Author's response

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Complementarity in the Study of Concept Formation

Before I respond to the various questions and comments I would like to thank the commentating authors for showing their interest in the target article by taking their time to comment it. I have enjoyed reading the comments since these matters naturally interest me and I am eager to discuss them. In addition, it has been enriching to read the agreements, reservations and new ideas presented in the comments. The concept of concepts can at times be an overwhelmingly diffuse size and yet it is likely to spur a debate every time it is touched upon. Now, that I have dared to disclose my own opinion on this matter, I am happy to find the good spirit in which the comments have been written.

My response is structured in four main sections as follows: 1. The complementarity approach, 2. Object individuation and the perception – conception dichotomy, 3. Social and functional aspects and 4. Concepts and words. There are definitely overlaps between these sections but each section represents a theme that I have found meaningful when comparing the comments.

The complementarity approach

Not surprisingly, one of the main themes of the comments has been whether or not the target article succeeds in moving the perception – conception debate forward. Krøjgaard questions the extent to which I actually succeed in accomplishing what I set out to achieve with this approach; Pauen and Träuble state that I claim that methodological pluralism will lead to a better understanding of the distinction between perceptual and conceptual categories and Mammen questions whether I have escaped what he calls the "empiricism-rationalism trap" by my approach. Before addressing each of these comments I find it necessary to specify what my aims have been with the complementarity approach.

A very quick summary of my presentation of the dual and single process views boils down to this: It is intensely discussed whether infant categorization and early concept formation is best described and explained as involving one or two processes. In the target article I conclude that it is virtually impossible to decide between these views based on empirical findings since these tend to confirm each view depending on the questions asked. As a possible solution I suggest a complementary approach to infant categorization and concept formation in which the data produced from the different views are seen a different aspects of the same psychologically meaningful process or ability (depending on whether we look at *how* categories are build or *what* the categories look like). So, as a parallel to the physicists seeing light as waves in some type of experiments and as particles in other, we should, I suggest, see perception and conception as two different aspects of one process or ability: Categorization. What follows from this is that the different aspects are equally important, and that we need to investigate both in order to fully describe what infant categorization and development of categorization is. What also follows is that with the complementarity approach it does not make sense to argue which one of the aspects is the more correct one or whether categorisation is one or two things. To make the point painfully clear, this would correspond to arguing whether waves or particles is the most "correct" way of describing light or arguing whether light is one or two things. I apologize for repeating myself, but this summary makes it easier to address the following related comments.

Krøjgaard in his comment asks the question: To what extent is the single process/dual process resolved? He writes:

> 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.

Rather than directly following the two requests (i and ii) by Krøjgaard I will address how they relate to the general aim of the target article. The first suggestion (i), that I should show that both opposing views are needed, cannot in my opinion be followed. What I have tried to argue is that *both* views are in error when they try to decide whether categorization is *exclusively* a matter of one or two processes. In this light none of the views *per se* are needed or even acceptable. On the other hand I have tried two argue that all of the experimental methods applied by the two views are needed in order to reach a

complete understanding of what infant categorisation and concept formation is. I have even suggested that we may have to apply other methods as well to seek " the totality of phenomena" on this issue. So, arguing that both opposing views as such are needed would be a bit beside the point, and would only add to the confusion I am afraid. I believe I have actually already addressed Krøjgaard's second suggestion (ii) in the target article at least at a general level. My suggestion of a complementarity approach is, in my view, precisely the metatheory or "third" theoretical framework that Krøjgaard find missing. The complementarity approach contains both the single- and the dual process view without "being" any of them. The complementarity approach allows for an inclusion of data and methods, which might at first glance seem incommensurable but nonetheless complement each other in a meaningful way. This, in my opinion, is exactly a reinterpretation of the current divergent findings, again: at a *general* level. Krøjgaard may have a point that the job is not done by this. We may need to follow this reinterpretation through on a more specific and detailed level. But as he writes "such an enterprise is not trivial for sure" and it has indeed been beyond the scope of the present target article.

Pauen and Träuble state that I claim that methodological pluralism will lead to a better understanding of the distinction between perceptual and conceptual categories. This is in a way correct, but it represents a potential misunderstanding, so I will attempt a clarification. Again, we have to be careful how we approach this matter. I do not suggest that at methodological pluralism will lead to a better *distinction* between perceptual and conceptual categories. I believe (as argued again above) that the complementarity approach grants a more productive way of viewing the categorisation processes, and methodological pluralism follows naturally from the complementarity approach. This does not by itself result in a better ability to distinguish between perception and conception. Instead, it enables us to make that distinction at times, when this is appropriate and meaningful, and to make *no* distinction when *that* is appropriate and meaningful. This choice would depend on what we are looking for. For instance, if what we are looking for is a detailed or microanalytic view into the process of categorization, it may be meaningful to regard a multitude of aspects including perceptual *and* conceptual aspects of this categorization. Whereas, if our main goal is to compare the ability of concept formation between species, it might be argued that we need to focus on fewer aspects of concepts in order to avoid incommensurability. If I were primarily seeking a better or clearer distinction between perceptual and conceptual categories, I would be playing the very game that I am attempting to avoid, in this case siding with the dual process view. So, what I believe is: 1) that the complementarity approach leads to a better *understanding* of the perception/conception distinction, 2) part of this understanding is that it varies whether it makes sense to make the distinction at all and 3) methodological pluralism is a natural consequence of the complementary approach.

Mammen points out, that the perception – conception dichotomy is closely related to the opposing positions of empiricism and rationalism. Keeping this in mind, he explains why it seems impossible to find empirical solutions to the question of psychological transition from perception to conception. I fully agree here. But Mammen (p. 25) further writes that:

> If membership of some categories are decided from perceptual criteria and membership of other ones from functional criteria, the first categories could be considered perceptual and the latter one conceptual. The ontogenetic question could then be reformulated to when infants move from purely perceptual categories to functional ones, i.e. conceptual categories.

I see why this would open a Pandora's box of troubles and I agree that such an approach would definitely not let us escape the "empiricism-rationalism trap" (Mammen, p. 25). But in all fairness I do not believe that this is what I am proposing in the target article. Contrary to this, I have tried to argue, that the perception – conception dichotomy may at times be counterproductive to scientific studies. The complementarity principle was introduced to suggest a vantage point that includes the terms or notions "perceptual" and "conceptual" *without* assuming an ontological dichotomy. As pointed out above and in the section "*Together we stand, divided we fall: How do we move on?*" in the target article I find it possible and far more fruitful to "omit" the ontological dichotomy and regard the terms perceptual and conceptual as terms that highlight different aspects of a complex process, but a *coherent* process nonetheless. This is seemingly in concurrence with Pauen and Träuble's statement (p. 33), that:

> The only way to solve this theoretical problem [of perceptual vs. conceptual categorization] is to think more deeply about the meaning associated with the term "concept". If we do not meet this challenge, we will never be able to communicate effectively about the processes underlying knowledge formation and memory activation in the infants' mind.

From my point of view the complementarity approach makes it very difficult to talk about purely perceptual or purely conceptual categories at all. We can, as researchers, focus on perceptual or conceptual aspects of categorization but it will almost always (I believe) be possible to focus on either. This relates to another critical comment from Mammen. He writes (p.26):

> […] In the artificial setup of psychological experiments it is always possible to present infants and animals, and even adults, to situations without meaning, thus concluding that affordances and functions are secondary, and that pure perception comes first.

I have to disagree. In my opinion *every* experience is meaningful on one way or the other, but the experience in the experimental setting may not be very similar to any other event experienced by the subject prior to the experiment. In the case of infants this is the inevitable result of taking the infants out of their ecological niche. This said, we do at times purposely present the infants to events that are very difficult to construe based on their prior real world experiences. This forces the

infants to react in an "inexperienced" fashion that might in lack of a better term be called "perceptual". As researchers we do this in order to investigate the faculties used by the infants in situations that are unfamiliar to them. This is important since such faculties are necessary for the infants in order to be familiarized (that is: become familiar) with their surroundings (ecological niches) when they first enter them. To make the point again: In this kind of experiments we sometimes tune into the perceptual aspects of processes that are undeniably also functional and meaningful in the infants' daily lives. Along the same lines, I would not contend that animals are restricted to pure perception and that only human beings are able to conceptualize. As argued elsewhere (Kingo & Krøjgaard, in press) it makes more sense to find the differences between human and nonhuman primate categorization in terms of which aspects of the world are weighed and processed the most (i.e. humans seem superior in extracting and abstracting the functional characteristics of objects).

The complementarity approach, as I have proposed it, finds it meaningful to talk about perception and conception but finds it untenable to distinguish between the two at an ontological level. It seems to me, that I am very much in agreement here with Nelson and the Functional Core Concept (FCC). In her comment she writes (p. 29):

> Contemporary arguments about perception and conception as separate, indivisible, parallel, or stage-like, appear irrelevant when the two are viewed as complementary as they were in the FCC.

I find that the FCC is still one of the best candidates to a model that incorporates perceptual and conceptual aspects of the categorization/conceptualization process in a complementary fashion. This is by itself impressive since it, as Nelson writes, was forged in the 70'ties.

Challenging the Perception – Conception dichotomy

Pauen and Träuble raises several critical but interesting questions regarding one of the proposed studies in the target article: Challenging the perception – conception dichotomy. They write that:

- The object-individuation paradigm does not "fix" the perception-conception problem (p. 33).
- Any positive (or negative) finding obtained with the methods described so far would be inconclusive with respect to the question of whether or not conceptual processes has been involved (p. 33).
- We think that it is necessary to demonstrate, that perceptual differences alone cannot account for object-individuation (p. 33).

Following the discussion of complementarity above, I never meant to suggest, that the proposed object-individuation study *per se* would solve the problems generated by maintaining a perception-conception dichotomy. On the contrary, the proposed study should be seen as a way of investigating aspects of early categorization without any *a priori* assumptions of such a dichotomy. In this sense it may be seen as a microanalytic approach to experimenting, and in this specific study, the aim would be to investigate the importance of certain object features when asking the infant the question "How many objects do you see?". As stated in the target article, the specific design was chosen in an attempt to generate data that will hopefully point towards one of two studies with, in my opinion, contradicting findings: The Xu, Carey and Quint (2004) study, which concludes, that overall shape of objects (from different global categories) is crucial when infants individuate objects (without having access to spatiotemporal information) and the Pauen (2002) study, showing that infant categorization of animals and furniture is possible even when objects from these categories are manipulated to be very similar in overall shape. Both studies address the categorical knowledge already possessed by the infants prior to the experiments, but the two studies differ in methodology since one has to do with object-individuation (supposedly based on existing categories or kinds (Xu, Carey & Quint, 2004) and the other has to do with categorization as such (concluding that knowledge-based categorization of animals and furniture is possible for 11-month-olds in an object examination task). Thus, a direct comparison of the conclusions is difficult, but what I find interesting is the possibility to investigate the conditions under which the overall shape of objects from different categories is important. We may learn something new about infant categorization by studying the necessary conditions for object-individuation to take place. Specifically, we may learn whether or not the shape-feature is equally important when infants categorize and when they keep track of the numerical identity of objects. As argued, I find this approach potentially rewarding *because* results from different yet overlapping studies and methodologies are compared. The study was mentioned in the target article *not* to suggest a solution or fix to the perception-conception problem but to suggest a possible alternative approach to the study of object concepts in infancy. An alternative that does not try to answer whether or not what we see is perceptual or conceptual processes, but rather one that tries to investigate specific relevant aspects of infants developing understanding of objects. As a consequence, I do not find it necessary to rule out perceptually based object individuation as such in the suggested study. Rather, the point of interest is what kind of perceptual information "trigger" a response that is difficult to explain without the infant tapping into prior "conceptual" knowledge of the objects in question. Here I am in agreement with Pauen and Träuble when they write that:

> Taken together, it seems impossible to draw any clear line between perceptual and conceptual processes even though they are not the same (p.35).

I further agree that the distinction between static and dynamic information is highly relevant and that this particular distinction seem to make sense also from a neuropsychological perspective. The ability to extract and abstract functional infor-

mation is, in my opinion, a very important part of early concept formation and possibly, the mastery of this ability is a particularly human trait (see Kingo & Krøjgaard, in press). I look forward to see the results from the study on the functional meaning of critical features mentioned by Pauen and Träuble.

Social and functional aspects

In the target article I point to the importance of social aspects when investigating cognitive development. Pauen and Träuble (p.32) write, though, that I do not explain how knowledge about social influences could possibly help us to define the nature of concepts. I will address this since I actually intended the inclusion of the social factors to do exactly that: To help us *define* the nature of concepts. I have tried to argue, that taking a social perspective has a high impact on the way we define what is conceptual. I base this argument on three factors: First, it is a natural consequence of the complementarity approach to seek and specify different aspects of the phenomenon of interest. Second, when we compare our categorization skills with those of our closest primate relatives, the scaffolding and enculturation of human offspring seem to make a major difference (Tomasello & Carpenter, 2007), which makes social aspects of concept formation especially interesting to study from a comparative point of view. Third, as argued, it is virtually impossible for an infant to understand the human object world without genuine social learning and shared attention since most of the objects in our ecological niche are artefacts (Tomasello, 1999). Consequently, it seems to me too exclusive to permanently omit social factors when we investigate the conceptual world. And since our choice of methodology is tightly tied to our definition of the research object, a tenable concept of concepts should, in my opinion, include the notion that conceptual aspects of objects are primarily learned through or with other people. As Nelson concludes in her comment (p.31): "meaningful concepts emerge from interactions". If so (and I fully agree), this tells us *a lot* about the nature of concepts. Especially when we regard the work of Csibra and Gergely (see Krøjgaard's comment) on the massive influence of ostensive pedagogical cues on infants' cognitive functioning.

Concepts and words

Mammen and Nelson in different ways point to the indivisibility of concepts and words. In relation to artefacts Mammen introduces the notions of *subjective meaning* (roughly an objects affordances to be discovered by the individual subject) and *objective meaning* (an objects "reason" or "place" within the society). He states that the infant directs its attention towards both of these meanings. As evident in the above discussion I would agree so far. But Mammen further states that a word (i.e. "cup") is only linked to the objective meaning and not the subjective; and further, that:

> Only objective meanings with a linguistic label deserve the nomination as concepts. This solves the problems of the concept of concept across the different contexts of discourse. (p. 26).

As much as I appreciate any attempt to clearly define what a concept is and what is conceptual, I don't see how Mammen's definition brings us closer to at viable concept of concepts. First, if linguistic labels are a prerequisite to a genuine concept, it makes no sense to talk about *pre*linguistic conceptions at all, and we would probably have to abandon all research in concept formation in children younger than 18 months or so. This by itself might not upset every researcher (especially not Piaget), and of course the problem could be solved in a crude fashion simply by not using the term "conceptual" when referring to observed processes before that age. But second, if the definition of concepts depends on objective meaning in Mammen's terminology, it becomes crucial (at least from a developmental point of view) *when* the child has reached an objective meaning. What are the criteria? Are these criteria met all at once or gradually? If they *are* met gradually will it be possible to talk about an "unfinished" or partial objective meaning? If children gradually move from subjective meanings to objective meanings, could this process be starting from before the age of 18 months, and what should we call the partial or unfinished objective meanings achieved before this age? This could also be addressed from a non-developmental point of view: Is there such a thing as a concept that we *completely* agree upon? Or the other way around: If Mammen's conception of the notion "objective meaning" is not exactly the same as mine, are they not concepts? The point I am trying to make is that the introduction of subjective and objective meanings does not solve the intrinsic problem with the concept of concepts. At best, it only moves the battleground from perception vs. conception to subjective vs. objective meaning, and from my point of view, that is a counterproductive action. Words and concepts play an important role in cognition long before they take the form of anything that resembles an objective meaning in the sense that the meaning is the same for every individual. Furthermore, we have every reason to believe that children posses something resembling concepts *before* they use words and that their first words denote meaningful concepts that are much broader and are more subjective than the consensual meanings among adults in the society (i.e. Mandler, 2004; Nelson's present comment; Oates & Grayson, 2004).

This said, I agree that words play an important role in infant concept formation not to be underestimated. As Nelson writes, there is a remarkable and mutual lack of interest between the fields of early concept development and language development. The relation between the development of concepts and language is complex, and for now I shall not address this relation more that I have already done in the target article. Suffice to say that since words are only meaningful when they refer to concepts and since adult verbal scaffolding seems to be of utmost importance in infants' concept formation, studying concepts and words separately (as we have done and still do) actually appear less meaningful than many of us would

like to admit. Still, this relation is by no means less complex when we investigate preverbal infants.

The naïve scientist?

As a last response I turn again to the question of methodological pluralism. Bohr wrote about this:

> Only the totality of the phenomena exhausts the possible information about the objects" (Bohr, 1958, p. 40).

Does this mean that we should keep on finding new ways to examine the same entities until we cannot imagine any more ways or perspectives? Probably not, but as a minimum it means that we have to remain open to the idea that the methods we are currently using do not necessarily paint the whole picture. As scientists we stand in many ways with the same overwhelming problem as the infant. How do we make sense of the world when it can be interpreted in so many ways? The answer, I believe, is somewhat the same for infant and researcher: By remaining open to all possibilities while accepting and regarding the specific human constraints and conditions that makes the world we experience meaningful.

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