The Concept of Concepts: Perceptual and Conceptual Categorization in Infancy under Scrutiny

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Abstract

The human gift of language is unique. It allows us to efficiently convey our experiences and thoughts to others by referring to concepts that others recognize and share. In order to obtain a thorough description of the unique cognitive processes behind our conceptual lives as human adults, we need to understand the relation between the child's perception of the world and the formation of concepts. However, in spite of a monumental data production by developmental researchers, there is crucial theoretical disagreement regarding the very nature of percepts and concepts. The present paper discusses the central literature on this topic, and due to the very divergent findings the author proposes a future approach to the perception – conception debate based on complementarity. It is contended that such an approach may bring us closer to a viable "concept of concepts", one that is facilitative for a specification of the particularly human conceptual world. A more comprehensive knowledge of our conceptual lives and the developmental dependence on social factors such as shared intentionality and linguistic labeling could potentially provide us with a more detailed knowledge of what set us apart from other species.

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Every scientist … is constantly confronted with the problem of objective description by which we mean unambiguous communication. (Bohr, 1958, p. 67)

It seems incredible that we have been in the mind business for hundreds of years and have not yet agreed upon some definitions of the terms we all use in our work. We still reside in our Tower of Babel, and until we knock it down or leave it, I doubt real progress will be made. (Mandler, 2004a, p. viii)

Introduction

Conceptual thought is an essential part of our lives as human beings. It is difficult to imagine a person without a least some notion of what things in the world *are*, and how they relate to other things. One obvious advantage of using concepts is that concepts are economic. Because of our concepts we are spared the taxing job of discovering things in the world anew every time we meet them, most often we need only to *recognize* them as an instance of something we already know. Language, one of our most valued and unique capabilities, is deeply connected to our concepts of the world, if not, language would not be a communicative tool mediating human minds (Nelson, 1996). The capacity for language is often described as one of the defining characteristics of human kind, a powerful tool enabling us to communicate about things beyond the here-and-now, and thus playing a crucial role in human cognition and the human culture encompassing past, present and future (Nelson, 1996; Spelke, 2003). Language goes beyond the mere ability to produce vocal sounds in a systematic way. What we really treasure is its ability to let us *share* concepts and ideas with other human beings in a very efficient way. The efficiency of our sharing of concepts is at the heart of our language capability – and is arguably a particularly human trait. Taken as such, a more comprehensive knowledge of our conceptual lives could potentially provide us with more detailed knowledge of what sets us apart from other species – what makes us human. Therefore it seems promising, from an *anthropological* perspective, to look at the existing and developing psychological knowledge of our concepts and the way conceptual thought unfolds in human lives. To begin an exploration of this possibility, though, we need to specify what we mean by "conceptual", we need to agree on a concept of concepts.

Unfortunately, the concept of concepts is one of the most ill-defined notions in the psychological literature (Madole & Oakes, 1999; Rakison, 2005b). Yet, the definition of concepts and their relation to perception, categorization and language is one of the most hotly debated issues in cognitive and developmental psychology and – it seems – in many other related fields[2]. Of particular interest in this debate is the distinction or relation between *percepts* and *concepts*, perceptual and conceptual processes or perceptual and conceptual categorization. Generally, the agreement is that perception is something we share with all other species since perception is basically a process of giving coherence and unity to sensory input (Reber & Reber, 2001). Conception on the other hand is often thought of as way of abstracting from concrete experiences, something humans are supposedly particularly adept at. Therefore, the distinction or relation between percepts and concepts has important implications for the way we compare ourselves to other species. In this respect, the percept/concept-distinction becomes an interesting anthropological question or problem as well as a developmental one.

Categorization is central in this discussion because it is the process by which we are able to group objects we experience[3], based on a comparison of similarities and dissimilarities (e.g. Mandler, 2004a). In this sense categorization is a very basic cognitive building block without which it would be impossible for us to relate to the world – we simply have to be able to tell some things from others (Oates & Grayson, 2004). Likewise, our perception or conception of something in the world will always be a percept or concept of something that is *different* from other things. This is why most (but not all) of the research on perception and conception concerns perceptual and conceptual *categorization* of some sort.

In the present paper these issues will be discussed from a developmental point of view. There are several reasons for this choice: First of all, the developmental perspective is the one taken by most of the researchers contributing to the perception-conception debate. Second, it may be agued that the best shot we have at grasping the foundations of our conceptions is to turn to the beginning of our conceptual lives, whether this is early childhood, infancy or even earlier (Gershkoff-Stowe & Rakison, 2005; Mandler, 2000a). Finally, a developmental approach, in particular, leads us to consider functional and dynamic changes in the phenomenon we study, potentially enriching our understanding of this phenomenon (see Krøjgaard, 2005).

However, choosing infancy as an area of focus for psychological experiments implies certain constraints too. We cannot

expect infants to understand any verbal instructions. Likewise, they cannot verbally tell us about their world experiences. We can only manipulate situations, observe the infants' behaviour and eventually interpret this behaviour within our theoretical framework. It is therefore immensely important that we are deeply conscious of our theoretical framework when conducting our experiments, when interpreting the data and when reporting our findings. We cannot expect data to speak for itself - a point to which I shall return.

Focus and content. The aim of this paper is to seek out the particularly human by an analysis of the current debate on categories and concepts among developmental psychologists. Of course categorization and concepts are only parts of what constitutes the foundation of language. There are many psychological areas of importance to language; areas of which category representation, concepts, words, brain and cognitive development, grammar, executive functions, Theory of Mind and socio-cognition are textbook examples (e.g. Oates & Grayson, 2004). Other relevant areas could be emotion and self-development (e.g. Stern, 1995) or society. I *will* discuss some of these areas later, but the primary aim of the present paper is to address the specific ongoing debate on perception and conception and to relate *this* particular debate to the more general anthropological questions. In other words, I offer an analysis of the perception – conception debate as a possible approach to anthropological psychology.

The paper will be structured as follows: In the first section, following this introduction, I will *provide A look into the perception – conception debate* outlining the setting and history of the debate. Subsequently, I will present two contrasting views in this debate in the sections *A dual process view* and *Single process views*. I shall later argue, that the very divergent findings from these views to a large extent are a consequence of different experimental methodologies. Following this, in the section *Together we stand divided we fall*, I will make some more general observations on some of the dead-ends and possible remedies of the perception – conception debate. In this section I incorporate and discuss the concepts of correspondence and complementarity (Bohr, 1958) as well as concepts such as parsimony and ontology. As I hope will be evident, this is to prepare for a potentially more rewarding way of viewing and comparing the different findings in the perception – conception debate. I follow up on these observations by suggesting that the existing research on concept formation should be supplemented by other approaches to the field in the section *Broadening the scope*. To anticipate, it seems that some of the recent research in infants understanding of the physical world may actually lead to a renewed emphasis on factors from the *social* sphere such as scaffolding, imitation and shared intentionality. In addition, I shall argue that this research may even provide a fuller understanding of the uniquely human conditions and constraints of early cognition. Finally, I make concrete suggestions of *Further research* and close with a *Summarizing conclusion*.

A look into the perception – conception debate

Categories and concepts. As mentioned, there is a close relationship between categories and concepts. They describe in different ways the "grouping together" process that underlies important parts of our cognition (Quinn & Oates, 2004), and they do so based on a comparison of similarities and dissimilarities (Mandler, 2004a). The "classical" approach to concepts and categorization traces back to ancient Greece and Aristotle. This approach, often termed the defining-attribute approach, assumes that a concept can be characterized by a set of defining attributes, which are those semantic features necessary and sufficient for something to be an instance of the concept (Eysenck & Keane, 2005). This is often exemplified by the concept "bachelor" with the defining attributes: male, single and adult. Although this might seem fairly straightforward and sensible, the consequences of this approach are substantial. For instance, in the defining-attribute view it is considered that all members of a give category are equal and that all demarcations between categories are unambiguous and clear.

One of the early critics of the defining-attribute approach was Ludwig Wittgenstein (Gardner, 1985). Wittgenstein pointed out, that words do not have clear and unambiguous meanings; since their underlying concepts are largely defined by the way they are *used* or how they take part in so-called *language games*. For instance: "The word *game* itself has a family of meanings, with no definition ever sufficient to account for all, and only all, games" (ibid. p.68).

The challenge from psychology to the defining-attribute approach was the *prototype* theory as suggested by several theorists most importantly Eleanor Rosch (1975; 1978). According to the prototype theory (in its most popular form) a prototype is a set of characteristic attributes or a summary representation of which some attributes are weighted more than others. Here, there are no defining attributes but only characteristic ones (Eysenck & Keane, 2005). An object is a member of the concept if there is a good match between its attributes and the prototype and a periphery member if the match is less than good (e.g. the Pope as a bachelor).

Embedded in the prototype theory is the notion that there is a "basic level" of categorization that is primary or fundamental (Rosch, 1978). It is still somewhat unclear exactly how this basic level is defined (Mandler, 2004a), but generally it is assumed that this level of categorization carries the most information and possesses the highest *cue validity*. The cue validity is defined as the extent to which an attribute predicts a particular category. This could be the extent to which the attribute "wings" predicts that something is a [bird][4] and does not predict a different category such as [butterflies]. Basic level categories are said to maximize the amount of within-category perceptual similarity compared with between-category dissimilarity (ibid.). In this way the basic level is the "middle" level of categorization (e.g. the category [dog]) lying between the superordinate (e.g. the category [mammal]) and the subordinate (e.g. [Golden Retriever]) levels. The strength

of the prototype theory was, that the idea of good and bad exemplars of the same category actually fit the description people gave of their categorical understanding. More recently it has been suggested that people may in fact base their prototypes on *specific exemplars* instead of summary representations of characteristic attributes (see Quinn & Oates, 2004).

In some contrast to the approaches mentioned above is the *developmental approach*. In this approach to categorization the *changes* in the ability to categorize throughout the ontogenesis is emphasised. Consequently, the child's growing experience with the world is taken into account[5]. One exponent of this approach is Jean Mandler (e.g. Mandler & McDonough, 1993; Mandler, 1997; 2000a; 2004a). She argues that infants begin to group objects together on the basis of perceptual features such as shape, colour, texture etc. Then, based on experience, initial perceptual categories might be formed by infants through the co-occurrence of certain visible features. In this way, a perceptual category similar to [door] might be formed because of the visible similarity of flat, rectangular things that are upright (see also Quinn & Oates, 2004). Mandler calls this kind of grouping *perceptual* categorization. She contrasts this with *conceptual* categorization, which is a process that results in categories that are richer; more imbued with meaning and are more open to reflection. This conceptual information is closer tied to the *function* of objects. In the instance of [door] it could be: "swings", "can be open or closed", "is a point of access" and so forth. These properties are not directly perceptual, but have more to do with what a [door] *is*.

The distinction between the terms perceptual and conceptual is tricky, and Mandler's definition is but one of many. Attempts have been made to describe a more common definition:

> Generally, the terms "perceptual information" and "perceptual cues" refer to properties or features of an object, entity or event that are consistently available in the sensory array. Thus perceptual information is often used to describe the surface properties of features of things such as size, color, shape, parts, and so on. In contrast, the terms "conceptual" "nonobvious" or "nonobservable" information generally refer to those properties or features of an object, entity, or event that are not often if at all available in the sensory array. Such properties are generally taken to include internal biological and technological components of animates and inanimates (e.g., beliefs, intention, and goals) and motion capabilities (e.g. self-propulsion, agency and contingent action). (Rakison, 2005b, p. 134)

I shall return to this distinction in greater detail later. For now, suffice to say, that it is commonly agreed that younger children and infants tend to rely on perceptual properties as the basis for categorization, whereas older children, typically toddlers and preschoolers, weigh more heavily the nonobvious or conceptual properties of objects in category membership decisions. Recent work with infants points to the same relative transition from the first to the second half of the first year of life (Quinn & Oates, 2004; Rakison, 2005b). It is also commonly agreed, that a description of how this development occurs is very dependent on the definitions of perceptual and conceptual categories *per se*. However, this is where the common agreement among the developmental researchers ends.

Perceptual and conceptual categorization: one or two processes? There is a common *dis*agreement on whether or not perceptual and conceptual categorization should be viewed as development of a single process or as parallel developments of two distinct processes (Carey, 2000; Gibson, 2000; 2000b; Mandler, 2000a; Nelson, 2000; Oakes & Madole, 2003; Quinn & Eimas, 2000; Quinn & Oates, 2004; Rakison, 2005b; Reznick, 2000; Smith, 2005b). In the following, I will present some of the most prominent advocates for the *dual process view* and *the single process view*[6]. As hinted, I believe that an important part of the disagreement concerning early categorization and concept formation lies in the different methodologies and in their assumed explanatory values as much as in the diverging theoretical frameworks. Consequently, I will describe the methodologies in some detail as I present the various views.

A dual process view.

The dual process view has, for some years now, centred on the work of Jean Mandler (Quinn & Oates, 2004; Rakison, 2005b) - one of the most committed advocates for an explicit distinction between perceptual and conceptual processes in infancy (e.g. Mandler & McDonough, 1993; Mandler, 1997; 2000a; 2004a). As outlined, Mandler has suggested that the word "category" actually covers two different and important ideas:

> [W]e must distinguish two types of object categorization in infancy. One is *perceptual* categorization, which is an automatic part of perceptual processing that computes the perceptual similarity of one object to another. It creates perceptual schemas of what objects look like. The other is *conceptual* categorization, which is based on what objects do. It consists of the redescription of perceptual information into conceptual form, particularly the paths that objects take and the interactions among them. This process creates the notion of kinds, such as animals, plants, vehicles, and furniture. The similarity in this kind of categorization is of roles in events, not the physical appearance of the objects. (Mandler, 2000b, p. 3, italics added)

What Mandler proposes here is that perceptual categorization leads to the ability to *recognize* objects (e.g. [dogs]) while conceptual categorization provide their *meaning*. Moreover, Mandler states that perceptual categorization takes place without awareness (that is: automatic and unconsciously) merely as a result of exposure to visual stimuli. In contrast, conceptual categories provide infants (and others) with information that is consciously accessible. The differences here are roughly the same as those between procedural and declarative knowledge (Mandler, 2004b).

Mandler arrives at these conclusions based on findings from several experiments conducted by her and others (Mandler, 2000a). The primary argument for the differentiation of perceptual and conceptual processes is that very different results have been reached when using *different methods* of study:

Different methods. One way of studying categorization in infancy is by using the familiarization/novelty-preference method. This method relies on the strong tendency infants have to prefer to look at novel things (Eimas & Quinn, 1994; Quinn & Oates, 2004). It has originally been applied in the variant "familiarization/preferential-looking" where pictures of members from one category[7] (e.g. [cats]) are shown to the infant one at a time. Eventually, the infant looks away for an increasing amount of time as he or she habituates to the pictures. Then, after the infant has seen pictures of several cats (the familiarization phase), two pictures are shown simultaneously (test phase) e.g. one of a novel cat and one of a dog (new category). At this point it is measured for how long the infant looks at either of the two pictures. Typically infants as young as 3 months of age will look longer at the dog picture, which is taken to indicate that the infant sees the dog picture as "more novel" than the cat picture. This, in turn, indicates that the infant has formed a category of the cat pictures that includes the novel cat exemplar but excludes the dog exemplar (Mandler, 2004a). If the pictures of dogs and cats are exchanged in the experiment, the reverse is true. This kind of studies has shown that infants 3 months of age are able to categorize on the basic level based on visual stimuli (Eimas & Quinn, 1994).

Another variant of the familiarization/novelty-preference method is the "familiarization/preferential-examining task" (or just object examination task). Drawing on the same principles, this task lets the infant *examine* small models of the objects with their hands instead of looking at pictures. Apart from that, the two tasks are almost identical (Mandler, 2000a). After the familiarization phase, it is measured for how long the infant examines a novel object from the old category compared to a novel object from a new category. Mandler and McDonough (1993) carried out a series of experiments using the object examination task. Surprisingly, they found that infants 7-9 months of age were *unable* to categorize objects at the basic level such as [dogs] and [cats] in this task (remember that basic level categorization was found at the age of 3 months when applying the familiarization/preferential-looking method). Instead, these infants formed broader or more "global" categories such as [animals] or [vehicles], categories that according to the prototype and basic level theory consist of objects that are very *dis*similar (low cue validity).

A third method of studying infant categorization is by "generalized imitation". This technique relies on two characteristics of infant behaviour: First, infants spontaneously imitate events they have observed. Second, their imitations are determined by what they have understood from their observations (Mandler, 2004a). Mandler and McDonough (1996; 1998; McDonough & Mandler, 1998) used this imitation method to study limits of the inductive generalizations infants make. Events were modelled for the infants using little replicas. For instance, the experimenter would give a dog a drink from a cup. Subsequently the cup would be given to the infant, but instead of providing a dog, the experimenter would present two other objects (e.g. a bird and a car) to see which object, if either, the infant would use to imitate the drinking (Mandler, 2004a). Mandler has argued that infants in such experiments effectively answer the question: "What sort of things drink?" (ibid.). Using the generalized imitation design, Mandler and McDonough (1996; 1998; McDonough & Mandler, 1998) found the same categorization pattern as when using the object examination design (Mandler & McDonough, 1993). For instance, 14-month-old infants were just as likely to generalize the drinking from the dog to a fish than to generalize it to a cat. But they were reluctant to generalize from a dog to any vehicle (Mandler & McDonough, 1996). In other words, infants tended to generalize the modelled actions to other objects from the same *globa*l category only (e.g. [animal]) without differentiating on the basic level.

Mandler has concluded that two different kinds of categorization are taking place in the different methodological setups, one perceptual and one conceptual. She argues that the findings from familiarization/preferential-looking tasks *and* from object examination and imitation tasks expresses perceptual and conceptual categorization respectively (Mandler, 2000a). She claims that the global categorisation of animals in their findings had to be conceptual on two grounds:

1. Domain-level global contrasts involve too much within-class perceptual variability to be categorised by the perceptual system alone. This argument says that the perceptual dissimilarity of the items is too great to enable categorisation on the basis of perceptual features. The shapes of elephants, birds, and fish vary too much to form a purely perceptual category. Therefore, if infants are sensitive to the category of animals, it has to be based on some kind of conceptual meaning.
2. The second argument is that the perceptual system alone cannot determine choice of responses in any kind of complex self-instructing task. […] Object examination activates the motivational system, and is not an automatic attentional shift to something perceptually new, which might be what is going on in the preferential looking task with young infants. (Mandler, 1997, p. 176-178)

The second argument also applies to the global categorization found in the generalized imitation experiments, since this categorization of perceptually diverse objects is taken as an expression of conceptual categorization (Mandler, 2004a).

The perceptual to conceptual shift. As mentioned earlier, there is consensus that that younger children and infants tend to rely on perceptual properties as the basis for categorization, whereas older children, weigh more heavily the nonobvious or conceptual properties of objects in category membership decisions. If the dual process view of categorization is to be taken in to account here, there must be some way of describing the shift in reliance from perceptual information to conceptual information, a transition known as the *perceptual to conceptual* shift (Rakison, 2005b). This transition has been of

particular interest to researchers in the field since a robust argument for the duel *or* the single process view of categorization must include *at least* a theoretical explanation for the developmental changes in categorization seen during childhood (Mandler, 2004a; Rakison, 2005b).

Mandler has proposed that conceptual categories may be derived from perceptual information via a *redescription* of the perceptual information into conceptual form, a process she calls *perceptual meaning analysis*[8] (Mandler, 1992; 2000a; 2004a). This analysis occurs when the child pays selective attention to certain aspects of the perceptual information. In this way the process of perceptual meaning analysis is different from perceptual processing, which occurs automatically and is typically not under the attentive control of the perceiver (Mandler, 1997). The perceptual information to be analysed in particular are the paths that objects take, and the interactions between them; it is *not* the physical appearance of the objects *per se* (Mandler, 2000a). Mandler suggests that the redescriptions resulting from this kind of analysis are in the form of *image schemas*:

> *Image schemas* are simplified redescriptions of various relations that are involved when objects take part in events. In spite of their name they are not visual representations. Rather, they are abstract spatial representations of paths that objects take; their onset and endpoints; as well as various containment, contact, support, and contingent relations that obtain among objects. They have been described by cognitive linguists as the basis on which understanding of language takes place (Johnson, 1987; Lakoff, 1987). (from Mandler, 2000a, p. 19)

Mandler claims that these are the first meanings learned by infants and that these meanings are combined to form concepts of kinds (conceptual categories). In the process of perceptual meaning analysis a new format emerges and some information is lost. The remaining information (in the new format) is accessible to consciousness. These newfound conceptual categories are at first global in nature such as [animal] or [furniture] as described earlier.

Mandler's findings and conclusions have met many challenges of varying degree (Carey, 2000; Gibson, 2000; Murphy, 2004; Nelson, 2000; 2004; Quinn & Eimas, 2000; Quinn, 2004; Reznick, 2000; Shutts & Spelke, 2004). I turn now to some of these exponents of a contrasting view on the matter. Again, different methodologies will be described fairly detailed in order to prepare for a proper discussion of the disagreements as such.

Single process views

The support for a single process of categorization development is very diverse and cannot be properly represented by a single psychologist or theory. I have allowed myself to focus on three different approaches to the single process view. One approach has by Quinn and Oates (2004) been called "*quantitative enrichment*". It is shared by the researchers Eimas and Quinn, and Rakison whose theoretical standpoints on the matter are somewhat overlapping. The second approach is the *microanalytic* approach suggested by Madole and Oakes. It offers a perspective quite similar to the quantitative enrichment but has a distinctive focus when it comes to the choice of experimental designs. The third approach is the one derived from *dynamic systems theory* (e.g. Gershkoff-Stowe, 2005; Smith, 2005a), in some senses the most radical version of the single process view. When reading through this section the reader will find a trend from a focus on the child and the object of categorization to a focus on variability of the context. This trend is, of course, a result of the present selection of theories, but it also emphasizes important differences between the theorists in favour of the single process view.

Quantitative enrichment. Eimas and Quinn have been reporting numerous studies on infant categorization (Eimas, Quinn, & Cowan, 1994; Eimas & Quinn, 1994; Quinn, Eimas, & Rosenkrantz, 1993; Quinn & Eimas, 1996a; 1996b; 1997; Quinn, Eimas, & Tarr, 2001). The bulk of their categorization research has been conducted on very young infants 3-4 months of age using the familiarization/preferential-looking method as described in the previous section. Eimas and Quinn (1994) showed that 3-4 months old infants were able to categorize pictures of cats and horses. Taking this method a step further, they showed that infants categorized *correctly* when seeing only the faces of cats and dogs whereas *no* differentiation occurred when the infants saw "faceless" bodies of cats and dogs (Quinn & Eimas, 1996a; 1996b).

These findings have encouraged Quinn and Eimas to suggest a single and *perceptual* account of infant categorization. They have speculated that young infants generate their initial categories by anchoring their representations to one or another salient perceptual property (e.g. the *faces* of animals), then, over time, these representations become structured by the inclusion of more elaborate sets of properties (Quinn & Eimas, 1997). This means that object-categories have certain salient object-features as their basis or core. Gradually, the object-categories become *enriched* by other features e.g. the *body* of animals, their *sounds* and their *motion* characteristics. According to Quinn and Eimas (ibid.), this inclusion of more and more information (here called "quantitative enrichment") is sufficient to explain the category formation at the basic level such as [dogs] *and* at a more global level such as [animals]: Correlations of attributes in the world are shadowed by correlations of these attributes in the infants' categories in a continuous and *single* process.

This theoretical framework is in opposition to Mandler's dual process view in stating that only *perceptual* processes are needed to explain *all* infant categorization even though we may tend to use the term "conceptual" when the categories reach a certain level of "richness":

> [W]e seek to explain the development of knowledge-rich concepts *without* invoking specialized processes and representational structures like perceptual analysis and image schemas. Mature concepts have their start with the joining together of the surface features and dynamic movement properties of objects that may be perceived and repre-

> sented *directly* by infants … [W]ith sufficient enrichment, behaviour can *appear* to undergo qualitative changes despite an underlying quantitatively changing process. (Quinn & Eimas, 2000, p. 56, italics added)

This statement bears some resemblance to the Gibsonian position with regard to the directness of perception of information. But Quinn and Eimas do admit to *some* information that cannot be perceptually represented namely *inferential* information (Quinn & Eimas, 1997). For instance, this information would be the kind used by infants in Mandler and McDonough's generalized imitation experiments to infer which of the objects were eligible to give a drink. Quinn and Eimas state that inferential knowledge cannot be perceptual in nature as it is a consequence of knowledge already represented. They maintain, though, that there is only one *categorization process* at work, and that this process is perceptually based since inference relies on information that has *previously* been acquired through perceptual input systems (Quinn & Eimas, 2000). Part of Quinn and Eimas' motivation for this theoretical framework is the principle of *parsimony* (ibid.); the argument being that introducing two kinds of categorization does not provide more explanatory power than relying on one kind. Therefore, the theory offered by Mandler including the notion of *perceptual meaning analysis* is considered redundant (Quinn, 2004).

Another prominent contributor to the perception-conception debate is David Rakison. He largely agrees with Quinn and Eimas' conclusion with the important exception of their stance on inferential information (Rakison, 2005b). Rakison's stance is that infants' representations are "perceptual" throughout infancy in the sense that all information concerning things in the world is derived from sensory input. On top of that, Rakison claims that these representations are in fact capable of supporting some kind of inferences about the properties of objects or their behaviours (ibid.). That is, the perceptual system in itself is capable of generating inferences and thereby expectations of the world. This claim rests partly on research from Rakison's own laboratory. Using a modified version of the generalized imitation design (Rakison, 2005b, calls it "inductive generalization") Rakison (2005a) modelled events combining certain movement patterns (e.g. walking, flying and rolling) with certain kinds of objects (different animals and vehicles). The test objects varied also in their different motion-relevant parts (e.g. wheels or no-wheels, legs or no-legs, wings or no-wings etc.) although no objects with "odd" object-part correlations (e.g. a bird with wheels) were used. In short, he found that when imitating the modelled event, 14-month-olds only marginally correlated the motions with the "correct" objects. Eighteen-month-olds correlated the "correct" motions with the "correct" kind (or category) of object *and* with other objects from another category but only with motion-relevant parts. Twenty-two-month-olds correlated the motions only with the "correct" object-kinds with motion-relevant parts (e.g. from a cat to a dog but not a dolphin) (Rakison, 2005a; 2005b). According to Rakison, these results imply a developmental trend where the first relations are between object-parts and the associated movements. Only later are the relations between whole objects and associated movements formed.

To summarize, young infants do not generalize the actions they observe on the inductive generalization procedure on the basis on non-observable properties or category membership. Instead, the data presented are taken to suggest that 14- and 18-month-old infants' knowledge of the motion properties of objects may be based primarily on an association between visible action or motion and the causally relevant functional parts involved in that action. In contrast, 22-month-olds appear to have extended this association to whole objects or categories of objects (ibid.). Rakison thus concludes that perceptual information is primary, and that the association between percepts (e.g. perceptual parts and motion) suffices to form "conceptual"-like categories.

The microanalytic approach. Madole and Oakes (1999; Oakes & Madole, 2003) have suggested what they call a *microanalytic approach*. This approach is an attempt to depart from the perception – conception dichotomy, by focussing on the *process* of infant categorization instead of the *content* (Madole & Oakes, 1999). Researchers, they argue, should not focus on which objects or actions infants put in which categories, as much as on the *way* these categories are formed and on which kind of information is used in the process.

Madole and Oakes see several problems with a strict distinction between perceptual and conceptual categorization as the one explicitly proposed by Mandler *and* as implied by Eimas and Quinn in taking a decidedly perceptual stance. They argue, that smaller "units" of the categorization process needs to be examined and that the somewhat bulkier notions of "perceptual" and "conceptual" categorization has only lingered because they seem easier to examine:

> The whole argument seems to have been corrupted by our tendency to ask questions in a way that conforms to principles of ANOVA-based experimental designs rather than in a way that conforms to psychological reality. It is far easier to generate hypothesis about the role of perceptual and conceptual properties when these are considered as independent and dichotomous properties. Questions become much more complex when one realizes that so-called perceptual and conceptual attributes are both ill-defined and highly correlated with another. (Madole & Oakes, 1999, p. 271)

To the extent that perceptual and conceptual features are meaningful notions, Madole and Oakes believe that categories are constructed from *both* perceptual and conceptual features[9]. This idea springs from the assumption that *perceptual* features are needed to identify objects but *conceptual* features determine which perceptual features an infant pays attention to when experiencing an object.

An example[10]: Imagine a girl 14 months of age who sees an object. This object potentially has many perceptual features for her to attend to. To narrow down the potential perceptual features of attention she has to rely on information from the context. This particular object is in the park (location), is running around (self-movement) and is interacting with other

objects (agency). This information points in the direction of a global or "fuzzy" category she has already obtained namely [animal]. Based on this conceptual information, it is now possible for her to pay attention to a limited set of perceptual features typically important when distinguishing different animals. Consequently, she attends to the size of the animal, the face, number of legs and the distinctive sounds it makes, and she decides that this is a [dog]. A similar process is needed, of course, to explain the selection of the important features for identifying the [animal] category and so on, but this example is meant to illustrate that it can be difficult to maintain a distinction between perceptual and conceptual categorization when we look at the categorization *process per se* as suggested by Madole and Oakes (1999).

Oakes and Madole (2003, p. 135) have suggested three principles for how access to information available for categorization *changes* with development:

- Principle 1: The development of motor, cognitive, and linguistic abilities broadens the pool of features.
- Principle 2: With development, infants become able to take advantage of the information available in different contexts.
- Principle 3: Increased background knowledge constrains the pool of potential features.

A recent example of a study on changing category structure is the study by Horst, Oakes and Madole (2005). The study was an attempt to directly assess how infants' categorization unfolds over time. Using a visual familiarization task the authors evaluated 10-month-old infants' learning of exemplars characterized by commonalities in *appearance* or *function.* When varying the kind of commonality (same function or similar features) of the objects during the familiarization, they found that infants familiarized to a category based on static perceptual information (appearance), first learned the features of the *individual* exemplars and only later learned the common feature, while infants familiarized to a category based on dynamic features (function), first formed a *summary representation* and only later learned the individual items. The overall conclusion from this study was that infants' categorization is flexible and context dependent as predicted from the three principles above. We turn now to a theory that emphasizes the flexibility and context dependency even more.

Dynamic Systems Theory. In the present field of theories *dynamic systems theory* (DST) constitute an extreme opposition to the dual process view simply by stating that there are *no* concepts (hence no perception – conception dichotomy). As such, DST poses an interesting (if somewhat antagonistic) perspective on the perception – conception debate. In DST the developmental process is viewed as a change within a complex dynamic system in relation to the environment:

> Complex systems composed of very many individual elements embedded within, and open to, a complex environment can exhibit coherent behaviour: the parts are coordinated without an executive agent, plan, or program. Coherence is generated solely in the relationship between the components and the constraints and opportunities offered by the environment. This self-organization means that no single element has causal priority. (Smith, 2005a, p. 278)

Changes in these systems are happening in different "nested" timescales: moment-by-moment, throughout a life span and as an evolutionary process (Gershkoff-Stowe, 2005; Smith & Thelen, 2003; Smith, 2005a). Potentially, these ideas have a massive impact on the notion of concepts since they mean that there can be no *stable* thoughts or ideas; thought is an in-the-moment unique event. Concepts, in this view, are seen as non-changing (rigid) symbolic or propositional representations and as such they have no place in the DST; they are unnecessary constructivist entities (Smith, 2005a).

From the DST point of view this approach has great advantages when trying to explain the *variability* of infant behaviour. In other lines of research, between-subject variability can be very problematic since it "swamps" any experimental effects. But in DST the metric is not whether or not a child "has" some static ability or not. Rather, as systems are always in flux, the important dimension is the *relative* stability of behaviour in its particular context over time (Smith & Thelen, 2003). In this way, children's categorization behaviours are fluid, opportunistic, *locally* unpredictable and only *globally* coherent and stable (Gershkoff-Stowe, 2005). It is also *embodied* since categorization is a result of the organism's actions in and towards the surrounding physical environment. The relationship between our bodies and the world directly causes our categories (Thelen & Smith, 1994).

To summarize, DST poses a view in which the notion of concepts is only a theoretical size and as such it is irrelevant to the discussion of categorization behaviour and development. According to this theory, the factors of relevance are the complex systematic interactions between organism and environment.

Together we stand, divided we fall: How do we move on?

Keeping track of the similarities and differences in even this limited selection of possible approaches to conceptual development is not a trivial problem. It is tempting to simply side with one of the approaches, to accept its arguments and methodologies and from that standpoint see where all the others went wrong. To avoid this pitfall, I find it necessary to turn to the theory and philosophy of science for a while, and I will do so for the remaining parts of this section. The problem to be dealt with is this: 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 let them complement each other when possible. Such an approach, I shall argue, may be more tenable than the more categorical discussion lingering in the field at present.

Divergent findings. I believe, that the present look into the perception – conception debate gives rise to several areas of concern. These areas boils down to the following:

1. There is disagreement regarding the number of processes by which infant categorization should be described.
2. No one has yet been able to *falsify* any theses contending that perceptual and conceptual categorization is a result of either a single or of more processes. But both theses have been qualified by data.
3. There is a wide spectrum of methods by which a better understanding of the development of categorization and conceptualization is sought.
4. The favoured methods of each group of researchers depend on their *a priori* assumptions and seem to confirm these assumptions *a posteriori*.
5. The concept of concepts varies considerably across theories and it is even discussed if we should utilize a concept of concepts at all.

It may seem unnecessary and irrelevant to list these points here. But in spite of the self-evident nature of the points, they are, in my opinion, still somewhat neglected in much of the perception – conception literature.

Ideally, when researchers present empirical evidence from within a specific area of interest, these researchers describe the *same* phenomena (more on the ontological questions later). But this does not seem to be the case in the perception – conception debate, at least not if we include the totality of empirical findings in this field. In the following 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. To do this, I have to discuss some of the dead-ends of the perception – conception debate.

What is simple about parsimony? A possible attempt to solve the problem is to invoke the *principle of parsimony*. This principle has its own inherent problems though, since simplicity of a theory might be judged on quantitative factors (such as the length or number of statements) or more qualitative factors (such as the "fit" of theory and the type of data).

What I argue here is that the issue of parsimony by no means is straightforward and that one might consider whether or not the "simplest" theory is always the best. I contend that psychological theories have an obligation to have a *meaningful* relation to the world experienced by real people. Therefore, the most parsimonious theory (judged on quantitative simplicity) may not automatically be the one that does the best job of extracting *meaning* out of data. Consequently, the principle of parsimony does not necessarily provide a good measure of our theories by itself, and it definitely *cannot* help us decide among the divergent concepts of concepts, since this would presuppose what we do not have: a mutual vantage point of such a comparison. Following this, the principle of parsimony may pose a dead-end in the perception – conception debate.

What kind of agreement are we trying to reach? – On correspondence and complementarity. The perception – conception debate results in a tautological problem since each different view on conceptual development seems to produce its own definition and determination of concepts. The Danish scientist Niels Bohr (1885-1962) elaborated on this problem on several occasions and he made the very perceptive distinction between *correspondence*[11] and *complementarity*[12] (e.g. Bohr, 1958). In the light of these principles we may look at the earlier described tautology problem again. It seems, that the tautology problem arises when we are trying to apply the correspondence principle as the *only* way of determining our phenomenon, concepts. We seem to need the complementarity principle as well to exhaust the possible information about the object. This is the crux of the matter: the two principles are equally important and should coexist. An acceptance of the complementarity principle, in addition to the correspondence principle, should prompt us to focus more on *how* the different approaches and derived findings complement each other instead of focusing solely on the discrepancies of the various descriptions of the phenomenon. At least, I suggest this as one possible way out of the present deadlock, making diversity a *virtue* in the process.

The ontology of percepts and concepts. As such, the complementarity principle does not help us decide in the perception – conception debate. We are still left with two importunate and related questions:

1. How can we discuss concepts as one ontological entity when they "look" different from different perspectives?
2. Are concepts relevant phenomena of empirical investigation? Or are we better off calling the target of our investigation something else? Recall the stance of the dynamic systems theory on this issue.

These questions are not easily answered. In my opinion, to answer the first question we have to decide on the second. I believe part of the solution lies in the discussion of parsimony above. If we strive for *qualitative simplicity* it makes sense to utilize a concept of concepts since this notion is an important part of the way we think about our mental lives as adults. Thus, without a concept of concepts we will have a hard time "translating" the findings of infancy research to something that is psychologically meaningful. Still, this does not decide for us in the perception – conception debate, it is only an acknowledgement of concepts as a valid notion in infancy research. Regarding the first question, it should be possible to discuss concepts (and percepts) in spite of their varying manifestations if, and only if, we *agree* that the notion of concepts is valid and relevant.

If we agree on the main points of the above discussion, we should be spurred to seek "the totality of the phenomena" regarding concepts to reach a proper understanding of concepts and their development. Utopian as this might be, at least it points to the fact that it may be a good idea to broaden the scope of empirical approaches in order to reach a fuller understanding of percepts and concepts. All the developmental theories described up until now have the feature in common that knowledge of infant concept formation is sought via different variations of *categorization* tasks. But this is not the

only possible approach, as I shall argue in the following section.

Broadening the scope: Other approaches.

Following the line of thought from the section above, I will now present and discuss some other possible approaches to the field of concept formation in infancy. I do not believe that *any* "new" approach I might introduce here would necessarily provide a better understanding of the themes and problems listed so far. In that sense "the totality of the phenomena" should not be mindlessly (that is without sound theoretical arguments) sought out. I have chosen to introduce the study of *object individuation* and to make some considerations regarding language, scaffolding, shared intentionality and embodiment. To anticipate: I will attempt to show how research on these subjects may fit a complementary approach to the existing debate without loosing the theoretical justification needed to maintain scientific integrity.

Object individuation. Categorization studies have so far been the primary choice of approach to the empirical studies of concept development in infancy. These studies have provided us with many fruitful answers to our questions but they have also led to serious disagreements and terminological confusion as seen in the perception – conception debate. It may be wise to look for additional and alternative ways of investigating conceptual development. The very productive developmental researcher Fei Xu has suggested that such an alternative may be found in the studies of infants *object individuation* (Xu, 2005). The process of object individuation is the process for establishing numerically distinct individuals (e.g. objects, persons) that can be tracked through time and space (ibid.)[13]. Issues of object individuation have a long history in philosophy but have recently become the focus of many empirical studies as well (for a review see Krøjgaard, 2004).

Figure 1 + 2: From Xu & Carey (1996)

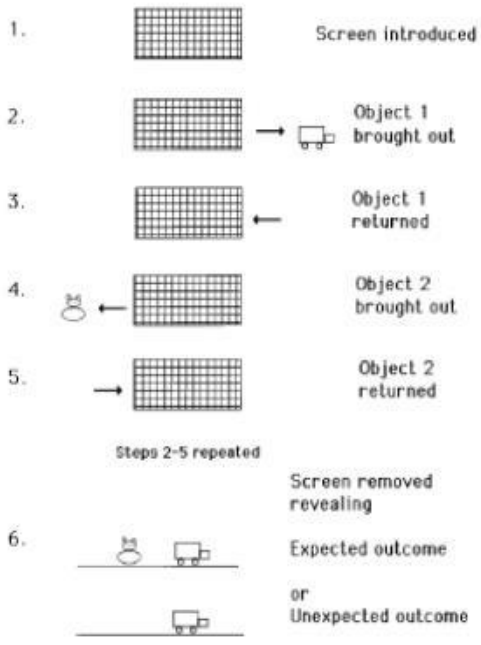


Figure 1:The Property/Kind condition

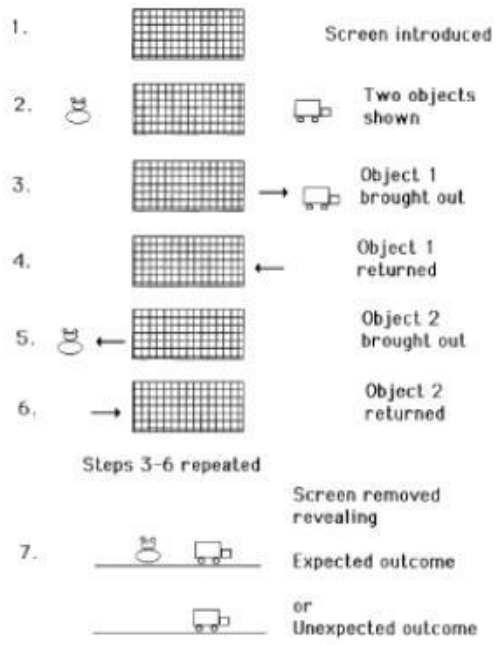


Figure 2: The Spatiotemporal condition

In (experimental) infant studies of object individuation the purpose typically is to test the infants' ability to determine the exact number of physical objects involved in various settings and events[14]. This is typically done using the "*violation-of-expectation*"-method. This method exploits the well-documented tendency that infants look longer at event-outcomes if these are "surprising" to the infant, that is, if these outcomes contradict or *violate* the infants' understanding of the event they have just seen (ibid.). An illustrative and "classic" example of such a study is the one from Xu and Carey (1996). In this study, the researchers were looking into the different kinds of information infants use when attempting to individuate objects. They let 10-month-old infants watch an event in which one object (e.g. a ball) emerged from behind a screen, moved to one side of the "stage" and then returned behind the screen. Shortly after, another object (e.g. a toy duck) emerged from the other side of the screen, moved to the opposite side of the stage, and returned behind the screen (see Figure 1). This sequence was repeated several times in an introduction/familiarization-phase. Eventually, the screen was lowered to reveal one of two outcomes: An *expected outcome*, where both objects remained on the stage; and an *unexpected outcome*, where one of the objects had been secretly removed leaving only one object for the infant to find.

It was now measured for how long the infants looked at these different outcomes. This first condition was labelled the *property/kind* condition since the infants were given only the information on the objects' properties (the objects appearances) and the objects' "kind" (denoting the infants' knowledge about the objects' behaviour, relation to other objects, role in events etc). To counter the simple tendency to look longer at two objects than one object, the looking times were compared to a *baseline* in which infants saw only the outcomes (one or two objects) without any prior introduction. It turned out that infants 10 months of age did *not* look reliably longer at the unexpected outcome than on the expected outcome in the property/kind-condition – they were not able to individuate the objects. These findings were compared to those from a *spatiotemporal* condition (see Figure 2). This condition only differed from the property/kind condition in one way: Before the introduction/familiarization-phase both objects were brought out once for the infants to see *simultaneously*. The infants were thus provided with unequivocal spatiotemporal information that two objects were present. This caused the infants to look longer at the unexpected outcome following the trial. Xu and Carey (1996) concluded from this, that infants at this age were able to individuate objects given spatiotemporal information, but unable when forced to rely on property/kind information. The researchers then made exactly the same experiment with infants 12 months of age. In contrast, the 12-month-olds were able to individuate the objects in the spatiotemporal condition *and* in the property/kind condition. Xu and Carey (1996) were thus able to conclude that the ability to individuate objects based on property/kind information emerged *between* 10 and 12 months of age, whereas object individuation based on spatiotemporal information was enabled *before* 10 months of age.

This study (among many others) shows that it is possible to examine infants' discrimination of objects by other means than by categorization experiments. Furthermore, it is possible to examine what kinds of information infants rely on to establish a representation of an object as a distinct individual, thus providing us with new insight about the nature of object-concepts. This possibility is even more evident in the following example: To further investigate the success of the 12-month-old infants in individuating objects based on property/kind information, Xu, Carey and Quint (2004) conducted a modified version of the Xu and Carey (1996) study. The modifications in the new study was motivated by the fact that the original property/kind condition was very broad and contained quit different kinds of information. In the modified study the researchers wanted to make a distinction between these different kinds of information. Consequently, they made four experiments: One, in which the two contrasted objects varied only in *colour* (experiment 1); one, with variation only in *size* (experiment 2); one, in which the objects varied in a combination of *colour*, *size* and *surface pattern* (experiment 3); and finally one where only the overall *shape* of the objects differed while keeping the other properties constant (experiment 4). These four different variations were chosen because most will agree that colour, size and surface pattern are clear cases of *perceptual properties* whereas shape is often correlated with *kind* (category) membership (Bloom, 2000; Landau, Smith, & Jones, 1988; Soja, Carey, & Spelke, 1991; cf. Xu et al., 2004). In addition, experiment 4 consisted of two different conditions: The Within-kind Condition, in which the two contrasted objects differed in shape but belonged to the same kind (e.g. two different bottles or two different toy ducks); and the Cross-kind Condition where the contrasted objects belonged to different kinds (e.g. a bottle vs. a box or a toy duck vs. a toy seal). The researchers found the following: The 12-month-old infants were *unable* to individuate based on the property information in experiments 1, 2 and 3 (although still able to do so provided with spatiotemporal information). The infants individuated *only* in experiment 4 and *only* in the Cross-kind Condition. Xu, Carey and Quint (2004) thus concluded, that perceptual properties *per se* were not sufficient to facilitate object individuation by this age group. The infants had to have information specifically pointing at two *different kinds* or categories of objects to be able to individuate them. Infants were thus using categorical or kind –information to solve the individuation puzzle.

Based on these findings, Xu (2003; 2005) has suggested that infants in fact posses two *different* systems of objects individuation: An early developing *object-based system* and a later developing *kind-based system*:

- The *object-based system* draws primarily on spatiotemporal information for establishing individual objects. Perceptual property information is only secondary to this process since strong spatiotemporal information can override perceptual property information. This system is in place *before* the kind-based system.
- The *kind-based system* draws primarily on kind/category information for establishing individual objects. Perceptual property information is also secondary here because this information is kind-*relative*: Different perceptual properties sometimes indicate the presence of two objects

(e.g. different sizes may indicate two different chairs) but not always (e.g. a plant is able to grow in size between Time 1 and Time 2 of seeing it).

The observant reader will notice how the distinction between object and kind –based systems of individuation bears some resemblance to the distinction between perceptual and conceptual categorization processes as suggested by Mandler (1997; 2000a; 2004a). The kind-based system, as suggested by Xu (2003; 2005) is dependent (primarily) on the category knowledge derived from the *conceptual processes* suggested by Mandler. Only when indications of kind are vague, does the kind based system rely on perceptual property information. On the other hand, the object-based system seems to rely primarily on spatiotemporal information, while relying only on perceptual property information when spatiotemporal information is unavailable or ambiguous.

Xu's theory of object individuation and the studies she has conducted reach into the very same psychological sphere as the one discussed among the categorization researchers. Object individuation is related to concept formation in at least two ways: First, the establishment of numerically distinct objects is a prerequisite for any kind of object-categorization to take place. Second, Xu's theory targets aspects of the cognitive development that enables infants to represent and use *nonobvious* information of their surroundings, information that has a high impact on the infants' ability to relate to the world whether or not the information is called conceptual. This means that the study of object individuation could be an alternative way of studying the requisite conditions for "conceptual behaviour" in infancy. Behaviour, that tells us when infants represent objects conceptually and act accordingly.

Language and the effects of labeling. The study of object individuation has been used to investigate the significance of *language* in the early conceptual development as well. Xu (2002) presented 9-month-olds with the same object individuation task as Xu and Carey (1996), the study described above. There was one critical manipulation though: As each object emerged from behind the screen, the infants heard a label for it in infant directed speech. Two conditions were examined in this way. In the *Two-word condition* infants heard two distinct labels (e.g. "look a duck" and "look a ball"). In the *One-word condition*, the infants heard a single label applied to both objects ("look a toy"). Half of the trials were labelled and half of them were silent. The results showed that in the Two-word condition, but not in the One-word condition, the infants looked longer at the unexpected outcome of one object. Thus even 9-month-olds were able to individuate the objects based on their kind, but only when the object was distinctly labelled. The success was not due to the presence of a word *per se* since the infants did not succeed in the One-word condition. Xu (2002) repeated the experiment with other auditory stimuli (two distinct tones, two distinct artificial sounds, and two distinct emotional expressions). *None* of these enabled the infants to individuate the objects, *only* two distinct words. Using novel objects and nonsense words (e.g. "a blicket" and "a tupa") did not change this pattern. Nonsense word labels enabled the 9-month-olds to individuate even unfamiliar objects.

These finding are very interesting since they point to an exclusive role of language in early cognition even for preverbal infants. Later object individuation studies (using a slightly different setup) have confirmed that labeling with two different words (and *only* words) leads infants to expect the presence of two objects *even when the infants have seen no objects while the labels were given* (Xu, Cote, & Baker, 2005). It seems that the labeling of objects by adults is of great importance even at this very early stage of the infants' conceptual development. Xu (2005) has even suggested that words are in effect "essence placeholders" for infants in the sense that infants expect labels to refer to distinct kinds and will therefore look for similarities between objects sharing the same label.

In my opinion, this brings the whole question of social interaction and scaffolding back into the heart of early cognition. If kind-based object individuation is an important part of the early conceptual development, then we cannot ignore the social interaction and environment within which this individuation takes place. Surprisingly, this fact has not played a major role in the theory development of cognitive psychologists for the last decades (Nelson, 1999). Furthermore, these findings give us a clue as to how the *human* development of concepts or concept-like representations differs dramatically from that of other species: Homo Sapiens is the only species capable of guiding their infants by providing distinct and exclusive auditory labels (words) to scaffold the infants' emerging kind-representations[15]. This ability affects the human understanding of its surroundings from very early in ontogeny, and may consequently very well constitute one of the most massive impacts of human enculturation on human cognition. Labeling is, of course, only one of many ways by which infants rely on other people in order to gain an understanding of their surroundings. I turn now to some of those who have discussed the role of other people explicitly.

Scaffolding, object-function and shared intentionality: The role of other people. The idea of other people playing a significant role in concept formation during infancy is not new. In Vygotskian theory child-adult interactions are considered *crucial* for the child's developing understanding of the world. The importance of culture and the proposed expert-novice relationship between children and adults is often described as one of the major differences between Vygotsky and Piaget, of which the latter emphasized learning and development as something that proceeds from *within* the child (Perret-Clermont, Carugati, & Oates, 2004). Piaget is often seen as the "father" of cognitive constructivism and in spite of many critics Piagetian thinking has played a major role in the study of categorization (Mandler, 2004a). This has left Vygotskian social constructivism with a somewhat lesser impact on the mainstream of the theory-development of categorization.

There have been important exceptions though. Three decades ago, Katherine Nelson proposed a theory of concept formation (and word learning) highlighting the *joint activities* of infants and adults (Nelson, 1974). Nelson proposed that concepts first emerged as *functional cores* of objects involved

in interactions with other people. Taking the concept of a ball or "the idea of ballness" as an example, the child would compare over time the various relations into which the ball enters and synthesize those relations or functions that are *invariant* across events (e.g. "rolls", "bounces", "is picked up", "is tossed", "is caught" etc.). This synthesis of "functions" would enable the infant to represent the notion of a ball *between* different encounters instead of representing each new instance of a ball separately (ibid.). The *functional core* theory assumed an important relation between social interaction, events and object-function, an assumption repeatedly defended by Nelson since it's initial presentation (Nelson, 1985; 1996; 2000; 2002; 2004). The idea of *object-function* (broadly speaking) as being important is in resonance with several of the present theories of concept development: Mandler (2000a) states that conceptual categorization is based on what objects *do*, dynamic systems theorists (e.g. Smith, 2005a; Thelen & Smith, 1994) state that categorization is a result of the organism's *actions* in and towards the surrounding physical environment, and from the microanalytic approach object-function has been of key interest as well as seen in the studies of form-function correlations and the relation between object-function and category structure. (Horst et al., 2005; Madole, Oakes, & Cohen, 1993; Madole & Cohen, 1995).

It is interesting how social interaction has found a new way back into the experimental cognitive infancy studies via object individuation and the effects of labeling and via the imitation studies introduced by Mandler and McDonough (1996; 1998; McDonough & Mandler, 1998). It is possible, that other kinds of scaffolding and the effects thereof can be investigated in the same way. This way of "mixing" different areas of psychology (social, cognitive, emotional etc.) with "old" and "new" ways of experimenting (categorization and object individuation) fits well with the correspondence and complementarity principles. It allows for a look into a broad range of phenomena while maintaining the methodological integrity prescribed by the correspondence principle. This fact alone cannot justify this kind of "mixing", of course, but it does make it more promising.

Some of the researchers who have focused on the aspects of social interaction argue for an integration of cognition and social interaction as well. A recent example of such an argument has come from Tomasello and Carpenter (2007). The points made by these authors are very much in tune with the points made above as I will show in the following: Based primarily on findings from comparative studies of human infants and chimpanzees Tomasello & Carpenter (ibid.) argue that *shared intentionality*[16] should be the common phenomenon for developmentalists to study for three reasons: First, it seems that a big part of what makes humans unique in the animal kingdom is shared intentionality. Our nearest primate relatives are capable of a wide range of social-cognitive skills (e.g. gaze following, social manipulation, group activity and social learning). Contrary to humans, however, behaviour that might be interpreted as sharing of intentions (e.g. joint attention, cooperative communication, collaboration and instructed learning) is never (or very rarely) exhibited (ibid.) (although it may be argued that enculturation of apes occasionally lead to behaviour that *resembles* these abilities (Byrnit, 2006)). This fits very well the notion that labeling (Fei Xu) and objects used in joint activities (Katherine Nelson) *could* be precursors to a uniquely human ability of conceptual thought. Second, as a phenomenon shared intentionality brings together aspects of development that are typically studied separately but should be studied together such as cognitive and motivational processes. Third, shared intentionality brings together in particularly intimate ways the workings of biology and culture (Tomasello & Carpenter, 2007).

Such wishes for integration in developmental research seem possible to pursue in the framework outlined here. Think again of the labeling studies of Xu (2002; Xu et al., 2005). In these studies the infants seemingly interpret the labels given by the adult in a very specific way, a way that only seems possible if the infants understand (or expect) that the adult *intends* the label to refer to an object (and not something else). Or think of the imitation studies by Mandler and McDonough (1996; 1998; McDonough & Mandler, 1998), where infants must combine predominantly perceptual skills (object-recognition) with social skills (imitation) to produce behaviour that follows culture-like rules for action (norms: what kinds of things do we give a drink?). According to Tomasello (1999), human infants are much more interested in the exploration of objects than nonhuman animal species, including our nearest primate relatives. Tomasello explains this partly with the very active interventions and instructions from adults when human children manipulate objects. Another important difference to recognize is the kind of objects human vs. nonhuman offspring experience. Contrary to other species, most of the objects experienced by human children are *man-made artifacts*. This means that most of these objects have an intended function in addition to any Gibsonian sensorimotor affordance (ibid.). These "intended affordances" can only be learned by infants in *interaction* with adults. In this way even simple objects in human infants' surroundings have normative object-functions that can only be discovered via other conspecifics. This should have implications for most developmental studies on object-function and object-concepts (i.e. Mandler and McDonough's generalized imitation studies) but even more so for comparative studies.

In sum, much points to an important but arguably underestimated relation between the social world and the object world in the ecological niches of human and nonhuman primates. The object world of humans is ultimately *incomprehensible* without genuine social learning and shared attention. This point may eventually help us choose the methods by which we wish to better understand the relationship between perception and conception as well as between human and nonhuman primate cognition.

The Human body and embodied cognition. At this point I shall briefly direct the readers attention to another factor sometimes overlooked in cognitive studies namely the specific architecture of the human body. Claes von Hofsten (2007) approaches this issue head-on by stating that:

> Cognitive development cannot be understood in isolation. It has to be related to the motives of the child, the action

> problems to be solved, and the constraints and possibilities of the child's body and sensorimotor system. (ibid. p. 58)

This statement is based on studies on the relation between motives and (possible) actions in infancy. It fits the notion that human cognition is determined or at least constrained by the relationship between the organism and it's surroundings – the notion of *embodiment* (e.g. Lakoff, 1987; Lakoff & Johnson, 1999). I have touched on this issue earlier when briefly outlining the dynamic systems theory and when describing the perceptual meaning analysis in Mandler's theory. The point to be made here is that the possibilities and constraints of the (infant) human body certainly are relevant factors when studying early concept formation. In infancy research we unavoidably come across important abilities that have more to do with our organisms as they have developed through human phylogeny than they have to with ontogenetic experience at this early point in life (Spelke, 2003). Looking at these factors increases our chances of detecting the basic conditions of human cognitive development *and* the influence of these conditions on our unique cognitive capabilities (Lindblom & Ziemke, 2006; Spelke & Kinzler, 2007). The importance of embodiment factors extends to comparative studies as well since the bodies, natural environments and required movement patterns naturally differ between species and may constitute important factors underlying some of the cognitive differences to be found. Our bodies are particularly human as well as parts of our cognitive system, a fact sometimes to obvious to receive the attention it deserves. For instance, the differences in posture and dexterity among primates are bound to result in different object experiences hence different object-concepts.

Further research

So far I have laid out the gross lines of the perception – conception debate, I have discussed some of the major problems this debate faces, and I have suggested how we may be able to move on from these problems: In general by accepting the complementarity of different methods or approaches and specifically by choosing object individuation and elements from the social sphere and embodiment as possibilities of such alternative approaches. I will now describe two concrete planned studies that attempt an implementation of *some* of the suggested approaches. These are followed by some more general considerations and suggestions regarding future *comparative* studies of concept formation.

Challenging the perception – conception dichotomy. This planned study is an object individuation study based on the Xu, Carey and Quint (2004) study. As described earlier, that study concluded that objects of *different kinds* (defined by their shape) allow infants 12 months of age to individuate these objects without seeing them simultaneously (= no unequivocal spatiotemporal information) during the familiarization-phase. The results from the original study and their interpretation pointed towards an important relation between the shape of objects and infants' ability to represent them as different kinds. This relation is to be further investigated in the following study:

We are going to manipulate the shape of objects from two substantially different (kind) categories: *animal* and *furniture*. The shape will be manipulated specifically to *minimize the overall shape differences* between instances of objects from the two different categories. This has been done earlier in a *categorization* study by Sabina Pauen (2002) using an object examination task, and the modified objects will be similar to hers[17] (see Figure 3).

Pauen (2002) found that infants as young as 11 months of age were able to discriminate between furniture and animals in spite of the manipulations minimizing the shape differences. These findings *challenge* the conclusion from Xu, Carey and Quint (2004) that shape difference is the most important factor when discriminating object-kinds.

In the planned study we will control the perceptual similarities between objects from different categories ("natural" or "artificial" -looking) as Pauen (2002) did but in an object individuation design similar to that of Xu, Carey and Quint (2004).

The hypotheses are:

1. If Xu, Carey and Quint (2004) are right, individuation of the objects should not be possible when shape differences are minimized.
2. If Pauen (2002) is right, individuation should be possible *in spite* of the minimized shape differences.

Deciding between 1 and 2 will help us understand the specific basic information needed for human beings to categorize. These specifics could be compared between species. If humans and nonhuman primates differ in the kinds of information used to keep track of physical objects, a determination of these kinds of information would not only point to species-differences but it would help us better understand the species-specific interplay between perception and cognition.

Investigating object-function as labels. This planned study attempts to investigate the influence of object-function on infant object individuation, this done by making use of the *imitation skills* of 12-month-olds. It is an extension of an object individuation study by Xu and Baker (2005). In the original study, objects were shown to 10-month-old infants in small events as outlined in Figure 4. Objects were brought out from the box and shown to the infants two times. After that, infants were allowed to reach into the box and retrieve an object. In the No-Switch Trials the object retrieved was identical to the object shown previously. In the Switch Trials the retrieved object was new.

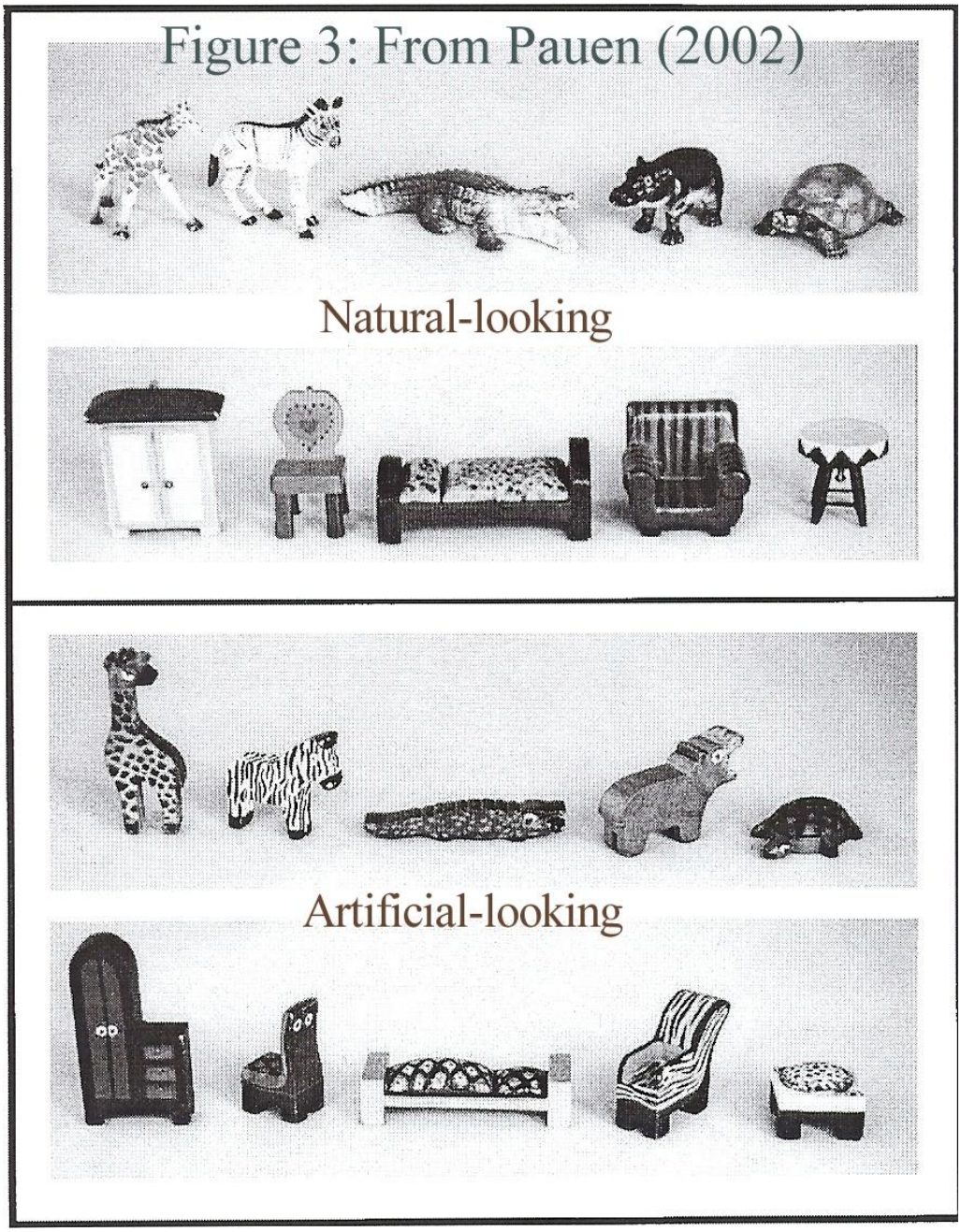


Figure 3: From Pauen (2002)

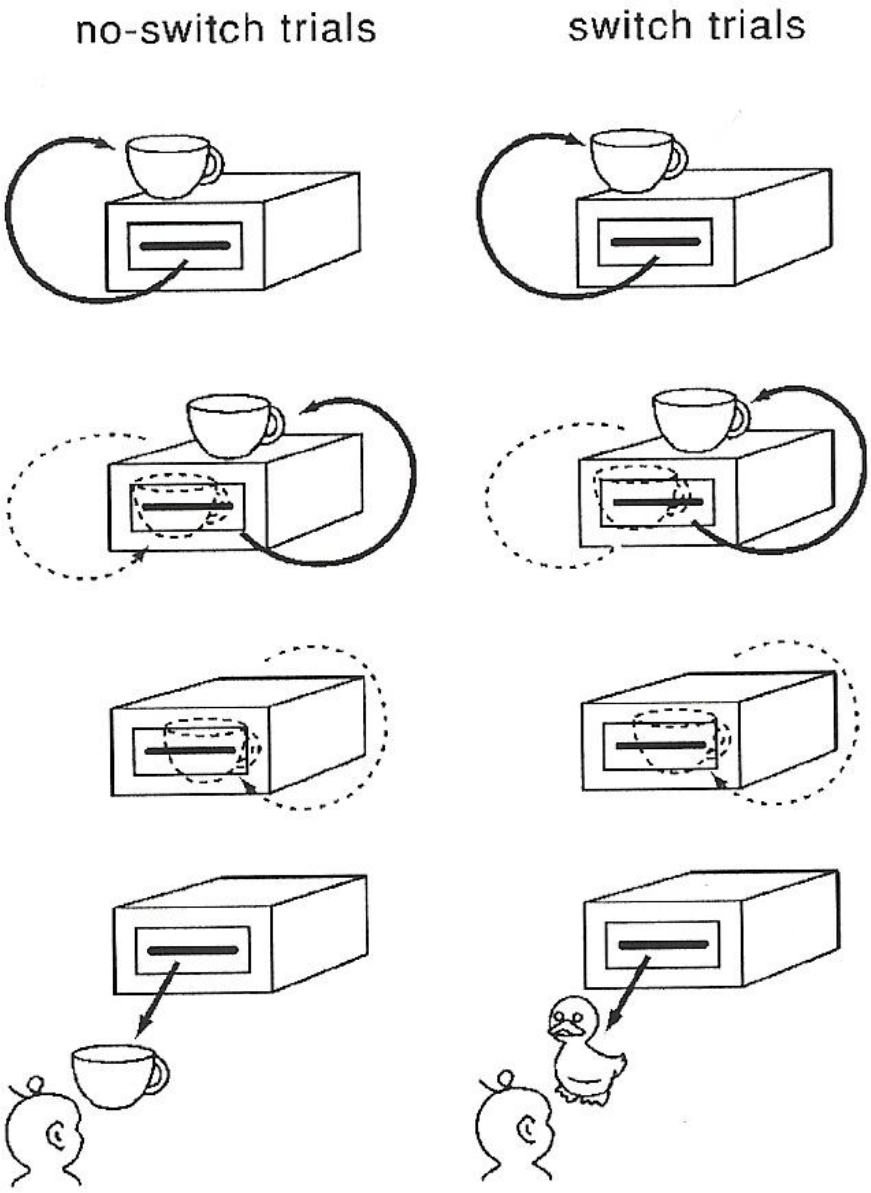
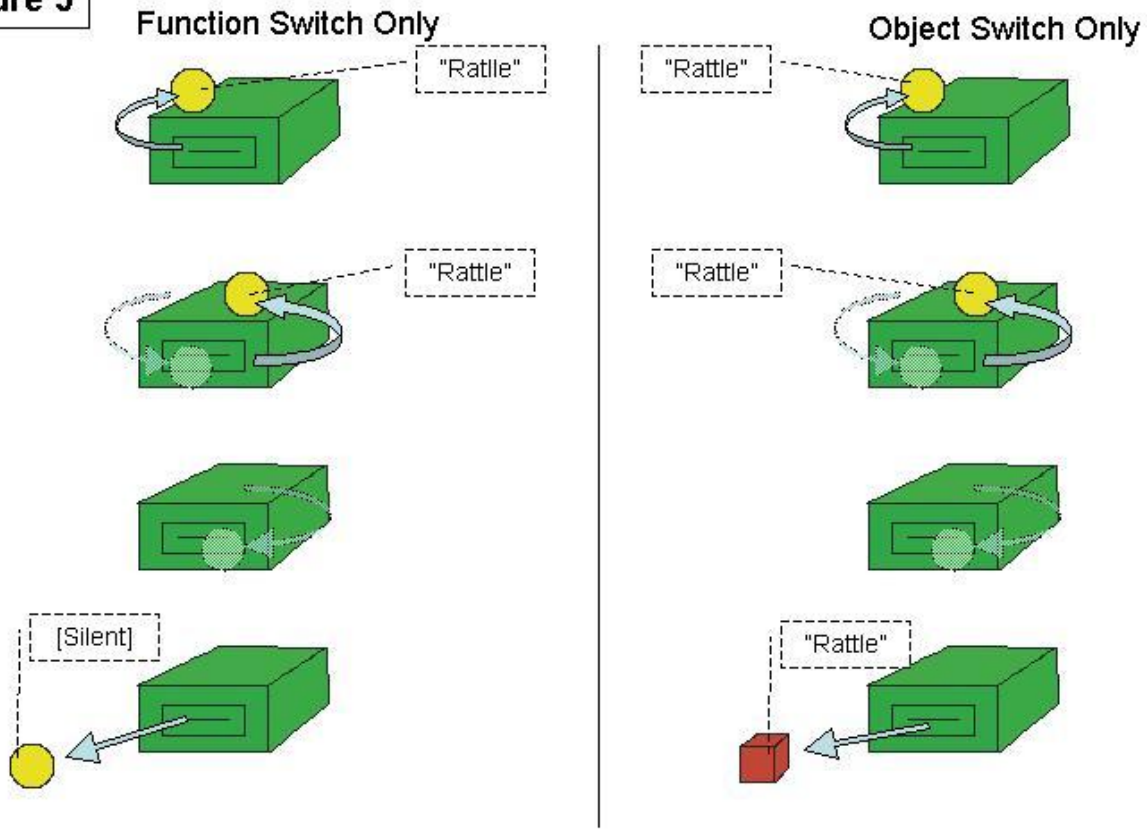


Figure 4

In both conditions infants were encouraged to reach into the box again. Following the violation-of-expectation paradigm infants were expected to search longer for an additional object in the Switch Trials if they understood that two objects were in play based on the differences in object features. This was indeed what the experimenters found: Infants 10 months of age searched longer in the Switch Trials thereby demonstrating the ability to individuate the objects (ibid.).

In the planned and modified study a "function" will be added to the design from Xu and Baker (2005). "Function" is made concrete by a "rattle" sound in some of the objects produced by shaking them. Contrary to the Xu and Baker (2005) study, we will be using simple geometric objects instead of exemplars of kinds. This is done specifically to avoid the potential effects different *kinds* might have on the individuation. The experimenter will model the "rattle"-function by shaking the objects while presenting them. The infants are able to "check" for the function when retrieving the objects by *imitating the shaking-action.* Examples of two of the conditions (Function Switch Only and Object Switch Only)[18] are shown in figure 5.

Figure 5



The hypotheses are:

1. If object-function *is* a salient cue to object-individuation (like word-labels), infants should be *more* likely to individuate when function and visual object properties go together and *less* likely to individuate when they contradict.
2. If the saliency of visual object properties greatly overpowers the saliency of the object function, infants should individuate based on whether or not the object switches regardless of the presence of the object function.

Based on the *functional core theory* (mentioned earlier) we hypothesize that object-function *is* a salient cue.

This study will hopefully deepen our knowledge of the basics of functional cues in the concept formation of humans; possibly answering some of the questions regarding important skills we excel in such as conceptual thought and tool use. If, for instance, functionality plays a major role in infant object individuation, human excellence in tool use and in language may be more related than previously assumed, and functional aptitude may be a very important human characteristic.

Comparative studies of concept formation. When investigating primate cognition, the distinction between perceptually formed categories and "genuine" concept formation has not been easy to make (Tomasello & Call, 1997). Here, as in developmental psychology, the term "concept formation" has been used to cover a wide range of cognitive skills. Many of these skills (i.e. being able to discriminate between pictures of humans and nonhuman primates) would be considered perceptual by those who favour a dual process view on categorization. In this way the perception – conception debate is very relevant to the study of primate cognition as well. Because of this "conceptual ambiguity" it would be interesting to study the earlier described object-based and kind-based systems of object individuation in a nonhuman primate population. The arguments for doing so are approximately the same as for human infants: We would gain a more detailed knowledge of the object features necessary for the formation of different categories. But furthermore, we might be able to specify a concept of concepts that tolerates a "direct" comparison of species. In addition, since this kind of study is already being carried out with human infants, we would be able to compare the differences in feature abstraction at a microanalytic level, potentially gaining valuably insight into the specificity of human concept formation hence the specific human conditions *per se*. A study on object-function might be especially interesting here if we feel confident that object-function is a crucial factor in concept formation. For instance, I see no obvious reasons why it should not be possible do conduct an experiment somewhat similar to the planned manual search study described above with nonhuman primates as well as with human infants.

Summarizing conclusion

I have presented in this paper a look into the ongoing discussion in developmental psychology regarding the nature of human concept development. Of special concern have been the possible perceptual and conceptual processes involved in this formation. I have attempted to demonstrate how the very different approaches and views represented in this debate have different *a priori* assumptions and use different methodologies that tend to confirm these assumptions. The nature of this debate makes it very difficult to reach an agreement, and examples of such difficulties have been given. To move on from the possible deadlock of the perception – conception debate, I have argued that we need to look at the *complementarity* of the different approaches and methodologies – this instead of piling up data and forging arguments to use *against* the other approaches. In addition, I have argued, that we *do* need a concept of concepts in developmental psychology if we hope to communicate our findings in a psychologically *meaningful* way.

An acceptance of the complementarity principle leads naturally to a search for other ways of describing the phenomenon of concern. I have suggested that such a way may be found by studying *object individuation* in infancy and by integrating more elements from the *social sphere*, *embodied cognition* and from *comparative* studies. Important social and phylogenetic factors seem to meet in the formation of concepts, making concept formation potentially rewarding area to look for the particularly human. In addition, I have suggested different possible ways of implementing some of these ideas.

In the introduction I stated that language and conceptual thought were essential factors when looking for the particularly human and that a concept of concepts was needed in order to investigate the specific nature of human conceptual cognition. The complementary approach to the study of concepts allows us to maintain such a concept in spite of the variety of the experimental designs and findings in developmental psychology, as long as we keep in mind, that our specific findings depend on our initial questions. This condition extends to anthropological psychology as well: A certain definition of concepts results in certain differences between humans and nonhumans – that is when conceptual cognition is the point of comparison. Change the definition and methodology, and you literally move the boundaries for the particularly human.

As a final remark, I would like to point to the fact that it seems possible to pin down a range of important *social* factors such as the ability to scaffold (by labeling, instruction, norms etc.) and to share attention and intention. These factors seem to have a huge impact on concept formation *regardless* of the specific designs utilized. As it happens (but properly not by coincidence), these abilities are also among those most easily identified as particularly human outside of the specific focus on concept formation (Tomasello & Carpenter, 2007). Consequently, if the fields of developmental and comparative psychology are to complement each other in specifying the human nature, it would seem promising to pay due attention to the facilitating and constraining elements of the *social* world of humans and nonhumans.

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Notes

[1] This paper was supported by a grant from the Danish Research Council for the Humanities (No. 273-05-0182).

[2] This was evident at the recent symposium *Concepts – Content and Constitution* in Copenhagen May 2007 arranged by the Danish Society for Philosophy and Psychology with the invited speakers: F. Gregory Ashby, José Luis Bermúdez, Daniel C. Dennett, Peter Gärdenfors, Ruth G. Millikan and Jesse J. Prinz.

[3] In principle *everything* we experience.

[4] Categories are in brackets [X] to emphasize that these are cognitive constructs and may vary depending on the individual.

[5] In this way the developmental approach resembles a *knowledge-based* view on categorization (see Eysenck & Keane, 2005, chap. 9)

[6] Inspired by a similar division in Quinn and Oates (2004).
[7] This is, of course, a category from an adult point of view since the experimenter has to remain open to the possibility that the infant categorizes the pictures differently than would adults.
[8] Mandler (1988; 1992) originally used the label *perceptual analysis.* Later she modified the label to *perceptual meaning analysis* to emphasize that it is a conceptual process for extracting meaning (Mandler, 2004a). As Mandler (1997; 2004a) notes, perceptual meaning analysis bears a certain resemblance with what Annette Karmiloff-Smith (Karmiloff-Smith, 1986; 1992) calls *redescription of procedural information*.
[9] This is the sense in which the microanalytic approach qualifies as a s*ingle* process view.
[10] This example is my own and I take the responsibility for its usefulness.
[11] Correspondence between the logic of the experiment and the description of results.
[12] Evidence obtained under different experimental conditions must be regarded as complementary.
[13] In this sense object individuation can be said to be a premise for categorizations since you have to be able to distinguish two objects in the first place to categorize them.
[14] Due to space limitations I will not go into the distinction between object individuation ("how many"?) and object identification ("which ones"?) (See Leslie, Xu, Tremoulet, & Scholl, 1998).
[15] For considerations of this particular species-specific ability from a biological and evolutionary point of view see the work of Ruth G. Millikan (for an overview see Millikan, 2001).
[16] Defined as collaborative interactions in which participants share psychological states with one another (Tomasello & Carpenter, 2007).
[17] Sabina Pauen has kindly provided details on the specifications of the original stimulus-objects.
[18] The remaining two conditions are: No Switch and Object+Function Switch