Peter Krøjgaard
Department of Psychology, University of Aarhus

Infant Categorization and the Principle of Complementarity[i]

(Commentary to Osman Kingo: The Concept of Concepts)

Osman Kingo (OK) has written an engaging and stimulating article on some of the key controversies regarding concept formation from a developmental perspective. In the article, specific attention is paid to the central dispute concerning whether categorization in infancy should be conceived of as something taking place in a *single* process (e.g., Quinn & Eimas, 2000) or whether a *dual* process approach (e.g., Mandler, 1997, 2004) is needed. Following a thorough, yet clear, outline of the most prominent theories and the empirical evidence supporting them, OK argues that devoted attempts to side exclusively with one of the opposing camps may not be the most promissing approach in order to move science forward. Instead, and inspired by the writings of the physicist Bohr (1958), OK suggests that we should carefully analyze the extent to which the theoretical and empirical findings accumulated in the two competing camps could eventually *complement* each other. In the author's own words:

> […] I will try to qualify the position that it is possible to move on towards a mutual understanding of this area in spite of the divergences (p. 9).

In accordance with Bohr's principle of complementarity, this pursue should not, however, be restricted to an analysis of theories and empirical evidence from *within* the specific domain at stake. Consequently, OK broadens the scope by involving recent research on object individuation, object function, and shared intentionality. The author hereby demonstrates convincingly, in my opinion, how research from other areas can be highly relevant for our understanding regarding infant concept formation. Especially stimulating I find the arguments concerning the need for bringing social interaction and adult scaffolding back into the field of infant cognition.

My comment will be in two distinct parts. In the *first*, I will question the extent to which OK actually succeeds accomplishing what he set out to achieve. The *second* part of my comment is less critical and is more an attempt to take up the challenge regarding how social interaction can have direct impact on infant cognition. In this vain, I will briefly present some very recent studies from Gergely Csibra and György Gergely and their colleagues who, in my opinion, have demonstrated the importance of this approach in a highly convincing manner.

To what extent is the "single process/dual process dispute" resolved?

After having presented exponents of the single process view and the dual proccess view and the empirical evidence supporting the two approaches, OK writes (p. 8):

> All the different approaches and researchers make good cases for themselves, so how are we to choose between them? In the following, I shall attempt to argue that we should not necessarily choose exclusively between them, but rather make them complement each other. Such an approach, I shall argue, may be more tenable than the more categorical discussion lingering in the field at present.

While I am sympathetic to the approach proposed, I am not entirely convinced that OK actually succeeds making the two positions complement each other. In order to substantiate the claim that we would be better off pursuing how the two opposing views could complement each other rather than choosing between them, a straightforward line of argument would be to show (i) that both of the opposing views are needed, and subsequently outline (ii) how the two opposing views and the key empirical findings from each camp might be interpreted from a third theoretical framework. However, I do not believe that OK ultimately succeeds accomplishing these two tasks or equivalent. I am somewhat left with the impression that we started out on a promissing journey but never really arrived at one of the key destinations we were heading for. In all fairness, such an enterprise is not trivial for sure, but if OK shall succeed convincing us that the two approaches do indeed complement each other, then we, in my opinion, would need more specific demonstrations regarding *where*, *how*, and to *what extent* that this is actually the case, than we are offered in the target article.

Social impact on infant cognition: Csibra and Gergely's 'human pedagogy'

When infants learn about the surrounding world it usually takes place in the presence of adult caretakers. However, when infant researchers attempt to investigate infant cognition, we often use experimental designs where any kind of social influence has been delimited to an absolute minimum, if not completely ruled out. This is for instanse the case in the majority of studies using the highly influental violation-of-expectation paradigm employed by many infant researchers including myself. In such studies parents are carefully instructed *not* to interact with their infants during the experiments and the experimenters are usually partially or completely hidden to the infants while the experiments are conducted (e.g., Baillargeon, 1986; Baillargeon & Graber, 1988; Krøjgaard, 2000, 2003, 2005, 2007; Wilcox & Baillargeon, 1998a, 1998b). The sound reasoning behind this systematical exclusion of social interference in the experimental setting is that we want to be able to control the experimental situation in order (i) to make test situations equivalent across infants, and (ii) to rule out potential confounders.

In contrast, when studying social cognition in infants, active and engaging adult experimenters are typically a natural and inherent part of the experimental design, simply because in those studies we specifically want to investigate infants' (and toddlers') understanding of social-cognitive notions like agency and intentionality (e.g., Meltzoff, 1995; Behne, Carpenter, Call, & Tomasello, 2005).

Thus, social interaction is either systematically removed from the experimental setting *or* the key issue of the experiment. However, surprisingly few studies have set out to investigate the possible effect of social interaction on how, for instanse, a given cognitive issue is understood or interpreted by infants. As already stated, OK argues that sooner or later we will simply have to take the social influence on cognitive development more seriously into account. I believe this is very true and would like to refer to some recent developments by Csibra and Gergely who at least implicitly take up this challenge.

Csibra and Gergely (2007; Gergely & Csibra, 2006) have recently argued that human beings may stand out from other species by being especially prepared for extracting cultural knowledge that may *not* be directly present in the visual array. One of their claims is that such cultural transmission is triggered and facilitated by ostensive pedagogical cues like eye contact, pointing, infant directed speech, and so forth. Very recently Csibra, Gergely and their collaborators have begun systematically to investigate how such communicative cues may influence typically cognitive aspects of development like for example infants' understanding of object locations. For instanse, in a very recent study by Csibra and Volein (2008), 8- and 12-month-old infants were presented with models gazing at one of two occluded object locations. When the occluders were removed an object appeared either at the location where the model had gazed or at the other location. The looking times of the infants were recorded and analyzed. The results revealed that the infants in both age groups looked reliably longer at the empty location when the location had been looked at by the model in comparison to empty locations that had not been indicated by the model. Thus, the results show that 8- and 12-month-old infants hold some kind of referential expectations about locations where models attend – even when the indicated location appears to be empty while another object location actually contains an object (Csibra & Volein, 2008).

In another very recent study on referential looking in 9-month-old infants, the possible effect of communicative cues like eye contact was investigated (Senju, Csibra & Johnson, in press). Placed in front of a plasma screen the infants saw a model looking straight ahead. Subsequently a picture of an object (e.g., a fish) was presented either on the left or on the right side of the model. The picture disappeared after which the model gazed at either the location where the object had just been presented or to the other side. To some of the infants the model established eye contact just prior to lateral looking, whereas to other infants the model did not. This difference turned out to have a profound impact on the results: Only when a preceeding period of eye contact was present a gaze-object congruency effect was elicited (Senju, Csibra & Johnson, in press).

While the results obtained by Csibra and colleagues are important in themselves within the social-cognitive domain, they are, in my opinion, also important and truly thought provoking as specific empirical examples of the kind of research that OK calls for in order to bring social interaction back into the heart of cognitive development. The results from Csibra and his collaborators make clear that the social interaction that infant cognition researchers systematically attempt to remove from the experimental setting can have important consequences regarding how a given test event is interpreted by infants. Thus, when attempting to understand concept development in infants and children we will probably have to explore the possible effect of social influence systematically, and the recent developments by Csibra and colleagues appear to be an important steppingstone in this regard.

In a broader perspective this may also indicate a revitalization of the key Vygotskian concepts of zone of proximal development and scaffolding. In light of the recent findings by Csibra and his collaborators the Vygotskian approach seems just as relevant in the everyday social interaction as in formalized pedagogical settings (e.g., school) where the notions are usually employed. Further, if we accept the human pedagogy thesis proposed by Gergely and Csibra (2006) as a departure point then it indicates that the Vygotskian approach seems to have a substantially stronger biological foundation than previously considered.

References:

Baillargeon, R. (1986). Representing the existence and the location of hidden objects: Object permanence in 6- and 8-month-old infants. *Cognition, 23*, 21-41.

Baillargeon, R., & Graber, M. (1988). Evidence of location memory in 8-month-old infants in a nonsearch AB task. *Developmental Psychology, 24*, 502-511.

Behne, T., Carpenter, M., Call, J., Tomasello, M. (2005). Unwilling versus unable? Infants' understanding of intentional action. *Developmental Psychology, 41*, 328-337.

Bohr, N. (1958). *Atomic physics and human knowledge* (1st ed.). New York: John Wiley & Sons, Inc.

Csibra, G., & Gergely, G. (2007). 'Obsessed with goals': Functions and mechanisms of teleological interpretation of actions in humans. *Acta Psychologica, 124*, 60-78.

Csibra, G., & Volein, Á. (2008). Infants can infer the presence of hidden objects from referetial gaze information. *British Journal of Developmental Psychology, 26*, 1-11.

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

Krøjgaard, P. (2000). Object individuation in 10-month-old infants: Do significant objects make a difference? *Cognitive Development, 15*, (169-184).

Krøjgaard, P. (2003). Object individuation in 10-month-old infants: Manipulating the amount of introduction. *British Journal of Developmental Psychology, 21*, (447-463).

Krøjgaard, P. (2005). Spædbarnsforskningens relevans for almenpsykologien [The releveance of infant research in relation to general psychology. (Target article with open peer commentaries)]. *Bulletin fra Forum for Antropologisk Psykologi, 15*, 6-51.

Krøjgaard, P. (2007). Comparing infants' use of featural and spatiotemporal information in an object individuation task using a new event-monitoring design. *Developmental Science, 10*, 892-909.

Mandler, J. M. (1997). Development of categorisation: Perceptual and conceptual categories. In G. Bremner, A. Slater & G. Butterworth (Eds.), *Infant development: Recent advances.* (pp. 163-189). Psychology Press/Erlbaum (UK) Taylor & Francis, Hove: England.

Mandler, J. M. (2004). *The foundations of mind: Origins of conceptual thought*. New York: Oxford University Press.

Meltzoff, A. (1995). Understanding the intentions of others: Re-enactment of intended acts by 18-month-old children. *Developmental Psychology, 31*, 838-850.

Quinn, P. C., & Eimas, P. D. (2000). The emergence of category representations during infancy: Are separate and conceptual processes required? *Journal of Cognition and Development, 1*, 55-61.

Senju, A., Csibra, G., & Johnson, M.H. (in press). Understanding the referential nature of looking: Infants' preference for object-directed gaze. To appear in *Cognition.*

Wilcox, T., & Baillargeon, R. (1998a). Object individuation in infancy: The use of featural information in reasoning about occlusion events. *Cognitive Psychology, 37*, 97-155.

Wilcox, T., & Baillargeon, R. (1998b). Object individuation in young infants: Further evidence with an event-monitoring task. *Developmental Science, 1*, 127- 142.

[i] The preparation of this paper was supported by two grants from the Danish Research Council for the Humanities (No. 273-05-0182; and No. 273-07-0009).