypothesis' (Xu, 2002, 2007) states that verbal labeling of an object functions as an "essence placeholder" and triggers the concept of a sortal kind category. Linguistic labeling leads to object individuation by representing the labeled object as "a particular member of a specific sortal-kind.

Evidence for this proposal comes from an experiment (Xu, 2002) that used the original Xu and Carey (1996) paradigm with the following crucial manipulation: as each object emerged from behind the screen, it was labeled verbally in infant-directed speech. In one of the conditions, the "two-word condition", the two objects that were used in the experiment were verbally labeled – using infant-directed speech – with two distinct labels. Infants heard: "Look, a duck" (when the duck emerged from behind the screen) and "Look, a ball" (when the ball was visible). In the "one-word condition", the same objects were used as in the other condition, however only one verbal label was used. Infants heard: "Look, a toy.", no matter whether it was the duck or the ball that emerged from behind the screen. (On some of the familiarization trials, the object was left stationary on the stage and the infant's looking time was recorded. Half of these trials were silent and half were labeled).

Following the familiarization trials the screen was removed to reveal either one of the objects (the duck or the ball) or both of them. Infants' looking time was monitored. In the "two-word condition" (but not in the "one-word condition") even 9-month-olds expected to find two objects behind the screen (Xu, 2002; for a replication of these results with nonsense words, see Xu, 2002)

Why were 9-month-olds able to individuate objects in this experimental procedure? This effect was clearly not simply due to hearing verbal labels, since infants in the "one-word condition" failed the task. Also, it was not the infants' increased attention (a potential consequence of verbal labeling) per se that accounted for the results. The analysis of the looking time data during familiarization revealed that labeling did increase the infants'

attention, however this increase was the same in the “one-word”, as in the “two-word” condition.

It appears that it was the presence of two distinct labels per se that led to an earlier success on this task by 9-months-old infants. It was argued that the reason for why 9-month-olds did individuate in the “two-word condition” was because the presence of distinctive verbal labels was indicative of the presence of more than one sortal kind categories leading to the conclusion that there must be more than one objects (object individuation). A verbal label, interpreted as a common noun, can facilitate encoding an object in terms of its kind because it can function as an “essence placeholder” for the kind, even if nothing more is known about it (Xu, 2002; see also Xu et al., 2005).

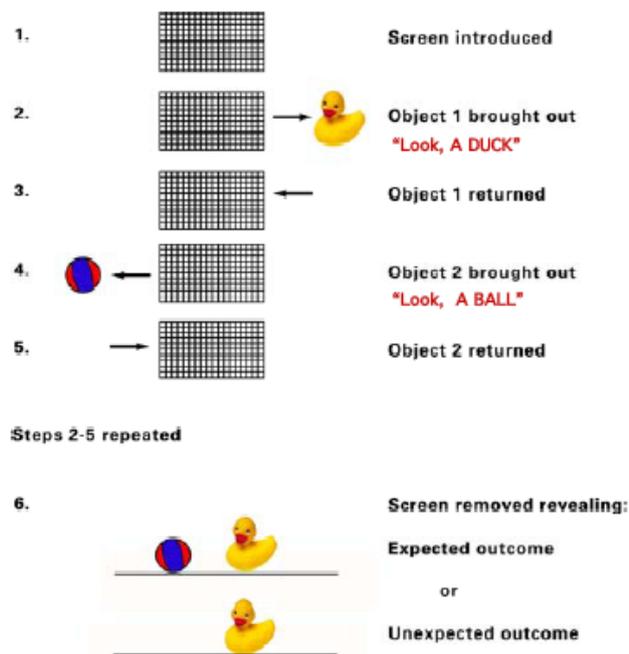


Figure 4.

Experimental setting for testing the role of linguistic labeling in object individuation

Below I will describe further evidence supporting the linguistic labeling hypothesis. In two experiments - using the Xu and Carey paradigm – those 10- and 11-month old infants who (based on parental report) knew the words for the objects used in the task succeeded, whereas thus, who did not know the words failed (Rivera & Zawaydeh, 2006).

Another study tested whether labeling alone could lead to establishing the representations of distinct objects. Using a manual search method, 12-month-old infants either heard the content of the box labeled with two different words or with just one word. Infants expected to find as many objects inside the box as the number of labels they heard (Xu, 2005).

These experiments show that infants expect to see two objects upon hearing two different labels. But is it also true that upon hearing two different labels, infants expect to see not only two objects, but two different kinds of objects?

In an experiment, 9-month-olds were first shown two possible outcomes: either two identical objects or two different objects. Then, the infants heard either two labels several times or one label repeated that referred to the context of the box. Infants expected to find see two different objects in the first case and two identical ones in the second. Further experiments showed that infants expect two distinct words to map onto two different-shaped objects but not onto two different-colored objects (Dewar & Xu, 2009). Since, as opposed to color, shape is a good indicator of kind membership, it seems that even 9-month-old infants expect distinct count nouns to map onto distinct kinds of objects, not just individual objects.

In sum, at the beginning of word learning infants expect count nouns to map onto kinds of objects, and therefore hearing count nouns as labels help them in identifying kinds in their environment.

The further hypothesis of the specificity of the causal role of linguistic labeling in triggering sortal kind assignment was tested by using two non-linguistic stimuli (two different tones or a positive vs. a negative emotive sound) instead of verbal labels in the classical object individuation paradigm (Xu, 2002). In this case no facilitatory effect on object individuation was present in 9-month-olds.

While this result demonstrates that infants rely on more specific information than correlated auditory stimuli when using object labels for object individuation, it does not necessarily support the claim the labels are unique in their power of identifying kinds. Evaluative valence information, expressed by emotive sounds are unlikely candidates to provide kind information about objects because, even if they are interpreted appropriately, they do not convey information about the kind-relevant properties of the object.

Is there any other type of information other than verbal labeling that can provide kind-relevant information about an object?

In our view, kind-based object individuation before the age of 12 months has 2 prerequisites: 1) a specific trigger that informs the recipient about the forthcoming of kind-relevant information, 2) a specific domain that the infant is inclined to treat as a kind.

According to the Theory of Natural Pedagogy (see, for example Csibra and Gergely, 2006), human communication is specifically adapted to transmit generic knowledge between

individuals (Csibra & Gergely, 2009). Humans evolved a special sensitivity and receptive fast-learning attitude triggered by ostensive communicative cues (such as eye-contact, eye-brow raising, being addressed in infant-directed speech) that they interpret as signaling the agent's communicative intention to manifest for the infant new and relevant cultural knowledge about referent kinds that is generalizable and shared by other members of the cultural community. In particular, it is hypothesized that ostensive cues trigger a 'generic encoding bias' in infants resulting in an expectation that the upcoming knowledge manifestation will convey kind-relevant and generalizable semantic information about the referent and its kind.

Despite the presence of the trigger, object individuation will only be facilitated if the trigger is followed by information within a specific domain that the infant is inclined to treat as a kind. Therefore, both the communicative trigger and the specific domain that the information presented belongs to are necessary prerequisites of successful OI.

A type of non-verbal information, function may be one of the specific domains that infants tend to treat as a kind, and thus play a functionally similar role to that of linguistic labeling in triggering kind assignment and, as a consequence, facilitating object individuation in young infants.

There is converging evidence that infants show sensitivity to function within the domain of actions in the first year of their lives. When taking the teleological stance, one-year-old infants readily represent actions by relating relevant aspects of reality (action, goal state and situational constraint) through the principle of rational action, which assumes that goal-directed actions function to realize goal-states by the most efficient ways available (Gergely and Csibra, 2003).

Further, by the end of the first year, infants become sensitive to function within the domain of artifacts as well. Artifacts are dominantly conceived by adults in terms of the function that their creator intended them to fulfill (Kelemen & Carey, 2007). Lacking the relevant information about the history of an object, one can infer such an intended function from other types of information available, such as the shape or other functionally relevant mechanical properties of the object, or its current use (Henrik & Csibra, 2009). Young infants pay attention to functionally relevant properties of objects (e.g., whether they can be used as containers, see Hespos & Baillargeon, 2001) from very early on and they can be trained to encode functionally not relevant but function-correlated properties of novel artifacts (Wilcox & Chapa, 2004). In addition, 11- to 12-month-old infants categorize novel artifacts according to their similarity in functionally relevant properties if, and only if, they have previously witnessed the object's functional use that highlighted specific properties as relevant for the

demonstrated function of the artifact (Tauble & Pauen, 2007). In fact, even 10-month-olds seem to assume that object labels map onto functionally relevant dispositional properties (such as producing a sound effect) rather than onto non-function-related visual properties (such as static object shape) of novel objects (Dewar & Xu, 2009).

Although all these studies suggests that infants are sensitive to artifact function demonstrations from very early on, none of them provides evidence for representing artifacts in terms of their kind inferred from their observed functional use. We hypothesized that communicative demonstration of artifact function alone – in the absence of verbal labeling of the artifacts - would be sufficient to induce kind-based artifact representation in 10-month-old infants. Demonstration of artifact function involves *causal intervention* on the artifact by an agent, which results in an effect. Most everyday tools are typically used to produce their effect on another object, an aspect of artifact use that we wanted to avoid in an object individuation task that measures infants' numerical expectations. To get around this problem, we created novel artifacts that allowed the demonstration of causal intervention and consequent effect on the same object (see Futó, Téglás, Csibra & Gergely, in press).

Hypothesis #1: Function is a specific domain that infants tend to treat as a kind

One of the aims of the present study was to test if 10-month-old infants are capable of setting up artifact kinds on the basis of functional information, and would display this ability in an object individuation task even in the absence of verbal labels.

While previous object individuation studies used objects that were differentiated in terms of features only (such as static shape, color, and pattern) (e.g., Carey & Xu, 1996; Xu, 2000; Bonatti et al., 2002), in the present study novel artifacts were used whose distinctive functional property was dynamically demonstrated by the action of a hand. Most kinds of everyday tools produce their effect on another object, which we wanted to avoid in an object individuation task that measures infants' numerical expectations. Thus, the novel artifacts we created allowed the demonstration of intervention and effect on the same object.

We hypothesized that if the infants encode the manifested function as a generalizable semantic property of the kind that the object belongs to, this may lead to enriched object representations in terms of kind assignment that would then be expected to facilitate object individuation.

To make our study fully comparable to previous studies with 10-month-olds (Xu, 2002) where using features only proved insufficient to induce object individuation, we presented our function demonstration manipulation in the same demonstration context as was

used by the feature only studies. In particular, to capture the infants attention before the object demonstrations, in these studies infants were verbally addressed in motherese by the experimenter (who was hiding behind a non-transparent screen) saying “Hi, baby, hi!”. Since these attention-inducing greeting sounds, while being linguistic, were uttered *before* the object was revealed, it was assumed that they cannot induce object individuation. Indeed, even if infants associated the verbal greeting with the subsequently appearing objects, since the verbal greeting preceding both object presentations was identical, it could not have differentiated between the kinds that the different objects belonged to. In fact, previous work has shown that when identical labels are used to name the two different objects, object individuation is not achieved in 10-month-olds (Xu, 2007). Therefore, in Experiment 1 and Experiment 3 before the objects and the non-verbal function demonstrations were presented infants heard attention-inducing greeting sounds uttered in motherese (“Hi baby, hi!”) that were emanating from behind the non-transparent screen, just as in the case of Xu’s (2002) feature only study

Hypothesis #2: Marking, as an ostensive-communicative cue

It is also possible, that marking, as an ostensive communicative cue (in this case, being addressed in motherese) may itself help induce object individuation. Therefore, if the non-verbal function demonstrations presented in Experiment 1 resulted in object individuation in 10-month-olds, it remains still possible that it was the infants’ expectation to receive generalizable semantic information about object kinds induced by the ostensive cue of being addressed in motherese that facilitated the interpretation of the function demonstrations as indicating a kind-relevant semantic object property that led to sortal kind assignment and to the consequent object individuation effect.

Therefore, Experiment 2 examines whether the dynamic manifestation of the distinctive functional property is itself sufficient to trigger object individuation, or whether this interpretive effect is dependent on the presence of marked ostensive cues (being addressed in infant-directed speech) that trigger a ‘generic encoding bias’ in infants (see Csibra & Gergely, 2006; Gergely et al., 2007). Experiment 2 will thus test whether the facilitatory effect of the function demonstrations observed in Experiment 1 would still obtain when the same function demonstrations are presented without preceding marked ostensive cueing (where instead of the infant being addressed in motherese, the subject will be presented with a physically equivalent non-linguistic attention-orienting cue matched for intensity level and intonational parameters).

EXPERIMENT 1: FULL FUNCTION DEMONSTRATION

Experiment 1 (Figure 5.) was designed to test whether object individuation at 10 month of age could be facilitated by non-verbal information about artifact kinds, namely, by the demonstration of their function.

Infants were tested on a complex object individuation task, following closely the procedure used in Xu and Carey (1996) *property/kind condition*. Infants were shown events in which two different objects emerged from behind a screen and then returned behind it, alternatively for a fixed number of times.

Infants were shown two novel objects different in shape and color with distinctive functional properties unfamiliar to the infants. One of the objects was a rectangular red box with a salient circular switch. The box played music if the switch was turned. The other object was a pink bell-shaped box with a handle on its side and 3 small lights on its frontal surface, which lit up in case the handle was pulled. The face and torso of the experimenter who was manipulating the objects could not be seen; only the hands were visible when moving the objects out of occlusion and demonstrating their respective functions.

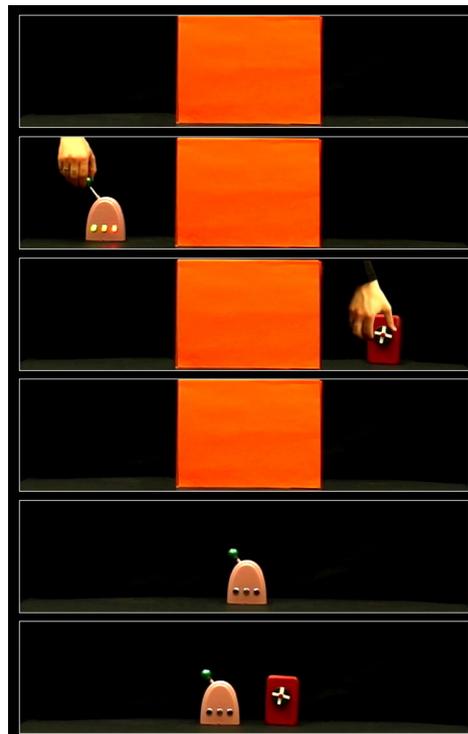


Figure 5.

The sequence of object presentation in Experiment 1.

Method

Participants

Infants were recruited by newspaper advertisements from the larger Budapest area. Before the experiment the parents signed an informed consent form. The infants received a toy gift after the study.

Twenty-four 10-month-olds participated in the experiment. Half of them were assigned to the Baseline Condition (6 males and 6 females; mean age: 307 days; range: 292-324 days), the other half (5 males, 7 females; mean age: 312 days; range: 298-322 days) to the Full Function Demonstration Condition. Seven additional infants were excluded due to experimental error (1), fussiness (5), or inattentiveness (1).

Materials

Stimuli were presented as pre-recorded video clips on a 21-inch computer screen. Stimulus presentation was controlled by PsycscopeX presentation software that ran on a Macintosh computer. The display area was 9 cm in height and 41 cm in width (further measures are given in screen size). In the middle of the display area, a red occluder (19.5 cm wide, 9 cm tall) stood on a dark grey surface.

Two objects were used in the study. One of them was a red rectangular box (4.0 cm tall, 2.7 cm wide) with a green circular dial (diameter: 1.5 cm) attached to its upper-mid portion. A white cross was painted on the dial. Turning the dial on this object resulted in it playing a melody. The other object was a pink bell-shaped box (4.0 cm tall, 3.5 cm wide). Three lights (diameter: 0.3 cm), each surrounded by a silver line were arranged horizontally on the lower third of the object's frontal surface. The colors of the three small lights were red, orange and green. A 1.5 cm long handle protruded from the upper right side of the object, ending in a green sphere (diameter: 0.9 cm). Pulling the handle resulted in the simultaneous flashing of all the three lights.

Procedure

The experiments were run in a silent dimmed room. Infants sat on their parents lap 70 cm from the monitor, with eye level approximately at the center of the monitor. Parents were instructed to keep their eyes closed and not to interact with the infants during the full length of

the measurements. An experimenter watched the infants' looking behavior on a separate computer screen connected to two video cameras (one placed above the monitor focusing on the infant's face, the other placed in one corner of the room) and registered the length of their visual fixation to each test event by pressing a key on the keyboard. The whole procedure was videotaped for offline analysis.

In the Full Function Demonstration (FFD) Condition, each infant received 2 familiarization and 2 test trials. In between trials a visual attractor stimulus was presented to direct the infant's attention to the display before the next familiarization trial began. At the beginning of each familiarization trial, the infant saw the occluding screen only while hearing a greeting ("Hi baby, hi!" in Hungarian) by a female voice in infant-directed speech (2 sec). Then one of the objects was pulled out from behind the screen by a hand, visible from the wrist. The object was moved along the gray surface with steady speed (4 cm/s) following a horizontal trajectory until it stopped at a position 6.5 cm from the edge of the occluder (1.6 s). The object then stayed stationary in this position for a period of 11.8 s during which the function demonstration on the object was repeated twice. The function demonstration consisted of the hand operating the manipulandum (the dial or the handle) on the object, as a result of which an effect was produced (turning the dial produced a melodic sound effect, or pulling the handle made the lights to flash three times). After the first function demonstration, the hand withdrew from the object and disappeared at the top edge of the display area. Then it returned and demonstrated the same operation again. Following the second function demonstration, the hand pulled the object back behind the screen following the same trajectory as when the object was originally pulled out from behind the occluder (1.6 sec). During the 1.5 s interval, when no object was visible, the same female voice was heard saying in infant-directed speech "Watch this!". The second object then was brought out from behind the screen by the hand to the other side of the stage. Two function demonstrations were then performed by the hand exactly as on the other side before, except that it involved the other object. Finally, the object was pulled back by the hand to its starting position behind the screen. At the end of the familiarization trial, an attractor stimulus was presented, and when the infant was looking at the display screen again, the second familiarization trial began.

The first phase of the test trials was identical to the familiarization trials. The second phase of the test trials started right after the second object was placed behind the occluder. The occlusion lasted for 5 s, during which the same female voice greeted the infants in infant-directed speech ("Hi baby, hi!"). Then the hand appeared from above, grabbed the occluder and removed it by lifting it upwards and revealing either one or two objects behind it. Infants' looking times were measured from the appearance of the outcome (one object or two objects).

Test events were terminated when the infant looked away from the computer screen for more than 2 consecutive seconds. The minimum looking time was 1 s and the maximum was 120 s. The order of test trial outcomes (one object or two objects), the object presented during the one-object outcome, and the presentation sides (left or right) of the two objects in the two-object outcome, were counterbalanced across participants.

In the Baseline Condition, infants were presented with two object presentation trials, which were identical to the second phase of the test trials in the FFD condition.

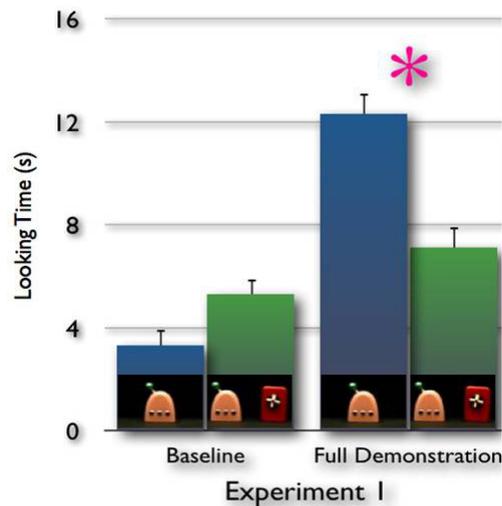
Results

All subjects' looking times were coded off-line. A second coder recoded 50% of the video-records measuring subjects' looking times for the test events. Inter-rater reliability was high ($r = .96$). Preliminary analyses found no effect of order of outcome, preference for a specific object, or gender. Subsequent analyses were therefore collapsed over these variables.

The average cumulative looking times during the familiarization trials were between 129.7 s and 138.56 s across all three experiments and all conditions with the SD varying between 10.0 s and 36.5 s. This measure showed no difference across experiments ($F_{3,42} = 0.317, P = 0.813$).

Looking times were analyzed by a 2x2 ANOVA with Outcome (One vs. Two objects) as within subject factor and Condition (Baseline vs. FFD) as between-subject factor. We found a marginally significant main effect of Outcome ($F_{1,22} = 4.029, P = 0.057$) and a significant interaction between Condition and Outcome ($F_{1,22} = 19.649, P < .001$). Planned t-tests were performed within each condition. Infants tended to look longer at the two-object outcome in the Baseline condition ($t_{11} = 1.943, P = 0.078; M_{one-object} = 3.33$ s, $SD = 2.09$ s; $M_{two-object} = 5.29$ s, $SD = 3.01$ s), while they looked significantly longer at the one-object outcome in the FFD Condition ($t_{11} = 4.12, P = 0.002; M_{one-object} = 12.31$ s, $SD = 2.78$ s; $M_{two-object} = 7.11$ s, $SD = 3.91$ s).

These results were corroborated by non-parametric tests showing that 11 of the 12 infants in the FFD Condition looked longer at the one-object outcome ($P = 0.006$, sign test), while 9 out of 12 infants looked longer at the two-object outcome in the Baseline Condition ($P = 0.146$, sign test). The difference between the two groups was significant ($P = 0.003$, Fisher's exact test).



Discussion

Our findings indicate that not only linguistic labeling, but also function demonstration can induce kind- or property-based object individuation in 10-month-old infants. Earlier findings suggested that conceptual representations of objects that cut across different domains, such as humans vs. non-humans (Bonatti et al., 2002) or self-moving agents vs. inert objects (Surian & Caldi, 2009) are sufficient for object individuation without spatiotemporal evidence or linguistic labeling. The results of Bonatti et al. (2002) show that 10-month-olds succeed on object individuation tasks in which the presence of a human-like face discriminates between the two objects involved in the test events (Bonatti et al, 2002; Bonatti, Frot & Mehler, 2005). Furthermore, recently Surian and Caldi (2009) investigated 10-month-old infants' ability to rely on dynamic features in object individuation processes. They found that infants of that age expect two objects (object individuation) when shown a self-moving non-rigid agent versus an inert object even when these are not accompanied by linguistic labels. The results suggest that infants can use dynamic information to detect agents in individuation tasks before they can rely on shape or surface features. These findings together indicate that for some types of stimulus features (such as being self-propelled or having a human-like face) that map onto highly salient kind categories (such as animate agent and human being) linguistic labeling is not a precondition for sortal kind assignment and object individuation to occur. Our results extend this phenomenon to the within-domain contrast between two artifacts, individuated by their function.

Function is an abstract and kind-defining property of artifacts, which cannot be

directly perceived but has to be inferred from properties (like shape) that are relevant for physical affordance, cultural conventions, or observed usage. Optimal information about function, however, is best provided by observer-addressed demonstration of use, because it could highlight the causally relevant properties of the object by interventions intended to be optimal for identifying object function. Thus, such demonstrations include two types of crucial information: (1) signals that indicate to the observers that the actions are performed for them (ostensive signals, Csibra & Gergely, 2009), and (2) causal intervention on the artifact that reveals its means-end structure by an agent.

EXPERIMENT 2: PARTIAL FUNCTION DEMONSTRATION

Experiment 2 was carried out in order to test whether the facilitatory effect of manual function demonstration on object individuation observed in 10-month-olds is independent of the 1) presence of the ostensive cues (addressing the infant in motherese) and 2) the causal intervention that preceded the function demonstration in Experiment 1.

As hypothesized by natural pedagogy theory (Gergely et al., 2007; Csibra & Gergely 2009) ostensive cues may trigger a ‘generic encoding bias’ in infants leading to an expectation that the agent is likely to manifest new and relevant information about some generalizable and kind-relevant property of the referent. In the present case therefore, the semantic encoding bias activated by the marked ostensive addressing cue of motherese may be necessary to encode the non-verbal function demonstration as a kind-relevant object property that sanctions sortal kind assignment. If so, the facilitation effect would disappear (or be significantly reduced) if the function demonstrations were not preceded by ostensive cues.

Similarly, causal intervention might be necessary for interpreting the demonstrated functions of the objects within a means-ends structure, therefore whether the changes that occur on the objects are interpreted as the function of the objects might depend on the presence of causal intervention.

Experiment 2 tested whether the facilitatory effect of manual function demonstration on object individuation in 10-month-olds is dependent on the presence of the marked ostensive signals (addressing the infant in motherese) that preceded, and the manual intervention that initiated the function demonstration in Experiment 1. Accordingly, this experiment included two conditions ($N = 12$ infants in each), in which we removed from the demonstration one or the other of these types of information. In the Non-Ostensive Function

Demonstration Condition (NOFD), the ostensive signals (implemented in infant-directed speech) that preceded the manual function demonstrations in the FFD Condition of Experiment 1 were replaced by a non-human melodic sound display generated to match the surface acoustic parameters of the original ostensive stimulus. In the No Casual Intervention Condition (NCI), the ostensive signals were present, but the manipulandum on the objects moved by themselves, without the hand's intervention, and produced the same effects that were followed in manual interventions in Experiment 1. In all other respects, Experiment 2 was identical to, and the results were analyzed the same way as in, Experiment 1. We compared the looking times in these experiment to those we obtained in the Baseline condition of Experiment 1.

Method

Participants

The participants consisted of 10-month-old infants. For the Non-Ostensive Function Demonstration (NOFD) Condition, twelve infants were retained for analysis (8 males, 4 females; mean age: 310 days; range: 296-319 days). An additional 6 subjects were lost due to experimental error (2) fuzziness (3) and inattentiveness (1).

For the No Causal Intervention (NCI) Condition, twelve infants were retained for analysis (5 males, 7 females; mean age: 305 days; range: 296-315 days). 5 subjects were lost due to fuzziness (2) and inattentiveness (3).

Materials

The stimulus materials used in Experiment 2 were identical to those of Experiment 1.

Procedure

The procedure of the Non-Ostensive Function Demonstration (NOFD) Condition was identical to that of the FFD condition in Experiment 1 except that the ostensive signals that preceded the function demonstration were replaced by non-human sound sequences matching the surface acoustic parameters of the ostensive signals. This auditory stimulus was created by synthesizing the pitch and rhythmic intonation pattern (without the high-frequency speech

components) of the original stimuli (“Hi, baby, hi!” and “Watch this!”) and playing it backward. The length and intensity parameters of the ostensive signals were thus preserved.

In the No Causal Intervention (NCI) Condition we retained the ostensive signals but removed manual intervention from the demonstration presented in the FFD condition. After the hand brought out an object from behind the occluder, it left the display area. The manipulandum on the object then started to move by itself (the dial turned or the protruding handle extended further outward) and these events followed by the same effects (music or light flashes) as in the FFD condition. Following the second self-animated movement and its effect, the hand reappeared and pulled the object back behind the screen.

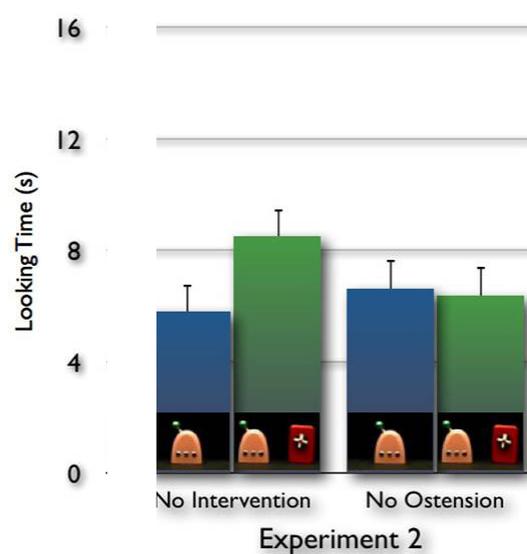
Results

All subjects’ looking times were coded off-line. A second coder recoded 50% of the video-records measuring subjects’ looking times for the test events. Inter-rater reliability was high ($r = .92$). Preliminary analyses found no effect of order of outcome, preference for a specific object, or gender. Subsequent analyses were therefore collapsed over these variables.

A 2x2 ANOVA with Outcome (One vs. Two objects) as a within subject factor and Condition (Baseline vs. NOFD vs. NCI) as between-subject factor yielded a significant main effect of Outcome ($F_{1,33} = 4.252, P = 0.047$) because the infants looked longer to the two objects than to one ($M_{one-object} = 5.25$ s, $SD = 3.32$ s; $M_{two-object} = 6.73$ s, $SD = 4.34$ s). There was no interaction between Condition and Outcome ($F_{2,33} = 1.536; P = 0.230$).

Comparing looking times of the NOFD and FFD (Exp. 1) Conditions in a 2x2 ANOVA with Outcome as the other factor resulted in a main effect of Outcome ($F_{1,22} = 9.535, P = 0.005$) and a significant Outcome X Condition interaction ($F_{1,22} = 7.898, P = 0.010$). We found no difference in the looking times to the one- vs. two-object outcomes in the NOFD Condition ($t_{11} = 1.99, P = 0.846$). A similar analysis with the NCI and FFD conditions resulted in a significant interaction between Condition and Outcome ($F_{1,22} = 17.131, P < 0.001$). In contrast to the FFD condition, infants tended to look longer at the two-object than the one-object outcome in the NCI Conditions ($t_{11} = 1.886, P = 0.086; M_{one-object} = 5.80$ s, $SD = 3.41$ s; $M_{two-object} = 8.50$ s; $SD = 5.64$ s).

Non-parametric Fisher's exact tests confirmed that the looking time patterns in the NCI condition significantly differed from the one we found in the FFD condition ($P < 0.001$), and tended to do so in the NOFD condition ($P = 0.069$) as well.



Discussion

These results suggest that both the presence of manual causal intervention and the presence of infant-directed speech, as a marked ostensive signal are necessary prerequisites of object individuation based on artifact function at 10 months of age. Such a conclusion is consistent with the proposal that kind-based object representation is specifically facilitated by communicative cues that bias infants to expect generalizable knowledge from demonstration directed to them (Csibra & Gergely, 2009). However, we have not demonstrated unequivocally that object individuation is achieved in this task by representing the objects in terms of their kind. This is so because infants could have encoded and compared the two observed artifacts in terms of their visual features, and the function demonstration might simply have played the role of facilitating this process rather than providing criteria for object individuation.

EXPERIMENT 3: DOUBLE FUNCTION DEMONSTRATION

In the final experiment we tested whether demonstrated function alone, in the absence of a difference in static visual features, can support object individuation in 10-month-old infants.

Most aspects of Experiment 3 were identical to Experiment 1. However, we used a sole object, which was created as a fusion of the two objects presented in Experiment 1. We

therefore obtained an object with 2 functions: turning the dial on the object induced a melodic sound effect and pulling its handle lit the lights.

In the Double-Function Demonstration (DFD) Condition, the same ostensive communicative signals (with the same timing) preceded function presentation as in the FFD condition of Experiment 1. However, the same object emerged from either side of the screen during familiarization, on which the hand performed different actions, resulting in different effects. During the test trial, when the occluder was removed, infants were either presented with one object (the same object they had seen during the familiarization), or with two objects that included only one or the other manipulandum (Figure 6.). Crucially, infants had not seen either of these objects before, and they should be novel to them in case they had encoded the visual features of the double-function artifact. We also included a Baseline Condition, presenting infants only with the outcomes of the test trials of the DFD condition.



Figure 6.

Presentation of object functions in Experiment 3.

Method

Participants

Twenty-four 10-month-olds participated in the experiment. 12 subjects were assigned to the Double-Function-Object Baseline Condition (7 males and 5 females; mean age: 309 days; range: 294-319 days), 12 (8 males, 4 females; mean age: 306 days; range: 294-317 days) to the Double-Function-Object Experimental Condition. 3 subjects were lost because of experimental error (1) and fuzziness (2).

Materials

The stimulus materials and procedure used in Experiment 3 were identical to those of Experiment 1 with a few important differences. Only one object was used in the familiarization trials, which was a fusion of the 2 objects used in both Experiment 1 and 2. This object was almost identical to the pink bell-shaped box used in the previous experiments; however, the green circular dial of the red rectangular box was attached to the middle of the pink object. Thus, an object with 2 functions was obtained: turning the green dial on the object caused a melodic sound effect, and pulling the handle caused the lights to flash.

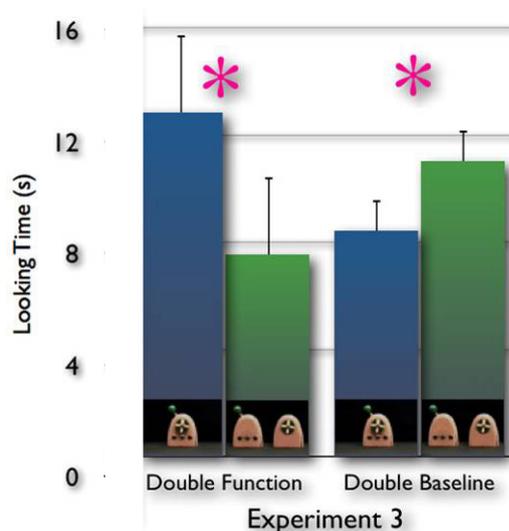
Procedure

The Double-Function Demonstration (DFD) Condition was identical with Experiment 1 except that the same object emerged from both sides of the screen during familiarization and the first phase of the test trials. However, different manipulandum was operated and different effect ensued at the two sides of the occluder screen. During the second phase of the test trial, when the occluder was lifted up, infants either saw one object, identical to the one used in the familiarization and the first phase of the test trial, or two objects: the pink bell-shaped box with three lights and a long handle but without the dial, or the pink bell-shaped box without the lights and the handle, but with the dial the middle of the object. Order and size of presentation were counterbalanced the same way as in Experiment 1. In the Baseline Condition, infants were presented with two object presentation trials corresponding to the second phase of the test trials in the DFD condition.

Results

All subjects' looking times were coded off-line. A second coder recoded 33% of the video-records measuring subjects' looking times for the test events. Inter-rater reliability was high ($r = .90$). Preliminary analyses found no effect of order of outcome, preference for a specific object, or gender. Subsequent analyses were therefore collapsed over these variables.

A 2x2 ANOVA with Outcome (One vs. Two objects) as within subject factor and Condition (Baseline vs. DFD) as between-subject factor on the looking times resulted no main effects but a significant interaction between Condition and Outcome ($F_{1,22} = 19.488$; $P < 0.001$). Infants looked longer at the two-object outcome in the Baseline Condition ($t_{11} = 2.741$, $P = 0.019$; $M_{one-object} = 8.44$ s, $SD = 4.05$ s; $M_{two-object} = 11.04$ s, $SD = 5.81$ s), while they looked significantly longer at the one-object outcome in the DFD Condition ($t_{11} = 3.56$, $P = 0.004$; $M_{one-object} = 12.86$ s, $SD = 9.98$ s; $M_{two-object} = 7.54$ s, $SD = 8.21$ s). These results were corroborated by non-parametric tests showing that 11 of 12 infants looked longer at the two-object outcome in the Baseline Condition ($P = 0.006$, sign test), while 11 of 12 infants in the DFD Condition looked longer at the one-object outcome ($P = 0.006$, sign test). The difference between the two groups was significant ($P < 0.001$, Fisher's exact test).



Discussion

The results of Experiment 3 replicated those of Experiment 1 despite that fact that the two functions were demonstrated on the very same object. In fact, infants' looking pattern

suggests that the two featurally novel test objects appeared to match their memory representation of the familiarization events, while the single test object (even though it was identical to the one they had seen during familiarization) resulted in an apparent violation-of-expectation effect. This suggests that infants did not encode the object during the familiarization events simply in terms of its overall visual features. One possibility is that infants selectively retained the representation of at least some kind-relevant features that were involved in the different function demonstrations. They represented these as the kind-specific properties of two separate artifacts that they inferred to be present. In this case, the two novel test objects matched both infants' kind-based numerical expectation and their expectation about the kind-specific visual features of the artifact kinds inferred. Alternatively, after having inferred the presence of two separate artifacts, it was only this numerical expectation that the infants retained.

In sum, our finding makes it unlikely that infants individuated the objects they had seen purely on the basis of their visual properties. Rather, it was the functional information about artifact kinds conveyed by the communicative demonstration of only one of the functions of the double-function object at a given time that was indicative of the presence of two objects rather than one. In other words, as a result of the communicative function demonstrations, the artifacts in the event became represented in terms of their kinds, which, coupled with the assumption that basic-level artifact kinds are defined by a single essential function, produced the illusionary inference to the presence of two objects behind the occluder.

GENERAL DISCUSSION OF THE OBJECT INDIVIDUATION EXPERIMENTS

It has been shown that verbal labeling facilitates object individuation even at 9 months of age, while visual information about different static object properties in itself fails to induce an inference to the presence of two objects (Xu, 2002; Xu, 2007). Xu hypothesized that language, through the power of common nouns, which refer to object kinds, plays a specific causal role in establishing kind representations for objects. The results of Experiment 1 indicate that representational kind assignment is not a unique causal property of language, as non-verbal demonstration of artifact function alone can also induce kind-based representation of objects in 10-month-olds.

The common causal property of linguistic labeling and function demonstration is that both are capable of identifying directly the kind that an object belongs to. Other types of

information, like emotional valence, visual features, or tactile properties, can also contribute to the recognition of objects, but they do not determine their kind membership. The results of Experiment 3 suggest that infants did not rely purely on visual object properties when inferring the presence of two objects behind the screen. Had they done so, they should have expected to find only a single object there because the visual properties of the double-function object remained unchanged throughout the whole demonstration phase. Thus, two different demonstrated functions, just like two different verbal labels (Xu, 2002), were sufficient to induce the setting up of two 'object files' (Kahneman & Treisman, 1984) in the absence of any other supporting correlated information. This illusion provides evidence that infants (a) used artifact function as an indicator of kind membership, and (b) expected that one specific function would define one specific kind.

The question of how infants represent functional properties of objects and what information is necessary to set up such representations requires further studies. However, our results clearly demonstrate that it was the distinctive demonstrated functions of the artifacts that young infants exploited to discriminate between them. Had they simply relied on the revealed dynamic dispositional properties of the objects, or on the saliently different musical *versus* light effects produced, they should have also succeeded in the No Causal Intervention condition of Experiment 2. The fact that a 10-month-olds individuate artifacts only when they are observed being used instrumentally in goal-directed human actions strongly suggests that what the child is looking for when facing a novel artifact is information about object function (Trauble & Pauen, 2007). Furthermore, infants appeared to expect a one-to-one mapping between functions and artifacts, suggesting that an essentialist construal of artifact kinds (considered to be a late achievement in cognitive development, see Kelemen & Carey, 2007), may constitute the source rather than the outcome of children's early learning about human artifacts (Henrik & Csibra, 2009).

The other type of information that seems to be necessary for triggering function-based object individuation in 10-month-olds is provided by the marked ostensive-communicative signal: infant-directed speech. While previous studies suggested that before 12 months differential verbal labeling is necessary for object individuation of basic-level object kinds (Xu, 2002), in the present study the kind-based object individuation effect in 10-month-olds was induced by ostensive function demonstration alone, i.e., *without* the two objects being verbally labeled when presented. This suggests that it is the ostensive communication of some kind-defining property (such as verbal labeling or function demonstration) that facilitates kind assignment under 12-months rather than linguistic labeling *per se* as was previously proposed (Xu, 2007). This conclusion is in line with the fact that in earlier studies the verbal naming of

the objects was delivered in an ostensive manner.

How do such communicative signals contribute to object representation in terms of function-based kinds? Ostensive signals set up a communicative context that indicates to the child that he or she is being addressed by the demonstrator. Such contexts have been shown to trigger referential expectation in infants (Senju & Csibra, 2008) and have been proposed to induce a 'genericity bias' leading infants to anticipate that the upcoming manifestation will convey kind-relevant information about the referent (Csibra & Gergely, 2009). This anticipation will allow the infants to interpret the demonstrator's intervention and its effect as an optimally formulated communicative act to reveal the most relevant information about an artifact (its kind-specific function) rather than reflecting idiosyncratic usage or an accidental by-product. The finding that in the absence of ostensive signals no object individuation was induced (Experiment 2) indicates that, while the mere observation of current object use is potentially (though not necessarily) informative of the kind the object belongs to, at 10 months of age it is not sufficient for infants to interpret it as the proper function of the object. When the same function demonstration is observed within an ostensive-communicative context, however, 10-month-olds do interpret the manifested function as indicative of an artifact kind. In this case, the effect of functional information on artifact representation was so strong that it even overrode perceptual information as demonstrated in Experiment 3. This suggests that an essentialist construal of functional information is already accessible to infants of that early age, even though for it to be actively applied they still need the priming of a semantic interpretive mode that the cues of ostensive communication activate. That dynamic functional information is a potential source of kind-relevant essentialist interpretation is suggested by the fact that static featural information even when accompanied by ostensive cues does not lead to comparable object individuation in 10-month-olds (see Xu & Carey, 1996; Xu, 2007).

In sum, we have shown that - within the domain of artifact understanding - function demonstration can induce kind assignment and object individuation in 10 months of age even in the absence of linguistic labeling. This effect, however only takes place in an ostensive communicative cueing context (motherese) which induces an expectation of generic, kind relevant information to be demonstrated as predicted by the semantic encoding bias hypothesis of Natural Pedagogy Theory.

All together it seems that markedness, as an ostensive communicative cue induces the kind-relevant interpretation of the upcoming information, therefore plays a crucial role in infants' concept formation and conceptual development in general.

**THE ROLE OF MARKED FORMS OF REFERENTIAL KNOWLEDGE
MANIFESTATION IN INFANTS' REPRESENTATIONAL DEVELOPMENT:
MARKING, PRETEND PLAY AND EMOTION REGULATION**

In this section, I will try to explore how marked forms of referential knowledge manifestations might contribute to infant's representational development. In order to investigate this question, I employed the Theory of Natural Pedagogy in the domain of emotion socialization.

I shall report on an empirical study that was aimed to explore the relationship between 1) 'marked' forms of parental communication during early contingent affect-mirroring interactions, 2) Maternal 'Mind-Mindedness' (see Meins, Fernyhough, Russel & Clark-Carter, 1998), especially 'Affect-Regulative Mentalization' and their relation to the representational and affect-regulative characteristics of pretend play at 2.5 years of age. Morphological similarity between early forms of marked parental communication on the one hand and pretend play, on the other and their similar representational and emotion regulative functions might suggest an inherent functional and possibly developmental relationship between them.

The aim of this study was to investigate the hypothesis that marked forms of parental communication (marked parental knowledge manifestations) during contingent affect-mirroring interactions at 12 months of age are associated with children's better overall pretence competence, more flexible use of pretence and a greater competence in the use of pretence for emotion-regulative purposes at 2.5 years of age. We hypothesized that marking mothers would be more likely to be characterized by 'Affect-Regulative Mentalization' as well, since both marking, as a pedagogical attitude and Mind-Mindedness require the monitoring of the internal states of the infant, and therefore treating the child as a psychological agent. Affect-Regulative Mentalization was believed to predict greater frustration tolerance and a greater competence in the use of pretence for emotion-regulative purposes.

CONTINGENT AFFECT-MIRRORING INTERACTIONS IN EARLY CAREGIVER-OFFSPRING COMMUNICATION

What are contingent affect-mirroring interactions?

A most probably species-specific characteristic of the human attachment system is the inclination of sensitive, infant-attuned caregivers to repeatedly present their infants during affect-regulative interactions with empathic emotion displays that imitatively ‘mirror’ their baby’s momentary affect-expressions (including the empathic mirroring of negative affect displays as well). Research confirms the common impression that caretakers can generally efficiently read their infant’s emotional expressions, and they can successfully attune their own affective responses to match those of the infant (Malatesta, Culver, Tesman & Shepard, 1989; Tronick, 1989).

Several studies show that affective communicative expressions – among other behaviors - are bidirectionally influenced and regulated within the caretaker-infant dyad from an early age (Beebe & Lachmann, 1988; Beebe, Lachmann, & Jaffe, 1997; Cohn & Tronick, 1988; Tronick, Edward, Als, & Brazelton, 1977; Tronick, 1989). Imitative matching of behaviors is frequent during caretaker-infant interactions (Uzgiris, Benson, Kruper, & Vasek, 1989), and the degree of matching and synchrony of these interactions increases with infant age (Tronick & Cohn, 1989). Caretakers and infants do not just ‘imitate’ any behaviors within the dyadic interaction. Mothers, for example produce more contingent imitations (differential facial attunements) of their baby’s’ categorical emotion displays than of ‘random’ facial movements (Malatesta & Izard, 1984; Malatesta et al., 1989). Further, the facial and vocal displays caretakers show in response to their children’s’ emotional displays are emotion-specific (see, for example Tronick, 1989). Young infants are sensitive to parental affect-mirroring and they actively participate in contingent affect-mirroring interactions (Tronick, Als, Adamson, Wise, & Brazelton, 1978; Murray & Trevarthen, 1985).

The functions of contingent affect-mirroring interactions in early caregiver-offspring interactions

Theories of 'sharing'

Many theories suggest that the function of early contingent affect-mirroring interactions could be that it enables the sharing of 'emotions, experience and activities' (e.g., Tomasello, Carpenter, Call, Behne, and Moll, 2005, p. 675.) with each other. Theories of primary intersubjectivity (Trevarthen, 1979, 1993; Trevarthen and Aitken, 2001; Braten, 1988, 1992; Meltzoff & Gopnik, 1993; Meltzoff & Moore, 1977, 1998; Hobson, 1993; Stern, 1985) often assume this 'sharing of psychological states' to be a species-unique human motivation itself. They also hypothesized, that sharing is the ultimate goal of human interactions from the earliest months of life.

Tomasello shares the view that the function of early contingent affect-mirroring interactions is sharing. He, however does not consider sharing to be the goal of human communication. He holds that 'the motivation to share feelings, experiences and activities with the other persons' (Tomasello et al, 2005, p. 687) is inevitable for the construction of shared goals and for having coordinated action roles for pursuing those goals. This shared intentionality enables unusually complex forms of collaboration to emerge, which – in turn – resulted in modern human cultural organization.

In sum, theories of primary intersubjectivity and Tomasello's theory consider 'sharing' to be a crucial element of contingent affect-mirroring interactions. While theories of primary intersubjectivity view sharing as the ultimate goal of contingent affect-mirroring interactions and all human communication, Tomasello believes that sharing is important because it is necessary for complex form of collaboration to emerge.

The Social Biofeedback Theory and the Theory of Natural Pedagogy

Sensitization to the infant's internal states, the establishment of secondary representations of emotions and emotion-regulation

According to the Social Biofeedback Theory infants initially do not have differential awareness of their basic categorical emotion states. Early caregiver-infant contingent affect-mirroring interactions contribute greatly to the development of infants' perceptual sensitivity to their internal affect states (Gergely and Watson, 1996, 1999).

The Social Biofeedback Theory assumes the existence of a 'contingency detection module' (Watson, 1979, 1985, 1994), an innate perceptual and representation-building mechanism. The 'contingency detection module' automatically analyzes the conditional probability structure of the contingent relations (temporal contingency, spatial similarity and correspondence of relative intensity) between stimulus events and responses in multiple modalities. The module uses two different and independent indices for calculating the magnitude of overall contingent relatedness. One of these indexes is the 'sufficiency index' that registers the conditional probability that an emitted response is followed by a stimulus event. The other, the 'necessity index' monitors the likelihood that a given stimulus was preceded by a response. With the usage of these two indexes, the contingency detection device is able to estimate the degree of causal relatedness between responses and stimuli (Gergely and Watson, 1999). There is evidence that infants as young as 2-months-of-age are able to detect the contingent relation between their responses and external stimulus events (Watson, 1972) and the detection of causal control over the environment is positively arousing for them (Watson, 1981). Further, while infants younger than 3 months generally prefer perfect contingencies, it appears that infants older than 3 months have a clear preference to explore high but imperfect degrees of response-stimulus contingencies (Bahrick and Watson, 1985; Watson, 1985). According to Watson (1994), infants' initial preference for perfect response-stimulus contingencies helps the differentiation of the self from the environment, supports the construction of the primary representation of the bodily self. The switch of preference from the perfect to the high, but imperfect contingencies at around the age of 3 months presumably supports or reflects a change in the infants' orientation from the self (self-other differentiation) to the social environment. A responsive social environment typically provides the child with high, but imperfect contingencies, which will now serve as further stimuli for the infant's representation building mechanisms.

Gergely and Watson (1996, 1999) hypothesized that early in infancy, the internal state cues of the infant's emotions initially cannot be consciously accessed as a distinctive (categorical) emotion state by the infant. However, during contingent affect-mirroring interactions, the caregiver repeatedly provides the infant with a highly contingent external reflexion of the baby's internal affect state. The infant's contingency detection module can detect the contingent relatedness between the internal cues of the infant's emotional state (physiological state changes and proprioceptive stimuli) and the external affect-mirroring display of the caregiver. As a consequence of the perceived and repeated contingency, the infant will gradually become sensitized to the internal stimulus cues (of the experienced emotion) that are involved in the contingency relation. Further, the baby will identify the set

of internal stimuli that correlates highly with the external affect-mirroring display and, consequently to the distinctive emotion category that the infant experiences. Therefore, as a result of the repeated contingent-affect-mirroring interactions that the infant experiences, he/she will gradually become aware of the differential internal cues that are indicative of certain categorical affect states and will become able to detect and represent his particular dispositional emotion states even without an external affect-mirroring biofeedback cue.

In case of interactions with sensitive caregivers, the infant quickly recognizes the contingent control he/she exhibits over his/her social environment. The identification of this causal control results in an elevated subjective sense of causal self-efficacy and agency, and an increased level of positive arousal. Therefore, sensitive caregivers, who show a high level of contingent reactivity to the infant's emotion expression, contribute directly to the online emotion regulation of the infant.

So, while theories of intersubjective sharing consider sharing to be an important aspect of contingent affect-mirroring interactions, the Social Biofeedback Theory emphasizes the (1) on-line emotion-regulative effect of contingent affect-mirroring interactions and (2) the role the social environment plays (through the contingency structure of early mother-infant interactions) in the development of the young child's primary sense of self-efficacy and social self-agency (Gergely, 2002; 2007a; Gergely & Watson, 1996).

A paradox

The Social Biofeedback Theory, thus tells us that an elevated level of positive arousal is generated in the child as a result of the recognition of having high degrees of causal control over the behavior of the social environment during affect-mirroring interactions. But infants are not only sensitive to the contingency structure of the caregiver's emotional displays, they are also sensitive to the quality of emotion reflected by the caregiver.

It is of utmost importance to identify the referent of the expressed emotions unmistakably. Imagine a crying baby and her caregiver mirroring the negative emotion display of the infant. The infant might as well attribute the expressed emotion to the caregiver as her actual, realistic negative affect state. The consequent perception of the parent's negative emotions could induce escalation – rather than soothing - of the baby's negative emotion state.

How are we capable of telling these two kinds of emotion expressions apart? How do we identify the referent of an expressed emotion as being the communicator's own emotional

state or as being outside the communicator's body, as in the case of social referencing and empathic affect mirroring interactions?

The resolution of the paradox: the 'markedness' of communicative knowledge displays

For the resolution of this paradox, we must consider that in humans, emotion expression appears in two forms of motor execution during affective communicative interaction:

1. in normative, canonical displays that expresses the real emotional state of the communicator
2. in marked manifestative displays

The 'markedness' of emotion-mirroring parental expressions is a subgroup of 'marked' manifestative knowledge displays of pedagogical knowledge transfer in general.

The 'markedness' of knowledge manifestations functions as a cue for the infant showing that the communicative content conveys relevant and culturally shared information about the referent. The 'markedness' of knowledge manifestations also help the child identify those aspects of the communicative content that convey new and relevant information (see Gergely, 2007b).

Here we argue, that early caregiver-child marked contingent affect-mirroring interactions can be considered to be a special case of pedagogical knowledge transfer (emotion socialization), where parents transfer relevant knowledge to the infant about culturally universal categorical emotions that are shared among humans. What is very unique about marked contingent affect-mirroring interactions is that the referent of the relevant knowledge is not an object in the environment, rather, it is the inner state of the infant.

We have seen, that according to the Theory of Natural Pedagogy, caregivers show a natural inclination to use 'ostensive' communicative cues (such as eye-contact, eye-brow flashing, contingent reactivity and marking) to express their 'communicative intention' (cf. Sperber and Wilson, 1986) to transfer new and relevant knowledge (Csibra and Gergely, 2006). Ostensive cues do not encode information about the content of the relevant knowledge to be transmitted. They purely inform the infant that the person producing the ostensive communicative cues has an 'overt communicative intent' that is specifically directed to them. (In case of social-referencing, the communicative intent is always expressed, it can, however sometimes be missing from more automatic instances of empathic affect-mirroring interactions). After 'reading' the 'communicative intention' of the other, the infant will start

searching for the referent of the information to be transmitted. This referent identification process is based on the adult's presentation of referential cues (such as eye-direction, gaze-shift or pointing). The content of the adult's referential intention (cf. Sperber & Wilson, 1986), the 'referential knowledge manifestation' is cued by being performed in a 'marked' manner.

During contingent affect-mirroring interactions, the cues of markedness of emotion mirroring parental expressions help the infant inhibit the attribution of the expressed emotion to the caregiver as her 'real' feeling by referentially 'decoupling' the emotion display from her (Gergely & Watson, 1999). The same cues trigger the infant's pedagogical stance, therefore the infant will start searching for the referent of the expressed emotion. The referential cues (such as gaze shift or pointing) exhibited by the caregiver help the child identify the referent of the expressed content. Since – during affect-mirroring interactions – the caregiver is looking at the child while displaying her emotion-reflecting expressions, the infant's attention will be directed towards his or her own face and body as the likely spatial locus of the referent to which the 'marked' (and 'decoupled') emotion-mirroring display should be referentially 'anchored'. Infants, at the same time perceive their own face and body as being the spatial locus of their automatic facial-vocal emotion expressions. The infant's contingency detection modul identifies that it is the emotion expressions of the self that exercise contingent control over the caregiver's mirroring responses (see Gergely & Watson, 1996). The infant will identify its own internal emotional arousal state and its motor expressions as the referent of the caregiver's 'marked' mirroring display. As a result, it will be the infant's own primary and procedural emotion program to which he/she referentially 'anchors' the representation of the caregiver's 'marked' mirroring displays. Therefore, it will be these mirroring displays that the infant internalize as the second-order representations of his/her own primary, procedural emotions. Thus, by communicating about the child's inner states using ostensive communicative cues, the infant's social mirroring-environment supports the building of cognitively accessible second-order representations of emotional categories.

Second-order representations of the inner states of the infant (as described above) support the development of successful emotion regulation and coping by providing the representational basis that make emotional self-monitoring, secondary re-appraisal processes and the affect-regulative use of pretence possible.

Emotion regulation, parental mentalizing and autobiographical memory

Another route through which marked forms of affect-mirroring interactions might be related to the emotion-regulative capacity of the child is through parental mentalizing (see, for example Sharp & Fonagy, 2008).

The ways emotionally stressful situations are treated within the framework of early attachment relationship seem to have long-term effects on our psychological well-being. It is well established that memories of early life events – through automatic responses and the self, social and directive functions of autobiographical memory - can have substantial influence on the development of our personality and relationships. They can provide the basis for long term motivations and attitudes and can have substantial effect on our self concept and later attachment relationships (Pillemer, 1998, 2003).

In a series of studies we have contrasted the phenomenal and narrative nature of early and later autobiographical memories (see Futó, 2005; Futó & Kónya, 2008; Futó, 2009a,b). The study was based on a semi-structured autobiographical memory interview. Subjects were asked to recollect eight memories from four different periods of their lives. The results of the study indicate that despite the paucity and the observable faintness of early memories, the emotionally most intensive early childhood memories seem to retain their intensive phenomenal characteristics and first-person perspective, and they are virtually indistinguishable from the most vivid recent memories in terms of their phenomenal characteristics and perspective. Further, it is not the specific or repeated nature of the original experience; rather, it is purely the emotional valence of the memory that predicts its phenomenal vividness.

Thus, memories of highly emotional early life events seem to persist well into adulthood and they constantly influence our psychological well-being through our automatic responses and through the self, social and directive functions of autobiographical memories (see Pillemer, 2001). The content of these autobiographical memories is influenced by the emotion-regulative capacity of the child that develops in the same social context within which the constant interpretation of life events takes place.

What aspects of the parent-child interaction might influence the child's developing capacity of emotion-regulation? We have seen that parental marking is hypothesized to lay the grounds for emotion-regulation by contributing to the establishment of its representational bases. Further, Sharp and Fonagy (2008) specifically hypothesized that parental mentalizing (the parents' capacity to treat the child as a psychological agent) could be related to emotion

regulation. ‘Mind-mindedness’ is a well-studied measure of parental mentalizing and it is defined (Meins et al, 1998) as the mother’s tendency to focus on mental and emotional characteristics when given an open-ended invitation to describe her child. ‘Mind-mindedness’ does not reflect competence in mentalizing abilities, rather, it reflects the individual’s readiness to use their understanding of internal states for the description of other people’s behavior (Meins, Harris-Waller, Lloyd, 2008).

In the framework of natural pedagogy (Gergely & Csibra, 2006), in order to be able to transfer new and relevant knowledge to the learner, good teachers must track what knowledge the learner has already acquired, and adjust their communicative acts accordingly. The ‘recipient design’ of marking, as a pedagogical attitude (no matter if it is used in teaching about objects or in emphatic mirroring) thus requires that the teacher invests into the monitoring of the internal states of the learner, which implies that the teacher treats the child as a psychological agent. Thus, marking parents are likely to be Mind-Minded as well. It is important, however to mention that some parents who give Mind-Minded descriptions of their children in emotionally neutral situations might not be able to remain Mind-Minded in emotionally stressful situations. Having a measure of ‘Affect-Regulative Mentalization’ could therefore be useful, when examining the relationship between parental mentalizing and children’s emotion regulation. Children of mothers characterized with ‘Affect-Regulative Mentalization’ are likely to have greater competence in emotional regulation, because their mothers remain Mind-Minded even in emotionally stressful situations, therefore they do get a chance to learn about their emotions, to develop second-order representations specifically of their emotional states during stressful situations. Children of mothers characterized with ‘Affect-Regulative Mentalization’ are also likely to have greater frustration tolerance, since they generally get adequate support in emotionally stressful situations, they develop the trust that soothing will come, stressful situations are bearable and survivable, and they also have an available model that is capable of facing stressful situations and coping with them.

PRETEND PLAY

One of the major developments of the second year of human life is the emergence of the ability to pretend. Pretend play occurs when children explore, experiment, and interpret social situations within an imaginary context or environment with the use of symbols (Vygotsky, 1978). Leslie (1987) identified three basic kinds of pretending: (a) object

substitutions (a banana is a telephone), (b) attributions of properties (the hat is wet), and (c) imaginary objects (a child pretends to hold something and says that he has a kitty in his hand).

Pretend play first appears in typically developing children between 18 and 24 months (Leslie, 1987; Piaget, 1962), although pretense activity of children as young as 15-16 months of age has been observed in free play (e.g. Fenson & Ramsay, 1981) as well as in experimental settings (Bosco, Friedman & Leslie, 2006; Walker-Andrews & Kahana-Kalman, 1999; Onishi, Baillargeon & Leslie, 2007).

Young children do not just produce pretense: they also recognize the pretence activities of others and participate in shared pretence activities. These multiple pretence abilities seem to be yoked and to occur at approximately the same time in development (Leslie, 1987, 1994). A period of solitary pretence does not seem to exist: pretend play has a social and communicative aspect from the very beginning (Friedman and Leslie, 2007).

Theories of Pretend Play

Traditional theories of Pretend Play

Traditional theories of pretend have only been concerned with solitary pretend play production, and they considered the emergence of pretense to be the consequence of certain new cognitive processes.

Piaget (1962), for example considered pretend play to be an extreme form of assimilation, where the object that is present shows a vague similarity to another, currently absent object. The object that is present evokes the mental image of the absent object and becomes assimilated to it, resulting in the creation of a symbol. Contrary to linguistic signs, the relation between the signifier and the signified is not arbitrary; rather, the props of pretend play show some iconic similarity to the objects that they represent. The ability to pretend therefore depends on this capacity to represent absent objects and situations.

Fischer (1980) considers the emergence of pretend to be the consequence of the formation of elementary representations resulting from the coordination of two (or more) sensorimotor systems.

According to Fein (1975), pretense involves transformations in a sense that certain subset of - for example - object features are selected (while others are ignored), and an analogy between separate entities are drawn based on their matching, selected features.

By the age of two years, children come to understand (1) pretend stipulations, (2) causal powers, (3) the suspension of objective truth and (4) an unfolding, causal chain in pretence. Harris (1995) considers the emergence of pretend play to be a consequence of ‘simulation’ - children’s ability to stipulate make-believe entities and understand them in their own mind. When understanding pretence stipulation, the child must remember these stipulations for the whole duration of the pretence episode. This is achieved by the ‘flagging’ of the relevant prop and the identity or the content of this prop. Importantly, the ‘flag’ is attached to the mental representation of the specific pretence episode, and not to the mental representation of the prop or its category.

ToMM Theory

According to Leslie (1987, 1994), pretend is an early manifestation of theory of mind (Premack & Woodruff, 1978). A specialized neurocognitive mechanism, the Theory of Mind Mechanism provides the basis of our ability to learn about the mental states of others. One of the most important functions of ToMM is to introduce metarepresentations. Metarepresentations introduce and are organized around a basic set of mental state concepts (PRETEND, BELIEVE, and DESIRE ETC.) and they allow us to attend to and learn about hidden mental states (Leslie, 2000b). Even very young children already possess the concept of PRETEND that allows the child both to engage in and to recognize pretend. Because of their shared root, the ability to engage in pretend and to recognize pretend emerge at around the same time in development.

According to Leslie, during pretend play episodes, there is a danger of ‘representational abuse’. In pretend, there are two simultaneous representations of the same situation. One representation is for how the situation is actually perceived and the other represents the pretended content or quality. In order not to get confused about fact and fiction, it is necessary that even young children—in pretending and seeing others pretend—somehow cognitively keep apart the propositions describing the pretence content ('this is an apple') and propositions about the real world ('this is a ball'). In case both representations were primary (represent aspects of the world in an accurate, faithful, and literal way, such as perception does), a contradiction would arise, since both representations refer to the same situation. Imagine that a child is pretending that a banana is a telephone. In case the child represented the pretend link by connecting the mental concept for banana with the concept for telephone, both concepts would change their meanings and become overextended. The more often the child engaged in pretend play, the more concepts would change their meaning in arbitrary

ways and the more chaotic the child's concepts would become. This is what Leslie (1987) called the problem of representational abuse.

According to Leslie (1987), the problem of representational abuse could be solved by the "copying" of a primary expression into a metarepresentational context and by separating or "decoupling" the copy from its original. Mental operations within the pretence scenario would then be operated on the copy. For example, the perceptual representation **this is a banana** is decoupled to '**this is a banana**'. The reference, truth, and existence relations of the first-order expression are suspended while it appears in the second-order, metarepresentational context, therefore it can be manipulated freely without the fear of representational abuse. Meanwhile, the primary representation, - this is a banana - will continue to exist parallel to the metarepresentation with its normal reference, relations and influence. Certain parts of the "decoupled" expression can temporarily be bound or "anchored" to primary representations ("this banana is a telephone"). In this way, while avoiding the representational abuse, the pretense can still be related correctly to the actual situation. Leslie (1987) defines the ability to pretend as **PRETEND (a, 'e_i', e_j)**, where **a** is an agent, '**e_i**' is a decoupled expression and **e_j** is a primary representation of the current perceived situation. This is a fundamental ability in normal children, which, once having emerged does not develop any further. On the other hand, there are a large number of factors that will affect the possible content of pretense. Two such factors will be especially important, namely level of conceptual development and extent of encyclopedic knowledge.

The behavioral theory - the 'behaving-as-if' account

According to the Behavioral theory (e.g. Harris, Lillard and Perner, 1994; Jarrold, Carruthers, Smith and Boucher, 1994; Lillard, 1994; Nichols and Stich, 2000, 2003; Perner, Baker and Hutton, 1994) young children do not possess the mental state concept PRETEND, rather, they represent pretense only as a kind of behavior. It is only later in development that children somehow acquire the mentalistic concept PRETEND.

According to the Behavioral theory, when young children engage in pretend they stipulate a scenario P, such as, THE BANANA IS A TELEPHONE. Differentiation, however has to be made between the real world and the make-believe (or as, for example Perner (1991) calls it: "as if" or using Nichols and Stich (2000) expression: "possible world"). P is decoupled, so the child does not actually believe that P is true. (Though Behavioral theories may differ in the terms used for decoupling or in their accounts of how decoupling operates, these differences are not relevant to the present discussion.) The child then *behaves as if* (see

Perner, 1991) P were true or, in a way that would be appropriate if P were true (see Nichols and Stich, 2000, 2003).

According to the Behavioral theory, pretence is simply a way of non-standard behavior, it is behaving as if some counterfactual state of affairs was the case, and an explanation of pretence does not need to require that the child represents what he or she is doing. When a child recognizes pretence, he represents the situation such that THE OTHER PERSON BEHAVES IN A WAY THAT WOULD BE APPROPRIATE IF P WERE THE CASE (Nichols and Stich, 2000, p. 139). Young children thus understand pretence as a kind of reality-inadequate behavior.

Evidence supporting the Behavioral Theory comes from a series of studies by Lillard (1993, 1998). Children heard stories about “Moe”, a troll from another planet. At the beginning of the experiment, children saw Moe performing an as-if-behavior, for example they saw Moe hopping like a kangaroo. Then, there was a premise stating that Moe was failing to fulfill an essential background requirement for kangaroo-pretence. In one set of studies, Moe lacked some cognitive prerequisites: he has never seen a kangaroo and did not know that kangaroos hopped (Lillard, 1993). In another set of studies, Moe's behavior lacked the intentional structure—he did not want to hop like a kangaroo (Lillard, 1998).

After children correctly answered the control questions (‘Does he know that kangaroos hop? Is he hopping like a kangaroo?’), they were asked the crucial test question if Moe was pretending to be a kangaroo or not. Children up to 4-5 years of age gave an incorrect answer to the question: they said that Moe was indeed pretending to be a kangaroo.

However, the blocking of extensional reading of premises is not well established in children before the age of 4 to 5 (e.g. Hulme, Mitchell & Wood, 2003). According to Rakoczy (2008), the failure of 4-5 year-old children on the “Moe” task might be due to such task demands having to do with intentionality.

The Intentional Behavioral Theory

Rakoczy et al (Rakoczy, Tomasello & Striano, 2004) developed a further account of pretend claiming that - while children before the age of 4 might not have an understanding of pretend in terms of beliefs and knowledge etc. – they probably understand the intentional structure of pretence. They represent pretence as intentionally behaving-as-if. This hypothesis was tested by comparing children's imitative and inferential responses to two kinds of as-if-behaviors: pretending and trying (see Rakoczy, Tomasello & Striano, 2004, 2006; Rakoczy & Tomasello, 2006).

Children were shown pairs of incomplete as-if-behaviors with objects. For example, someone either pretended or unsuccessfully tried to pour from an empty container into a cup. The movements produced by the actor were the same in both cases, however, the way the actor marked his actions was different: in case of pretending, he showed signs of playfulness and accompanied his movements with sound effects of pretending to pour. In case of the unsuccessful trial, he expressed surprise and frustration.

Rakoczy et al. (2004, 2006) hypothesized that if children were behaving-as-if theorists, they would not be able to distinguish trying and pretending. However, in case children understood the intentional structure of the two kinds of acts, they should respond differentially and appropriately to the two kinds of model acts. Results showed that after watching the trying action, 3-year-olds (and to some lesser degree 2-year-olds as well) tried to perform the real (pouring) action that was aimed by the model, and unsuccessful trials were often accompanied by matching comments. ("I cannot do it either"). However, in case the model performed a pretence action, children did not care about the effects of their own actions. Children, therefore clearly differentiated between these two kinds of actions involving different intentions.

According to Friedman and Leslie (2007), there are some general problems with the Behavioral Theory and the Intentional Behavior Theory as well. As he noted, the behavioral description of pretence used by the Behavioral Theory (BEHAVING IN A WAY THAT WOULD BE APPROPRIATE IF P WERE THE CASE) is too broad. Other kind of behaviors, for example acting failures and accidents could also fit this description. Therefore young children should commit overextension mistakes: However, no evidence shows that children frequently mistakenly interpret other people's behavior as pretend.

According to the intentional Behavioral theory, children identify a behavior as pretend if they recognize that someone acted with the specific intention to act as if P. However, in most cases we act as if P when P is true, and therefore non-pretend behaviors would be interpreted as pretend far too often.

Friedman and Leslie (2007) describe some other phenomena that neither Behavioral theory nor the Intentional Behavioral Theory can account for. For example children's production and recognition of pretend sound effects or motions. When someone pretends that his finger is a snake, gives the sound of a snake and moved his finger as a snake, it is not true, that the actor pretends as if his finger was a snake. In case it really was a snake he would not give sounds and move his finger that way, when dealing with a real snake.

In the following sections, pretend play will be conceptualized within Leslie's metarepresentational framework.

Markedness and pretence

There are a number of common features between markedness and pretence that suggest an inherent functional and possibly developmental relationship between them. The most important commonalities include 1) morphological similarity; and similar 2) representational and 3) emotion regulative function.

Regarding the morphological similarity between marking and pretence, the transformation of the normative display patterns of realistic emotion expressions in 'marked' emotion displays of contingent affect regulative interactions and social referencing show remarkable formal similarity with the marked 'as if' manner of executing 'real' expressive and goal-directed action schemes in pretend play (Gergely & Watson, 1996; Fonagy, Gergely, Jurist & Target, 2002). Such transformations of the normative behavioral displays in pretend play include exaggerated motions and verbal intonations, mistimed actions, more talk about the pretence behavior than the real one, more laughters/smiles and sound effects and mothers look much more at the child when they pretend (see, for example Leslie & Happé, 1989; Rakoczy et al., 2004; Richert and Lillard, 2004; Lillard & Witherington, 2004). These cues might help the observer interpret the observed actions that do not coincide with their knowledge about the real world as pretend. Attending to these cues might prevent children from mistaking regular actions for pretence. (A mistake that we would expect children to commit if pretend worked according to the Behavioral Theory). Friedman and Leslie (2007), however argue that the presence of the cues typical to pretend make the pretend action resemble less to the original action, therefore the recognition of pretend would be worse than without such cues (if we consider the definition of pretence described by the Behavioral Theory 'behave as if P' true). So, the presence of pretend cues would decrease the chance that a regular action is interpreted as pretence, it would, however decrease the chance of spotting true pretend behaviors as well. The production and interpretation of pretence cues, however make sense within the framework of the ToMM theory, according to which the child hypothesizes that the behavior of the pretender is rooted in his mental state of pretending. The child will then be able to test the cues to find those that reliably imply that someone is pretending, simply because he possesses the concept of PRETEND.

Furthermore, pretend play and marked contingent affect-mirroring interactions and social referencing seem to require the very same cognitive mechanisms allowing for metacognitive access and voluntary transformation of procedural knowledge representations for their production. (It is noteworthy that just as contingent affect-mirroring interactions, the propensity to spontaneously engage in pretend play seems also a species-unique characteristic of humans.) We have argued that the cue of ‘markedness’ in caregiver-infant communicative interactions fulfills two important interpretative functions: a) it triggers referential ‘decoupling’ of the content of the manifested display from its primary referent, and b) it triggers the referential ‘anchoring’ of the display content to a new referent entity. Markedness can play the same functions in pretence. As pointed out by Alan Leslie (1987) in his seminal paper on the metarepresentational structure of pretend play, the very same representational operations and interpretive referential functions of markedness are also crucial cognitive requirements for producing and understanding pretence (see Gergely & Watson, 1996). For example, when a child pretends that a building block is an airplane, seeing the block in the air and hearing the brrrr...’ sound help to referentially decouple the function of building from the object in question and to anchor the features of an airplane to it.

We have previously mentioned the emotion regulative function early marked contingent affect-mirroring interactions could serve. Emotion regulation is one of the important functions of pretend play as well: re-enacting traumatic episodes, adaptively modifying their contents, changing the role of passive recipient to active agent or modifying or extending the episode to include a happy ending, etc. (see Freud, 1920/1995) all play an important role in the neutralization of a traumatic event.

Imagine the following situation. A 2-year old child becomes sick and is taken to the hospital by the ambulance. The child is extremely scared while being transported to the hospital. At the hospital, after getting the proper medication the child is allowed to go home. A week after the event, the child starts playing with a small red car, pretending that it is an ambulance. He takes a little puppet boy and pretends that the ambulance comes to pick him up and take him to the hospital. The child seems highly stress during these episodes of play. After several repetition of the original event, slight transformations of the original scenario appear: first, the child, who is taken away by the ambulance, is allowed by the driver to help him drive the car. More and more transformations come about, all in the direction of making the little boy a more active participant of the ambulance episode. At the end of the game, the boy is the driver of the ambulance who is being called to pick up kids when they get sick. The little boy is to decide in the game when to stay and when to go, when the intervention is necessary and when it is not. He becomes an active participant of the stressful event, at the

end having full control over the unfolding of the events. A few days later the very same child starts pretending that he is a doctor, takes a bag, carries it around, examines and treats dolls. By re-enacting the traumatic ambulance episode with more and more changes, this little, 2-year old boy managed to neutralize an otherwise rather traumatic event without having the opportunity to re-experience the original episode.

On the grounds of the morphological and representational similarities described above and the similar roles pretend play and early marked caregiver-child emotional interactions might play in emotion regulation, Gergely & Watson (1996) have specifically hypothesized that repeated experience with marked parental affect-mirroring interactions may play an important causal role in

1. the establishment of second-order representations
2. the development of the representational functions of referential decoupling, anchoring, and keeping pretence separate from reality
3. the development of a better ability to use pretence for emotion-regulation

Moreover ‘Affect-Regulative Mentalization’ was hypothesized to be associated with

1. better frustration tolerance
2. better ability to use pretence for emotion-regulative purposes.

AN EXPERIMENT ON MARKEDNESS AND PRETENCE

To test these assumptions, we examined the developmental relation between a) the markedness of contingent maternal reactions in a group of 12-month-old infants, b) measures of Mind-Minded maternal emotion-regulation (Affect-Regulative Mentalization) at 2.5 years of age on the one hand, and different aspects of pretence competence of the same children at 2.5 years of age, on the other (Futó, Bátki, Koós, Fonagy, & Gergely, 2004). Marked forms of contingent affect-mirroring were measured at 12 months in the so-called three-phase Mirror Interaction Situation (MIS) (see Koós & Gergely, 2001) that is a modified version of the standard Still-face paradigm (Tronick, Als, Adamson, Wise, & Brazelton, 1978). The methods mothers used to calm their baby were accessed by a questionnaire, Mind-Mindedness scores were based on the Mind-Mindedness Interview (Meins et.al, 1998)

We followed up a sub-sample of these infants and between 2-3 years of age. We administered a modified and enriched version of the battery of pretence tasks originally

developed by Harris and Kavanaugh (1993) to measure representational aspects of pretence competence along the lines of Leslie's (1987) analysis of the metarepresentational structure and representational operations implied by understanding and producing pretend play. We also developed further coding categories to specifically measure those aspects of spontaneous elaborative and creative use of pretence that went beyond the representational task requirements of the Harris and Kavanaugh tasks such as elaborations, modifications and creative extensions; measures that are indicative of what we call 'pretence fluency'. We considered these aspects of pretence competence to be particularly important in the functional use of pretend play for affect-regulative purposes (such as re-enacting traumatic episodes by adaptively modifying their contents by changing the role of passive recipient to active agent or by modifying or extending the episode to include a happy ending, etc., see Freud, 1920/1995). A measure of 'pretence stability' was developed by adding up pretence refusals and reality intrusions. We also included open-ended pretence scenarios that involved separation or physical injury and invited the children to spontaneously complete them. These extensions of the set of pretence tasks and modifications of the coding categories allowed us to measure the children's ability to creatively use pretend play for affect-regulative purposes. Our complex coding system allowed us to characterize each child's overall representational pretence competence on the one hand, and pretence fluency and stability, on the other.

Method

Participants

Children participated in a longitudinal research project. In all cases, studies were conducted in the following order:

Session 1: Mirror Interaction Situation;

Session 2: Pretend Play Task, maternal 'Mind-Mindedness' interview,
questionnaire

Session 1: Mirror Interaction Situation

105 infants were included in the final sample (11,6-13,4 months; mean age = 12,2 months; 57 boys and 48 girls). 16 subjects were excluded from the study (8 males, 8 females). 5 did not finish the study due to fuzziness/tiredness. In case of another 5 subjects data was

available but was uncodable (face moved out of screen in most cases). 6 additional children were excluded because they did not come with their primary caregivers.

Session 2: Pretend Play Task, maternal 'Mind-Mindedness' interview, questionnaire

Of the 105 infants performing session 1, 68 children were included in the final sample of session 2 (28-35 months; mean age: 30,60 months; 40 boys, 28 girls). 1 child was excluded due to fuzziness.

All together 65 mothers (28-35 months; mean age: 30,60 months; SD = 2.06 months; 40 boys, 25 girls) filled out the questionnaire and answered the maternal Mind-Mindedness Interview. 3 mothers could not fill out the questionnaire, because their child became fuzzy following the Pretend Play Task.

The data obtained in the 2 sessions can be divided into 2 groups:

Group 1: 58 children participated in the Mirror Interaction Situation and the Pretend Play Task (28-35 months; mean age: 30,48 months; SD = 2.05 months; 36 boys, 22 girls).

Group 2: 57 children (28-35 months; mean age: 30,47 months; SD = 2.03 months; 34 boys, 23 girls) participated in the Mirror Interaction Situation, and their mothers filled out the questionnaire and answered the Mind-Mindedness interview.

Subjects were recruited through newspaper advertisements. Children came from mixed socio-economic backgrounds and were all native Hungarian speakers.

Session 1: Caregiver-child affect-mirroring interactions - Mirror Interaction Situation (MIS)

Procedure and coding

The mother and the infant were seated 2 meters apart, next to each other, both facing a one-way mirror. They were separated by an occlusion screen which made it impossible for them to touch or see each other directly, but they could interact by facial and vocal gestures with each other using the mirror. Two video cameras placed facing (but invisible to) them on the other side of the one-way mirror recorded their facial and vocal behaviors. These records

were fed into a mixer which created a synchronized time-coded split-screen record of their interactive behavior for off-line analysis.

The situation consisted of 2 two-min interaction phases separated by a two-min stressor phase. In the initial phase, the mother was instructed to freely interact with the baby through the one-way mirror. In the second phase, the “Still-face period” (similar to the procedure used by Cohn and Tronick, 1988), the mother was instructed to put on a motionless neutral ‘still-face’ while fixating the infant’s face in the mirror. In the final phase, the mother was instructed to become ‘normal’ again and interact freely with the infant. The split-screen records of the facial and vocal behaviors during the two interaction phases were independently coded off-line by two trained coders using a coding system focused on instances of four types of contingent responsiveness by the mother: (a) contingent verbal reference to the infant’s state or activity (e.g. the infant pouts and the mother says “What happened? It will be OK soon!”); (b) vocal reaction to the infant’s activity or state expression, involving a high pitch contour and exaggerated vocal intonation pattern — characteristic of strong motherese or infant-directed-speech (e.g. mother says “Oooh!” in response to infant’s pouting); (c) imitative vocal reaction to infant’s vocal behavior (e.g. the infant says “brrr”, the mother says “brrr”); (d) facial imitative reaction that reflects the infant’s facial expressions back to the infant (e.g. the infant smiles and, with eye contact, the mother smiles back). On theoretical grounds (see Gergely & Watson, 1996, 1999) the first measure was taken to represent the factor of “unmarked maternal responsiveness” that consists of primary default forms of maternal displays expressing or deriving from the mother’s present dispositional states or reactions. In contrast, measures b, c and d were combined to represent the factor of “marked maternal responsiveness” where “markedness” refers to the characteristically transformed, exaggerated versions of the motor execution of the mother’s primary default forms of expressive and reactive displays. Markedness is assumed to function as a cue signaling that the use of the maternal display is referentially ‘decoupled’ from and is not about the mother’s own subjective internal state or current dispositional reaction (Gergely & Watson, 1996, 1999). Rather, such marked forms of maternal reactivity represent acts of ostensive referential communication addressed to the infant that make reference to (and are intentionally about) the infant’s current internal dispositional state that is being expressed or that is inferred and attributed to her by the adult (Gergely & Unoka, 2008). One third of the videos coded by Coder 1 were also coded by Coder 2, while one third coded by Coder 2 was also coded by Coder 1. The average inter-rater reliability between the two coders for the four contingent measures was sufficiently high (Cohen’s Kappa, $\kappa = .89$).

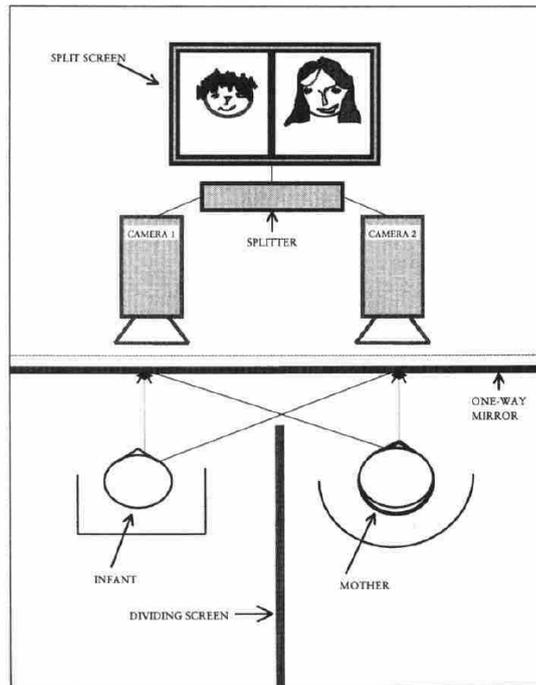


Figure 7.

The Mirror Interaction Situation

Session 2: Pretend Play Task (PPT), maternal ‘Mind-Mindedness’ interview and questionnaire

The order of tasks administered to the subjects during Session 2 was as follows:

1. pretend play tasks (in the order indicated at the description of the PPT)
2. maternal ‘Mind-Mindedness’ interview (after Meins et.al, 1998)
3. questionnaire about the child’s temperament, play habits, mother-child interactional characteristics including the way the mother usually calms the child

Pretend Play Task³

Procedure and coding

A modified and enriched battery of pretence tasks and open ended pretence scenarios (based on Kavanaugh & Harris, 1993) was administered to the subjects to measure

³ See Appendix 1. for a detailed description of the tasks and Appendix 2. for the detailed scoring scheme.

1. overall representational pretence competence
2. 'pretence fluency'
(spontaneous, adequate and creative extension of pretence)
3. 'pretence stability'
(disruption of pretence activity, fluctuation between pretence and reality)
4. affect-regulative use of pretence

During the play session, a red block was placed in front of the child. This object had no identity and could have been freely incorporated by the child in any play situations with undetermined identity.

Components of the Pretend Play Task:

1. Understanding make believe stipulations

- The aim of this task was to see if children were able to understand make believe stipulations and to guide their pretend response in accordance with the pretence request.
- Warm-up phase
In the warm-up phase, the experimenter pretended to give food and drink to a teddy bear and then encouraged the child to do the same. The aim of the warm-up phase was to encourage children to participate in pretend games.
- Experimental phase
The warm-up props were removed and were replaced by the experimental props.
In this phase, children were encouraged to give food and drink to toy animals without previously seeing the experimenter doing the same action. (For example, the child was encouraged to pour tea from a tea kettle into a cup and to give it a stuffed elephant).

2. Adjusting pretend actions to a make-believe identity

- The aim of this task was to see if children were able to express their understanding of somebody's pretence initiative by engaging in novel acts of pretence.
- The task consisted of two scripts, each script contained three distinct episodes. In both scripts 3 props were introduced within a specific make-believe context. The three

target props were underdetermined so that they could easily be assigned more than one make-believe identity. During the games, the experimenter referred to the props in terms of their make-believe identity and then invited the child to act with the objects accordingly.

- (For example, one of the props was a round yellow block. In the first scenario, the experimenter asked the child to cook an egg to a piggy. In the second scenario, the experimenter asked the child to wash the piggy with a soap. Thus, in the first scenario the child was intended to use the block as an egg, in the second scenario, the stipulated identity of the block was a soap and the child was expected to act on the block accordingly).

3. Understanding make-believe transformations

- In pretend play, it is not only the identity of an object that can be stipulated, but an object can also go through make-believe transformations. (For example, one can pretend that his hand got wet). This task examined children's' understanding of such transformations.
- The task consisted of two scripts, each script containing two pretence transformations. The child was asked to react to one of the transformations in each of the scripts. (For example, there were two little cows in front of the child. A puppet pretended to hit one of them and to pour tea on the other cow. The child was then asked either to pet the cow in pain or to dry the wet cow).
- The order of the scripts, the order of the transformations and the order of the questions were counterbalanced across subjects.

4. Open-ended situations

- These situations were specifically created to test the affect-regulative use of pretend play. Two different scenarios were used. In both scenarios the main character (a doll) experienced an emotionally distressing situation (bodily pain or separation). In case children did not spontaneously try to sooth the doll, they were directly encouraged to do so (Try to calm the doll!) a maximum of three times. Children's' soothing reactions were scored.

Additional measures

The following additional measures of the Pretend Play Task were used in the final analysis:

1. Pretence refusal

- The child is unable to perceive a certain situation as a make-believe scenario. The flood of pretence is suddenly disrupted.
- For example, in one of the scenarios the child is expected to feed an animal from a tin. A small, closed tin is placed in front of the child. As the child tries to feed the animal, he suddenly pauses while saying that the tin is closed. The specific pretend play is disrupted by one of the realistic features of the prop.

2. Reality intrusion

- The child brings a real object into the pretence scenario and uses it according to its real function.
- For example when the child is expected to wash a teddy bear's teeth with a toothbrush, instead of choosing the right prop among the available ones, he suddenly stands up, runs to the bathroom, returns with a real toothbrush and uses it to wash teddy's teeth.

3. Adequate extension of pretence

- The child extends one specific pretend activity to several objects.
- For example, the child is asked to give food to a stuffed animal in the 'understanding make believe stipulations' task. The child does not only feed the toy animal s(he) was originally asked to feed, but (s)he adequately extends the same pretence action to other toy animals.

4. Creative pretence (with a real prop or with imaginary objects)

- The child creatively invents a new pretence activity and incorporates it in the ongoing game.
- For example, while putting the ‘egg’ in the sauce pan, the child imagines and an oven is also present, he pretends putting the sauce pan in the oven, waits, takes out the food and feeds the animal with the ‘egg’ afterwards.

Overall Pretend Play Score

Overall Pretend Play Score was calculated as shown below:

Understanding make believe stipulations + Adjusting pretend actions to a make-believe identity + Understanding make-believe transformations⁴ + Open-ended situations) – (absolute value of) pretence refusal – (absolute value of) reality intrusion + adequate extension of pretence + creative pretence

‘Mind-Mindedness’

Procedure and coding

The experimenter asked the mother to describe her child to her: ‘Can you describe [child’s name] for me?’ Mothers were given no guidance on how to respond. In case they asked for clarification they were told that there was no right or wrong answer, they should just tell what their child is like.

The answers of the mothers were audio-taped for later analysis and mothers’ answers transcribed verbatim.

The criteria established by Meins et al (1998) was used to assess the extent to which mothers described their children as mental agents. Answers were categorized as ‘mental’ if they mentioned something about the child’s will, mind, imagination, interest, intellect, metacognition, desires (not only likes, dislikes), emotions etc. For example: ‘Gabor is very sensitive, he always pays attention to the emotional state of the others’.

Measures

⁴ Only the first make-believe transformation task was included in order to avoid alterations resulting from access memory load.

1. 'Mind-Mindedness' proportion score

- ratio of mental descriptions / all descriptions

2. High vs. low 'Mind-Mindedness'

- Mothers were divided into two groups based on their 'Mind-Mindedness' scores. Subjects, whose 'Mind-Mindedness' proportion score was greater than .33 were assigned to the high 'Mind-Mindedness' group (53% of all subjects). Those with a proportion score of .33 or less were assigned to the low 'Mind-Mindedness' group (47% of all subjects).
- The mid-score of .33 was chosen to divide the whole sample into two subgroups because it was this division score that provided the best approximation for two same-sized groups.

3. 'Affect-Regulative Mentalization'

- Subject who were in the high mind-mindedness group AND who used mentalistic calming strategies for soothing their child as revealed by the questionnaire described below were said to be characterized by 'Affect-Regulative Mentalization'. All together 13 of the 65 subjects (20%) met the criteria for 'Affect-Regulative Mentalization'.

Questionnaire

Following the 'Mind-Mindedness Interview', a questionnaire was administered to the mothers. It contained questions about the child's temperament, play habits, mother-child interactional characteristics including the way the mother usually calms the child.

Here we shall focus only on the measures that were used in the final analysis, namely: the calming strategy of the mothers. Mothers were asked the following question: 'Is there a specific method that usually helps calm your child?' The calming strategies were divided into a mentalistic and a non-mentalistic group⁵.

⁵ For a more detailed description of the measures see Appendix 1.

Results

In the Mirror Interaction Situation, one third of the videos coded by Coder 1 were also coded by Coder 2, while one third coded by Coder 2 were also coded by Coder 1. The average Inter-rater reliability between the two coders for marking was sufficiently high ($\kappa=.89$).

In the Pretend Play Task, a secondary coder coded approximately one third (23/68) of the videos coded by the primary coder. The Inter-rater reliability between the two coders for the average of all scores calculated within the pretend play scenario was high: $\kappa=.92$. Inter-rater reliability for the Mind-Mindedness Interview was $\kappa = .98$.

We first analyzed the relationship between maternal marking in the MIS at 12 months of age and children's' pretence competence at 2.5 years. Results indicate that children of marking mothers

1. receive higher overall pretend play score ($t(56) = -2.845, p = .006$),
2. perform better in the spontaneous, adequate and creative extension of pretence ($N = 58, Z = -2.49, p = .013$),
3. are less disrupted in their pretence activity (pretence refusal + reality intrusion) ($N = 58, Z = -2.16, p = .031$)

than children of non-marking mothers.

	MARKING MOTHERS		NON-MARKING MOTHERS	
	Mean	SD	Mean	SD
overall pretend play score	1.321	.394	.981	.362
spontaneous, adequate and creative extension of pretence	.542	.370	.235	.273
pretence refusal + reality intrusion	.750	1.357	1.892	2.302

Further, the children of mothers characterized by ‘Affect-Regulative Mentalization’ (mothers who use mentalistic strategies to calm their children AND receive high scores on the ‘Mind-Mindedness’ interview)

1. receive higher scores in the open-ended situation
(N = 65, Z = -2.15, p = .032)
2. can bear frustration in stressful situations better as indicated by the longer total duration of the Still Face episode of the MIS⁶
(N=57, Z = -2.094, p = .036)
3. the fewer disruptive behaviors in the open-ended pretence scenario
(N=65, Chi² = 4.103, p = .043)

than children of mothers not characterized by ‘Affect-Regulative Mentalization’.

	AFFECT- REGULATIVE MENTALIZATION MOTHERS		Non-AFFECT- REGULATIVE MENTALIZATIO N MOTHERS	
	Mean	SD	Mean	SD
Open-ended situation	.750	.220	.575	.319
Duration of MIS 2nd episode	82.692	23.286	66.216	27.428
Disruptive behavior in the open-ended pretence situation	1.846 ⁷	.375	1.538	.503

Further, children who could not bear frustration in the Still-Face Episode of the Mirror Interaction Situation (shorter total duration of MIS 2nd episode) (M = .567, SD = .323) receive lower scores in the open-ended pretence situation. (N = 58, Z = -2.083, p < 0.037) (M = 0.727, SD = .239).

⁶ The Still-Face episode was disrupted if children showed signs of extreme distress (e.g. extreme crying etc.)

⁷ Dichotome variable. The value of non-disruptive behavior was 1 and that of disruptive behavior was 2 in the analysis.

Discussion

In accordance with our original hypothesis, we have seen that children of marking mothers developed a better overall pretend play competence than children of non-marking mothers. Two of our measures, adequate and creative extension of pretence on the one hand, and pretence refusal or reality intrusion on the other are indicative of two different aspects of pretence competence: ‘pretence fluency’ and ‘pretence stability’. Respectively, children who can use pretence fluently readily grab certain aspects of their environment and use them as cues for starting new pretence scenarios or to extend already existing ones. At the same time, children who are more skilled in pretend play are better at keeping reality and pretence separate. The simultaneous presence of fluency and stability in the pretend play of children of marking mothers indicate that these children have better control over the boundaries between reality and pretence: they can more easily generate new pretend elements and - at the same time - are better at keeping the pretence representation separate from reality.

Our results thus clearly indicate that children with extensive experience of marking in emotion regulative interactions during the first year of life have a stronger capacity of overall pretence competence, moreover their pretend play is more fluid and stable. This may be so, because marking interactions support the establishment of second order representations and provide experience with the representational mechanisms of ‘decoupling’ and ‘anchoring’.

The relationship between the presence of marking in early affect-mirroring interactions and later competence in the emotion-regulative use of pretence in the ‘open-ended situation’ was also examined. Contrary to our expectations, we found no difference between the children of marking and non-marking mothers in this measure. Competent affect-regulative use of pretence was, however strongly associated with maternal ‘Affect-Regulative Mentalization’.

Solving an emotionally stressful pretend play scenario successfully requires 1) the availability of the second-order representations of emotions, 2) the ability to cope with the stress induced by the pretend play scenario 3) the implementation of effective solutions to the situation.

As we have seen, maternal marking in early contingent affect-mirroring interactions can effectively foster the development of second-order representation of emotions. It is possible that by the emergence of language, another important route becomes available that could contribute significantly to the development of second-order representations of the inner states of the child. Interactions with mind-minded caregivers, especially mind-minded interactions in emotionally charged situations could be an effective way of teaching children

about their own emotions. Contingent verbal labeling of the experienced emotion of the child contributes to the development of second-order emotion representations even without the use of marking, since the verbal content of the message can alone convey the same information that marking does with respect to decoupling the expressed emotion from the communicator and anchoring it to the addressee. That is, with the availability of language use, mind-minded emotion regulative interactions with the caregiver may – in routes that are independent of marking – enhance the establishment of second-order representations of the inner states of the infant and support the development of successful emotion regulation.

By remaining mind-minded and by focusing on the child's inner states during stressful experiences, the caregiver may help the child develop an understanding of these situations and his emotional reactions to it. Mental, mind-minded calming is probably the only calming method where the mother stays within the situation together with the child, helps him understand it and leads him through it until more or less complete emotional relief is achieved. The child is not left alone with his overwhelming emotions. All other forms of calming strategies mentioned by the caregivers participating in this study (punishment, not paying attention, attractive promise, redirecting attention or a combination of these) involve some kind of escaping of the stressful situation.

The children of mothers characterized by 'Affect-Regulative Mentalization' thus probably gain a greater understanding of emotionally disturbing situations and their emotions within it, further, they are more likely to have experienced model behaviors of 'implementing appropriate solutions' within emotionally stressful situations. This hypothesis was supported by the results of our study: children of mothers characterized by 'Affect-Regulative Mentalization' had greater frustration tolerance than children of mothers not characterized by 'Affect-Regulative Mentalization' as indicated by the fact that they were able to bear the frustrating Still-Face Episode of the Mirror Interaction Situation for a longer period of time. Moreover, they were better able to use pretend-play for emotion-regulative purposes and they were less likely to give a disruptive reaction to the emotional stress induced by the open-ended pretend play scenarios.

In sum, we have seen that excessive experience with maternal marking during early contingent affect-mirroring interactions enhance overall representational pretence competence and the fluency and stability of pretence presumably through enhancing the development of second-order representations. Marking, however was not found to be associated with greater competence in the emotion-regulative use of pretence. It is the 'Affect-Regulative Mentalization' of the caregiver that seems to support the frustration tolerance of children and provides useful model behaviors for emotionally stressful situation.

Thus, within the domain of emotion socialization, we have seen that marked forms of referential knowledge manifestations support the establishment of second order representation of emotions. Specifically, marked contingent affect-mirroring interactions during the first year of life play an important causal role in

- 1) developing a better skill of marking through the establishment of a generalized communicative code of 'marked' expressions
- 2) the development of the representational functions of referential 'decoupling', 'anchoring' (as seen both in the context of emotion socialization and pretend play)
- 3) and contributes to emotion-regulation by establishing one of its prerequisites, namely the second-order representation of categorical emotions.

GENERAL DISCUSSION

In this paper, we investigated the role of marked forms of communicative expressions in infants' conceptual development and representational abilities. First, we encountered the broadness and universality of infant-directed communicative modifications, and concluded that markedness seems to characterize all of them. We differentiated two forms of marked communicative expressions: markedness as an ostensive communicative cue and marked forms of referential knowledge manifestations. Two separate lines of studies were described that investigated how these two forms of marked communicative expressions contributed to infants' conceptual development, in the first case and their representational abilities, in the latter.

The conceptual development of children was approached from the perspective of object individuation. By identifying sortals that infants of different ages are able to use for telling objects apart, one can gain an understanding of the concepts that infants possess and that provide the basis for categorization. We know that besides spatiotemporal information and perceptual object features, information on object kind can also serve as a useful cue for object individuation (see, for example Xu & Carey, 1996). But how can children learn about kinds through only limited experience? In other words, it is of question how children – before the onset of language - can learn generic things on the basis of sporadic episodic experience. According to the Theory of Natural Pedagogy (Csibra and Gergely, 2006), it is possible to induce generic interpretation from a single exposure. Ostensive cues trigger a 'generic encoding bias' in infants, which results in an expectation that the upcoming knowledge manifestation will convey kind-relevant and generalizable semantic information about the referent and its kind.

The generic interpretation of episodic information contributes significantly to infants' category formation and conceptual development in general. We have seen in our object individuation studies that marking, as an ostensive communicative cue substantially contributes to the kind-based interpretation of the information received. However, even in the presence of this trigger, object individuation will only be facilitated if the trigger is followed by information within a specific domain that the infant is inclined to treat as a kind. Our studies indicate that contrary to what was previously thought, within the domain of artifacts, information about object function is readily interpreted as kind-relevant and therefore can successfully be used for object individuation. These results present a strong contradiction to previous accounts where it was hypothesized that the acquisition of basic-level kinds depends

on acquiring verbal labels, such as count nouns, that map onto kind concepts (see, for example Xu, 2002).

In sum, we concluded that markedness as an ostensive communicative cue supports infants' conceptual development by inducing a 'generic encoding bias' of the information that follows with the constraint that the content of the communicative manifestation must be within a specific domain (object function, in case of artifacts) that infants are inclined to treat as a kind.

In the second experiment, we investigated the role of marked forms of referential knowledge manifestation in the representational development of infants. In particular, mother-infant dyads were observed within a situational context that was specifically designed to induce emotional stress in the infant. During this, so called Mirror Interaction Situation (see Koós & Gergely, 2001) the normal flow of caregiver-infant interaction was disrupted by a period of maternal unresponsiveness (Still-Face Phase), which induced stress in both the infant and the mother. The last phase of the situation was a period of free interaction, where maternal soothing behavior was observed within a context where direct bodily contact was made impossible. It was hypothesized (see Gergely & Watson, 1996, 1999) that one way to avoid the escalation of emotions that could be caused by maternal mirroring of the baby's negative affect state is by making these 'non-real' forms of emotion expressions readily distinguishable from normal realistic emotion expression. The markedness of emotional expressions was a readily observable behavioral modification in the Mirror Interaction Situation. The sample of mothers could be divided into a group of marking and a group of non-marking mothers. Early experience with marked contingent affect-mirroring interactions was expected to contribute to the development of second-order representation in infants through the contingent experience of visual/vocal (marked maternal emotion expressions) aspects of a specific emotional category together with corresponding proprioceptive stimuli. Establishing a connection between these two kinds of information originating from two different sources can be achieved by the contribution of the pre-wired contingency-detection module (Gergely & Watson, 1996, 1999) that perceived the spatial, temporal and sensory relational aspects of contingent relatedness between these two types of stimuli. At the same time, infants become familiarized with the representational mechanisms of 'decoupling' and 'anchoring'. In other words, children of marking mothers are expected to have an advantage in the building of second-order representations of their categorical emotions when compared to children of non-marking mothers. Having reliable second-order representations of our emotions is a necessary prerequisite of successful emotion regulation. It is, however not sufficient for it. Being able to consciously represent our emotional states is not enough for the

successful resolution of emotionally stressful situations. Being in possession of effective coping mechanism and being able to implement them is equally important. Correspondingly, it was not maternal marking, rather, it was maternal ‘Affect-Regulative Mentalization’ that was found to be significantly connected to children’s emotion-regulative abilities at 2.5 years of age.

Another question that we aimed to investigate was whether the development of second-order representations as an effect of early marked contingent affect-mirroring interactions is specific to emotions or whether it is a broader, more general phenomenon. Children’s representational abilities were measured by analyzing their competence in pretend play at the age of 2.5 years. According to Leslie (1987), pretend play is one of the first steps in the development of Theory of Mind and being able to pretend requires the ability to establish and manipulate second-order representations (or metarepresentations – as he calls them). Further, the very same representational mechanisms of ‘decoupling’ and ‘anchoring’ that are believed to be fostered by excessive experience with early marked forms of contingent affect-mirroring interactions are required for pretend play as well (Leslie, 1987).

Our results indicate that marked pedagogical knowledge manifestations during early contingent affect mirroring interactions do foster the development of second-order representations, and this effect is not restricted to emotions. Children of marking mothers were characterized by a better overall pretence competence as well as more ‘fluid’ and ‘stable’ pretence activity than children of non-marking mothers. Children of marking mothers seem to learn about ‘marked’ forms of communication in general, that is a decisive component of many different forms of interactions, such as certain forms of teaching and pretend play, as we have seen.

But what exactly early experience with marking does to us? We have seen that it supports conceptual development and the establishment of second-order representations. Could it, in some ways have a more general effect on infants’ learning?

In a study we carried out (see Watson, Futó, Fónagy & Gergely, 2009) 173 infants were trained in a situation in which visual fixation of a specified location would lead to a contingent rewarding stimulus if, and only if, the act occurred within 6 sec of opening their mouth. The discriminative function of this internal (proprioceptive) cue was compared to that of a purely external stimulus of a schematic face opening its mouth and to that of a combination of both the external and the internal stimuli. One-year old infants displayed robust use of the cue in each condition. Infants of mothers who showed marked responsiveness to them in the course of a Mirror Interaction Situation (done within a week of this experiment), when contrasted with infants not contingently responded to or responded to

in a less marked manner manifested substantially greater sensitivity to external cues and somewhat greater sensitivity to internal cues on one of three indicators.

Why are infants of mothers whose responsiveness is marked particularly alert to external stimuli? A post-hoc account of these findings may be found in recent theoretical advances made in the understanding of how infant social learning is linked to the quality of parent-infant attachment relationship. We know from both observational and experimental investigations that the quality of maternal sensitivity (contingent marked mirroring) is strongly predictive of the quality of the infant's attachment to the mother (Atkinson, Goldberg, Raval, Pederson, Benoit, Moran, Poulton, Myhal, Zwiers, Gleason, & Leung, 2005; Kalinauskiene, Cekuoliene, Van IJzendoorn, Bakermans-Kranenburg, Juffer & Kusakovskaja, 2009; Fearon, Van IJzendoorn, Fonagy, Bakermans-Kranenburg, Schuengel, & Bokhorst, 2006). Marked responsiveness on the part of the mother likely indicates an underlying secure (trusting) relationship. What Gergely and colleagues [see, for example Gergely, 2007b) term '*epistemic trust*' refers to the generic human orientation to the other as a source of information about the world. To feel certain that we will not be misled, as we try and judge the risks associated with environments (social referencing) or the appropriate attitude to a third person we use feelings of bonds or attachment as the guarantor of authenticity. Thus the more robust reliance of infants whose mothers normally engaged in marked mirroring on external cues may well be an indication of the greater epistemic trust these infants show in exogenously provided information.

Besides the effects that greater basic epistemic trust might have on learning from exogenously provided information, I believe that markedness supports learning through other mechanisms as well. Namely, through its attention attenuating effect.

We have seen, that infant-directed communicative modifications in general have strong attention attenuating effects (see, for example Werker, Pegg & McLeod, 1994; Masataka, 1996, 1998; Gogate, Bolzani & Betancourt, 2006). It has also been shown, that these kinds of communicative modifications enhance the attention of infants to the communicative act per se as well as to its referent (see, for example Lockman & McHale, 1989).

We know that our information processing capacities are limited and that even a single object or act observed in the environment can provide us with potentially unlimited information. Presumably one of the most important things that infants need to learn at the beginning of their lives is what to pay attention to. What is it that 'defines' a chair? Is it the color that counts or the shape or number of the legs, maybe the little scar on its upper left corner? Of course, one way to learn about what I call the 'definitive feature' of certain objects

or action, events etc. is through the finding of commonalities during repeated experience. Here, I shall emphasize the role marked forms of communicative modifications might have in directing the infants attention and supporting effective learning of 'definitive features'. As we have seen, marked forms of referential knowledge manifestations foreground the most important, the most relevant aspects of the communicative flow. When teaching someone how to open a window, we will emphasize how to turn the knob, pull the window, and we will probably not put much emphasis on which hand is to be used and similarly, we will try to avoid marking our unexpected sneeze. Marked ostensive communicative cues might serve exactly the same function: they foreground those segments of the communicative flow that are relevant for the addressee (and at the same time, due to our limited information processing capacities 'silence' all other kinds of information), and therefore should be paid attention to. After getting the initial attention of the addressee (as a result of marked ostensive cues), the marked forms of knowledge manifestations focus the attention of the addressee even further. Attention is focused to information that is observed to be marked. Thus, the effects of ostensive cues and marked forms of referential knowledge manifestations 'add up' to direct the infant's attention to the things that the communicator believes to be important or to be the 'definitive feature' of opening a window. That is, marked communicative manifestations direct the attention of the addressee to the 'definitive feature' of the object/event etc., they teach the addressee what to pay attention to.

We are getting very close to the phenomenon of the 'generic encoding bias' here. The most important function of this bias is to make the addressee interpret forthcoming information as relevant to a whole group of objects/event etc, and not just to the one that was seen during the demonstration. But is it possible to learn about a single object/event at all? When we encounter that a certain kind of information is highly relevant with regards to a specific object/event etc., this aspect will stand out when encountering new experiences, no matter what we do. The difference between the effects of communicative demonstrations and observations could simply be caused by the difference in the salience of the kind of information 'that counts'. As long as one captures what the 'definitive features' are, it might not matter whether it was captured as a result of observation or communicative demonstration. Can this interpretation of the role of marked forms of communicative modifications explain the findings of the experiments described in this dissertation?

Let's first turn to the results of the object individuation studies. When, in Experiment 1, object features were demonstrated in a marked context (marked ostensive communicative cues), infants encoded the demonstrated object function as the 'definitive feature' of the object, and as a consequence of the 'generic encoding bias', as the definitive feature of the

artifact kind. Their attention was focused on the function of the object, and it is likely that other object features, such as color or size were paid lesser attention to. The explanation that follows is the same as described before in the discussion of the experiment. Since two definitive features were demonstrated, by expecting one function to define one object kind, infants expected to find two objects behind the screen. It is likely, that the features of size, color etc. were not coded (attention was not focused to them), since, we have seen in Experiment 3, infants falsely expected to find two object behind the screen when different functions of the same, double-function object were demonstrated alternating. In Experiment 2, when no marked ostensive cues preceded the presentation of the objects this attention focusing effect might have been missing. When lacking appropriate guidance, the same attention recourses allocated to the task (looking time during the familiarization trials in the non-ostensive condition did not differ significantly from the other conditions – see above) were unfocused, and therefore did not lead to function (as 'definitive feature') based object individuation. We are currently running an experiment, which is almost identical to Experiment 1. The only difference is in the test phase. In one of the conditions, we kept the functionally relevant parts of the original object, while other features, such as object shape and color were changed. In the other condition, the original color, size etc. of the objects remain unchanged, it is only the functionally relevant part that does remain the same. We would expect 10-month-old infants to individuate when the presentations of the objects are preceded by marked ostensive cues if, and only if the functionally relevant parts of the object remained unchanged. This would be so, since, if the line of thought about the attention focusing effect of marking on 'definitive features' is true, these features should have been coded and bound to the object file. In case of non-ostensive function presentation, however we would expect no feature-binding, and therefore no object individuation even if functionally relevant parts were unchanged - due to the lack of the attention focusing effect of the marked communicative cue.

How does the attention focusing effect and the learning of 'definitive features' fit the results of the second line of experiments presented? During the Mirror Interaction Situation, marked forms of referential knowledge manifestations focus the infants' attention to those aspects of the communicative flow that are relevant with regards to the emotional state of the infant. From here, the explanation goes as described in detail before. One aspect of the results was, I believe not sufficiently explained by the explanation offered earlier. It is clear why the representational pretence competence of children of marking mothers is better than that of the children of non-marking mothers. 'Pretence stability' is closely related with representational abilities. However, the strong connection found between 'pretence fluency' and early

experience with marked affect-mirroring interaction – I believe – is not directly connected to the better representational abilities. Why would someone with better representational competence be more creative in his/her use of pretence? Why would (s)he be more ready to get out of the planned line of play and incorporate imagery objects etc. All children who participated in the study were representationally competent enough to do so. Not all of them did so.

It is possible, that, by highlighting the 'definitive feature' of objects/events etc., early marked interactions support learning about objects, actions, events etc. by the building of effective, well-defined concepts and categories. Let's now think about how pretence is used. Why is one object substituted by a certain prop and not by another? Usually the prop shares some of the important features of the object that it substitutes. The more well defined categories one possesses, the more readily, the more 'fluently' one can recognize similar important properties of objects of different kinds. As long as one possesses the representational competence required for pretence, we would expect those with more 'clearly defined' categories to be more fluent in finding props that possess some kind of similarity of the original object. What happens in case of imagery objects? What constitutes the basis of the similarity between an object and an imagery object? The common feature is the action itself. The action of the one dealing with the object or the imagery prop. How one deals with an object (in case of artifacts, its function, as understood from our object individuation studies) is also an important (in case of artifacts, 'definitive feature') of the object that is often learnt during marked pedagogical knowledge manifestations. Thus, fluency in terms of object-related actions is probably linked to exactly the same mechanism as other object features. Therefore, according to this line of thought, children of marking mothers would be expected to be more fluent, creative in their pretence activity. It could also be tested, whether these children are better in, for example the sorting of object into different categories.

In sum, we have seen that early caregiver-infant interactions significantly contribute to the conceptual development of children, possibly, through the effect of focusing the infants' attention to the 'definitive features', to making it clear what to pay attention to, what is important and what is less important in different groups of actions, objects, events etc. Marking also helps the representational development of children, as measured by their competence in their pretend play. The availability of the second-order representation of different emotions was, however found to be insufficient for better emotion-regulative abilities. Maternal 'Affect-Regulative Mentalization' was a better predictor of children's emotion-regulative abilities at 2.5 years of age. Marking, therefore seems to be an important

aspects of early caregiver-child interactions and it might be worth examining other contributions it might have on the development of infants.

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APPENDICES

APPENDIX 1

Pretend play experiments

1. Understanding make believe stipulations

Warm up phase

Props: an empty box of orange juice, a glass, a teddy bear, biscuit box, a plate and a spoon

Experimenter: *Here's a teddy bear. The teddy bear is thirsty. I'm going to give him a little orange juice.* He/she puts the empty glass in front of the teddy bear and acts as if he/she poured orange juice from the box, lifts it to the teddy bear's mouth, turns it as if he/she wanted to make the teddy bear drink. Then he/she says: *The teddy bear wants some more orange juice. Now you give him orange juice.* The experimenter pretends to pour orange juice into the glass, gives it to the child and prompts the child to give some orange juice to the teddy bear. This phase is repeated if necessary.

Experimenter: *The teddy bear is now hungry, he wants to have some biscuits.* He/she pretends to put some biscuits from the box to the plate, then the experimenter acts as if he/she gave the biscuit to the teddy bear with a spoon. *The teddy bear wants to have some more biscuits. Now you give him a biscuit.* The experimenter pretends to put biscuits onto the plate, gives the plate to the child and prompts him/her to give the food to the teddy bear.

Experimental phase:

Props: cup, empty teapot on one side of the child and a can, a small plate and small spoon on the other side of the child.

Two animals are acting in the following order: a monkey and then an elephant. Both are placed in front of the child, between the two groups of props.

At the beginning of the experiment the experimenter introduces the props. *This is a teapot that contains tea. This is a can of corns with corns inside.* In case of both animals, the experimenter says: *Here's a... The is very thirsty, give him something to drink. / He is very*

hungry, give him some food. In case the child does not react to this call the instruction has to be repeated. If we still receive no answer, the child is given a new instruction: *Give the ...some tea / Feed the...with some corn.* What each animal gets (tea or corn) is counterbalanced across subjects.

2. Adjusting pretend actions to a make-believe identity

Props for the “morning” and “evening” game situations: teddy bear, teapot, cup, baking-dish with a wooden spoon, small plate, fork, empty toothpaste tube, a small piece of rod, a yellow wooden roll and a piece of paper. (The last three are the critical objects that are given different pretend identities in the two situations.)

There are three episodes in both situations. The order of the situations has been counterbalanced across subjects.

Morning scenario:

The following objects are placed in front of the child: teapot, a glass, a baking-dish, a wooden spoon, a plate, a fork, a piece of rod, yellow wooden roll and a piece of paper.

Episode 1

The experimenter says: *“It’s morning. Piggy wakes up and goes out to the kitchen to have breakfast. He drinks some tea.”* Then the experimenter lifts the teapot and the cup and acts like pouring tea from the pot to the empty cup, gives it to the child and says: *Mix piggy’s tea with the spoon!* The experimenter repeats the instruction if necessary. In case nothing happens after the repeated instruction, the experimenter gives the wooden rod to the child and says: *Mix piggy’s tea with this spoon!* This instruction shall also be repeated if necessary.

Episode 2

The experimenter says the followings while handing the baking-dish with the wooden spoon to the child: *Piggy is hungry and wants to have eggs for breakfast. Prepare the eggs for piggy and feed piggy with the eggs!* In case the child does not react even for repeated instructions the experimenter puts the yellow wooden roll into the baking-dish, acts as if he/she was baking it, then assist the roll to the plate using the wooden spoon and says: *Piggy’s egg is ready.* Gives the plate and the fork to the child: *Piggy is hungry. Feed piggy with this egg.*

Episode 3

The experimenter points at piggy and says: *Ah, piggy's face became smeary by the egg. Show me how you clean piggy's face with the towel.* In case the child does not do anything even after repeated instructions the experimenter gives the sheet of paper to the child while saying: *Clear piggy's face with this towel!* If necessary this instruction shall also be repeated.

Evening scenario:

The following objects are placed in front of the child: empty toothpaste tube, wooden rod, yellow wooden roll, a piece of paper.

Episode 1

The experimenter says the followings while giving the toothpaste tube to the child: *It's evening. Piggy is getting ready to sleep. It is time for piggy to brush his teeth. Brush piggy's teeth with the toothbrush.* In case nothing happens after repeated instruction, the experimenter pretends to put toothpaste onto the wooden rod then he gives it to the child and says: *Here's piggy's toothbrush. Wash piggy's teeth with this toothbrush.* The instruction shall be repeated if necessary.

Episode 2

The experimenter: *It is time for piggy to get washed. Wash piggy with the soap.* In case the child does not react even after repeated instructions, the experimenter gives the yellow wooden roll to child while telling him/her: *Wash piggy with this soap!* Repeat if necessary.

Episode 3

The experimenter: *It is time for piggy to go to sleep. Place piggy's head onto the pillow so that he could fall asleep.* In case repeated instruction remains unsuccessful, the experimenter places the piece of paper onto the table in front of the child and says: *Lay piggy's head onto this pillow and make him sleep.* Repeat if necessary.

3. Understanding make-believe transformations

Props (in both episodes): one puppet: the 'misbehaving Yoggi Bear', two identical toy cows and two identical elephants. In both episodes the two little cows were placed on one side of the child and the two elephants were put to the other side of the child (sides were counterbalanced across subjects). The experimenter says: *Here's Yoggi Bear, look, he is misbehaving again. Look what he is doing!*

Episode 1

Props: teapot, a small towel, a small rod, two little cows and the puppet. The experimenter lifts the teapot and says: *Look, there is tea in this pot. Look what this misbehaving lion is doing!* The lion ‘pours’ pretend tea on one of the little cows. Then the lion puppet puts down the teapot and picks up the wooden rod. The experimenter says: *Look, that is a stick. Look what this misbehaving lion is doing!* The experimenter pretends that the lion beats the other little cow with the stick. The experimenter then puts down the puppet and says: *Wipe the cow that became wet!*

Episode 2

Props: teapot, a small towel, a small rod, two toy elephants and the lion puppet. The experimenter lifts the teapot and says: *Look what this misbehaving lion is doing with the teapot!* The lion ‘pours’ some pretend tea on one of the elephants. Then the lion puppet puts down the teapot and picks up the wooden rod. The experimenter says: *Look what this misbehaving lion is doing with the stick!* The experimenter pretends that the lion beats the other elephant with the stick. The experimenter then puts down the puppet and says: *Fondle the elephant that is in pain!*

In case of a single child the order of pouring and beating was the same in both scenarios. The order of pouring and beating was counterbalanced across subjects.

The examination protocol was as follows: 1) pour + beat → question: pour

2) pour + beat → question: beat

or: 1) beat + pour → question: pour

2) beat + pour → question: beat

4. Open-ended situations

Props: two sides of a carton box (that symbolised the walls of a room), dollhouse furniture, puppies (children - boy and girl - mother, father, brother, dog), toys, toy food. The sex of the puppy child used always corresponded to the sex of the test subject.

Physical pain

Look, in this house lives Kate/Leslie with his/her mom, dad and dog (while saying this, the experimenter points to the corresponding characters). Kate/Leslie is alone in the room, all other characters are outside in the open area. Examiner: Kate/Leslie wakes up in the morning and has a terrible stomach-ache. So he/she is crying. What do you think will happen next? Show me. (We wait for half a minute and if nothing happens:) Kate/Leslie is having a bad stomach-ache. (S)he is crying. Try to comfort him/her.

Separation

The props and the toys are introduced the same way as they were above except for the fact that the mother is in the room with the child and she is putting the child to sleep. The mother says: *Hello, Kate/Leslie, my darling, sleep well and have a nice dream. Cupp-cupp. We'll be in the other room with daddy.* Then the mother leaves the room. Examiner: *Kate/Leslie is afraid alone and can't fall asleep. What do you think will happen next? Show me. (We wait for half a minute and if nothing happens:) Kate/Leslie is very much afraid and is crying. Try to comfort him/her.*

APPENDIX 2

Detailed coding system of the pretend play task

Understanding make believe stipulations

	Action	Points
1.	The child touches the required object(s) only (in case of drinking: tea kettle and/or cup; in case of eating: can and/or plate)	2
2.	The child touches both the required and the wrong the objects (in any order)	2
4.	The child touches the wrong object(s) only (in case of eating: tea kettle and/or cup; in case of drinking: can and/or plate)	1
5.	Nothing is done.	0

Adjusting pretend actions to a make-believe identity

	Action	Points
1.	The child spontaneously chooses the right object and completes the required action with it.	3
2.	The child spontaneously chooses a make-believe object (different from the one originally intended to be used) and completes the required action with it.	3
3.	The child spontaneously chooses the right object, but he needs reinforcement for completing the action.	2
4.	Experimenter has to prompt the object to be used. (For example: the child asks the experimenter ‘ Where is the spoon?’)	1
5.	Nothing is done	0

Understanding make-believe transformations

	Action	Points
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1.	The child completes the right action on the right animal only. (For example, the child strokes only the animal which is in pain).	3
2.	The child completes the required action on both of the animals and he first completes the action on the right animal. (For example, the child first strokes the animal which is in pain and only then strokes the one which got wet).	2
3.	The child completes both of the actions simultaneously (using both hands) on one of the animals. /There was no such case/	1
4.	The child completes the required action on both of the animals, but he first completes the action on the wrong animal. (For example, the child first strokes the animal which got wet and only then strokes the one which is in pain).	1
5.	The child completes the required action on the wrong animal only. (For example, the child does not stroke the animal which was hit, instead, he stroke the one which got wet).	1
6.	Nothing is done	0

Open-ended situations

	Action	Points
1.	The child actively uses the dolls to solve the situation. (For example: the mother doll kisses the crying child doll and therefore calms her).	6
2.	The child himself calms the doll. (For example, he kisses the crying doll).	5
3.	The child himself or by using the dolls tries to do something with the crying doll with the intention to calm it. The way the child approaches the situation is adequate: (s)he understand, accepts and faces the stressful situation. However, the solution (s)he gives to the problem is not the most appropriate one. (For example, the child first takes the doll out of its bed and asks: 'Why does it hurt?' then, he answers his own question by saying: 'She drank too much water'. He still looks concerned, but then instead of stroking or kissing the doll, he starts turning the doll's head and then continues playing a different game	4

	with the toy, forgetting about its pain). So, the child gets into the situation, s(h)e first gives an adequate reaction to it, but then, suddenly (s)he just gets out of the stressful situation without offering an appropriate solution to the problem.	
4.	First the child gives a superficial reaction to the stressful situation. For example (s)he states that the doll is in pain, and then gets out of the situation, without touching or doing anything relevant. When (s)he is directly encouraged to calm the doll, the child touches it, but inadequately, without any intention to calm it.	3
5.	First the child gives a superficial reaction to the stressful situation. For example (s)he states that the doll is in pain, and then gets out of the situation, without touching or doing anything relevant. When (s)he is directly encouraged to calm the doll, (s)he either does not pay attention to the encouragement or s(he) overtly refuses to do so. ('The doll is crying'-says the child and starts asking 'What is this?' about other toys that are part of the scenario. She gets out of the situation. When directly asked to sooth the doll she says 'no' several times).	2
6.	Denial ('the doll is not in pain')	1
7.	The child freezes, does not do anything to solve the situation.	0
8.	The child gets out of the situation, does something else, does not have any reactions to the situation.	0

Categories 1, 2 and 3 were characterized as adequate reactions. Categories 4, 5, 6, 7 and 8 were considered to be inadequate calming methods possibly due to the disruptive effects of the emotionally disturbing situation.

Pretence refusal

	Action	Points
1.	No sign of pretence refusal	0
2.	The child mentions something about the real characteristics of the object (that contradicts its intended make-believe function), but the	0

	pretence activity is not disrupted. (For example, the child mentions that the tin is closed, but he pretends to get some food out of it right away).	
3.	The child mentions something about the real characteristics of the object (that contradicts its intended make-believe function) and stops his pretence activity. However, as soon as the experimenter gives some help, the child continues with the pretence activity. (For example, the child mentions that the tin is closed and stops his pretence activity. As soon as the experimenter tells him, that ‘we pretend that it is open’ or he pretends to open the tin, the child readily accepts the situation and pretends to get some food out of the tin).	-1
4.	The child asks for help at least twice. (For example, the child mentions that the tin is closed, he stops his pretence activity and asks the experimenter to open it. The experimenter pretends to open the tin, hands it back to the child, but the child insists that it is still closed and hands it back to the experimenter). In this category, children generally asked for help 4-5 times. They could only go back to pretence if their general activity was somehow disrupted for a while. (They got out of the game, talked about something totally different, went back to the game and continued with the right pretence action.	-2
5.	The child is disrupted in his pretence activity and is unable to continue.	-3

Reality intrusion: -3 points.

Adequate extension of pretence (even if the child extends the same actions to more different objects): 1 point.

Creative pretence (either with a real prop or with imaginary objects): 3 points.

Mothers' calming strategy

Mothers were asked the following question: 'Is there a specific method that usually helps calm your child?' The answers were sorted into the following categories:

1. Punishes the child.
2. Does not pay attention.
3. Promises something nice.
4. Tries to redirect attention.
5. Talks about it with the child.
6. Talks about it and one of 1-4.
7. A mixture of strategies 1-4.

Categories 1-7 were further divided into a mentalistic (5, 6) and non-mentalistic (1,2,3,4,7) group.