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Keeping track of individuals: Insights from developmental psychology

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Abstract

According to Mammen and Mironenko (2015) our sensitivity to objects' history (i.e., objects' whereabouts across space and time) has been neglected in much of contemporary psychology. In this paper I present evidence from a developmental psychological perspective indicating that although the terminology is different, some research concerning these important issues has actually been conducted. First, research primarily under the heading 'essentialism' has shown that children are sensitive to at least some aspects of an object's history. Second, research on object individuation has revealed that for infants spatiotemporal information appears to have primacy relative to featural information. Finally, research on episodic development has provided evidence that a continuous (hence historical) sense of 'me' may be a necessary, although not sufficient, precondition in order to have episodic memories. It is argued that the available evidence converges, which only underscores the relevance and importance of the issues raised by Mammen and Mironenko (2015).

Keeping track of individuals: Insights from developmental psychology

1. Introduction

In their paper Mammen and Mironenko (2015) offer a scholarly presentation of Activity Theory. Not only is the reader treated with a thorough and elaborate outline of the historical roots and development of Activity Theory. In addition Mammen and Mironenko (2015) specify a number of problems in contemporary mainstream psychology and propose how a theoretical approach based on Activity Theory may provide solutions to these problems. In particular, Mammen and Mironenko (2015) argue that what they call the 'interface' between human beings and objects in the world by much of contemporary psychology has been, either implicitly or explicitly, reduced to proximal streams of 'sensory discriminations', which for instance makes successful identification of particular objects or individuals (e.g., heirlooms, museum exhibits, not to speak of pets, friends, and family members) a mysterious process.

In order to show how attempting to single out particular objects exclusively by means of sensory discriminations or features is bound to fall short, I will start out with an example from everyday life, that I hope Mammen and Mironenko will acknowledge as being in accordance with their thinking (for a further elaboration, see Krøjgaard 2009a): Consider a student attempting to find her bicycle outside the auditorium after a lecture. This student's specific bicycle has a number of distinct features (e.g., color, shape, size, brand etc.) which will help the student to single out this specific bike from the many other bikes that may be parked outside the lecture hall. Thus, in order to find her bike, the student does indeed make use of sensory features as typically argued. However, whereas featural information is necessary to solve the task, it is not sufficient. One typically overlooked or neglected aspect of solving the task of finding a particular object (in this case a bike), is that the student is likely to look for her bike at a highly specific and well-chosen location, that is, where she left the bike (i.e., outside the lecture hall, in a specific city), and not in any other location. Note, that by keeping track of the history of this unique bike, the necessary 'feature search' is restricted to a specific location (compared to finding her specific bike among all the bikes in the world), which makes the task of singling out the student's specific bike tremendously easier. This may seem trivial, but it is not. The point is that the process of keeping track of an object's history often passes unnoticed and is probably rarely reflected upon in everyday life.

According to Mammen and Mironenko (2015) our sensitivity to objects' history (i.e., objects' whereabouts across space and time¹) has been neglected in much of contemporary psychology, and if we are ever to understand how human beings identify particulars, a broader conceptualization of the interface between person and object is warranted. In order to remedy this gap in our understanding, Mammen and Mironenko (2015) argue in favor of conceptualizing our relationship with the surrounding world as a new 'duality' on a materialistic basis: As human beings we do not only make sensory discriminations regarding objects (e.g., assessing their size, shape, color, texture, and density); we are *also*, at least in principle, capable of tracking an objects' history through space and time. Although hitherto overlooked, this sensitivity towards the *historical threads* of objects (animate as well as inanimate) is by Mammen and Mironenko (2015) considered absolutely essential for the lives of human beings as illustrated by the following quote:

The objects we meet also have their numerical identity, their particularity as individual objects independent of their qualities [...]. What is our relation to the object? Do we own it? Do we have a history together? [...] To take an example: If I wear a wedding-ring the whole meaning of it is bound to its history and the one who gave it to me. It could be replaced by another one which I could not distinguish from the original, but if I found out, it would of course lose its meaning [...]. (Mammen & Mironenko, 2015, pp. 703-704)

According to Mammen and Mironenko (2015) these historical threads between objects in the world cannot be derived from, or reduced to, the sensory discriminations we can apply to objects, no matter how fine grained and sophisticated these discriminations may be. Hence, the ability to single out specific objects (i.e., individuals) can typically not be done by referring to the objects' universal qualities (e.g., size, shape, color, texture, density etc.), but requires that we keep track of the object's whereabouts in space and time – for instance by using our body as a physical reference (e.g., by keeping the wedding ring on one's finger).

This hitherto neglected sensitivity to objects' history is not only important and relevant for our understanding of personal belongings like gifts and heirlooms, but is also assumed to be responsible for how we attribute *meaning* to objects in general and man-made artefacts in particular:

¹ For the sake of convenience I in this paper use the terms 'objects' whereabouts across space and time' and 'spatiotemporal information on objects' as synonyms. The latter has typically been used in the developmental literature.

Also the meaning of objects is not reducible to sums of their qualities or affordances. All objects have a history, a trajectory, of their own, and especially for artifacts their meaning is not a snapshot of qualities but bound to the intentions laid down in their production and in our acquisition of them. Two coins may be indistinguishable in relation to sense categories, but the one is a valid coin from The Royal Mint, and the other is a counterfeit produced in some obscure locality. The historical “threads” bound to particulars are defining a new dimension in reality [...]. (Mammen & Mironenko, 2015, pp. 706-707)

Thus, being able to assign meaning to an artifact *relies* on the ability to acknowledge the spatial and temporal history of objects, because it is exactly an objects' history (e.g., that some people actually were authorized to make this specific coin for The Royal Mint for the benefit of society) that constitutes the coin's meaning, *not* its qualitative features.

Many aspects of the paper by Mammen and Mironenko (2015) deserve attention, but as a developmental psychologist I will here restrict myself to concentrate on insights regarding the matter from a developmental perspective. In brief, I will attempt to show that the sensitivity towards objects' history may not be quite as neglected and overlooked in the developmental literature as claimed by Mammen and Mironenko (2015).

With reference to the field of object individuation, Mammen and Mironenko (2015) mention in passing that even infants seem, at least to some extent, to be sensitive to the afore-mentioned duality in our relationship with objects. Here I would like to present and discuss some of the evidence from object individuation studies in more detail, since, in my opinion, the evidence from this area underscores the importance and relevance of the proposed need for a duality in our relationship with the surrounding world.

In addition, I would also like to review some of the research conducted with children, typically framed under the heading *essentialism* (Gelman, 2004, 2013), which basically have shown that also children do, at least to some extent, keep track of objects' history, that is, their whereabouts across space and time. This research has also shown that children, at least under some circumstances – much in line with adults, but in contrast to infants – track and endorse ownership; they differentiate between originals and exact replicas, and they tend to prefer their own possessions to exact copies. Note, that in order to be able to endorse ownership, and to distinguish between originals and identically looking replicas, children must be sensitive to and acknowledge the importance of objects' whereabouts in space and

time (i.e. spatiotemporal information), at least in a restricted time frame. In short, I believe the findings from studies on essentialism show that even children are sensitive to the basic building block of objects' history which Mammen and Mironenko (2015) consider crucial, albeit neglected.

Finally, I will attempt to argue that research on episodic memory may also provide evidence, that human beings are sensitive to a historical depth in our world. Again, I will present evidence from a developmental perspective. The basic argument is, that in order to have genuine episodic memories (e.g., 'remembering when I saw the Eiffel Tower in Paris in July 1985 together with my friends'), one needs a fairly stable and continuous (historical) sense of self as an anchor point for one's experiences. Thus, is it probably no coincidence that episodic memories manifest themselves in the ontogenesis only *after* the infant has passed the mirror-self recognition test. After presenting evidence from each of these three domains, the findings are discussed in relation to the claims put forth by Mammen and Mironenko (2015). I begin with evidence from experiments with children.

2. Children are sensitive to objects' history

Although from a somewhat different theoretical departure point, Gelman (2004, 2013) seem to have pursued some of the same questions that have puzzled Mammen and Mironenko (2015) as for instance: "Why do art collectors pay more money for an original painting than for an exact copy?" (Gelman, 2004, p. 404). Her answer is that, at least in part, we are *essentialists*. In Gelman's (2004, p. 404) account, psychological essentialism refers to the idea that some categories seem to have an underlying essence, reality, or true nature, that although these core characteristics cannot not be observed directly, they constitute an object's identity. Psychological essentialism appears to be especially (but as we shall see, not exclusively) prominent in domains like biology, where for instance the essence of 'man' is whatever that remains unchanged from infancy throughout adulthood. One might think that looking beneath the surface and being able to capture an underlying essence would be an advanced ability requiring knowledge and experience, which all things equal would make it less likely that essentialism should be present in children. An interesting aspect of Gelman's (2004) account is that although children are neither knowledgeable nor experienced relative to adults, children *are* essentialists.

In two elegant experiments Gelman and her collaborators (Gutheil, Gelman, Klain, Michos, & Kelaita, 2008) contrasted preschool children's use of featural and spatiotemporal

information, when attempting to determine an object's individual identity, or numerical identity to use the terms preferred by Mammen and Mironenko. Children, 4-5 years of age, were asked to conduct various tasks (e.g., make drawings) in different rooms in the presence of different dolls who 'watched' their creations. In the critical condition the children carried out the tasks in the presence of one out of two identically looking but numerically distinct exemplars of individuals (i.e., two identical Winnie-the-Pooh dolls). Subsequently, the children were asked whether each of the two dolls 'knew' what had been drawn by the children in each room. The results revealed that the children were indeed sensitive to where each distinct exemplar of the dolls had been and hence what each specific doll could, and could not, know (Gutheil et al., 2008). Thus, all the featural aspects (shape, size, color, texture) including the *names* of the dolls were the same across the individuals involved in the critical condition. Nevertheless, the children – just like the adults acting as controls – were able to keep track of the whereabouts of the individual dolls, and used this spatiotemporal information to decide which 'individuals' knew what.

In another study Gelman and colleagues showed that children also use spatiotemporal information to decide object ownership (Gelman, Manczak, & Noles, 2012). Two- and three-year-olds were given sets of three objects in which one object was designated as the child's, a second object was designated as the experimenter's, whereas the third object was not assigned ownership. After assigning ownership the objects were lined up, and the children were then asked which object was theirs and which object belonged to the experimenter. Note that in the critical condition, three *identically* looking exemplars of the same kind of object (e.g., three identically looking toy trains) were involved, effectively ruling out the possibility that ownership could be decided on basis of featural differences. Thus, in order to decide ownership, the children had to rely on spatiotemporal information. The results revealed that the three-year-olds (but not the two-year-olds) were able to keep track of ownership by means of spatiotemporal information – just like the adult controls (Gelman et al., 2012, Exp. 1). A sequel experiment revealed that both the three-year-olds as well as the two-year-olds also *preferred* their 'own' toys relative to the identically looking exemplars 'owned' by the experimenter (Gelman et al., 2012, Exp. 2).

The results from these studies suggest that preschool children, at least in western cultures, appear to be sensitive to ownership and to prefer their own possessions. Are preschool children also sensitive to the difference between originals and exact copies, just like adults are? This question was addressed in two studies by Hood and Bloom (2008). In the

first study 3- to 6-year-olds brought their favorite toy to the lab. The children were presented to a 'copying machine' and were told that this machine could make exact copies of objects. The children were allocated to two different groups based on whether their brought-along favorite object by their parents had been assessed as being an 'attachment object' or not. The children were now asked to have their toy 'copied'. It turned out that attachment objects made a profound difference: The children, for whom their favorite object was an attachment object (but not for the other group), were less likely to even *allow* their favorite object to be copied at all! And for those in the 'attachment object group' who did allow the attachment object to be copied, they clearly preferred the original to the copy. Interestingly, when asked why the children preferred their own object to an exact copy, the typical response was simply: "Because it's mine." (Hood & Bloom, 2008, p. 459). In a second study also involving the 'copying machine', six-year-old children were asked to choose between the original and an exact copy of a small metal item that the children were told either (a) had belonged to Queen Elizabeth II, or (b) were a precious metal. The results revealed that whereas the six-year-olds were equally inclined to choose the original or the copy of the objects made of a 'precious' metal, the children clearly preferred the original item which had (apparently) belonged to Queen Elizabeth II to the exact copy (Hood & Bloom, 2008, Exp. 2).

To summarize, these results suggest that at least under the circumstances employed during the tests, children are sensitive to spatiotemporal information, and even when the use of featural information is effectively ruled out (in the Gutheil et al., 2008, study even the names of the dolls were identical), children are capable of using spatiotemporal information to single out individuals. In addition children seem to share some of the preferences present in the everyday lives of adults: By means of spatiotemporal information children track and endow ownership. Children also distinguish between originals and exact replicas, and prefer, at least in some cases, the originals to copies. Note, that this sensitivity to specific objects' whereabouts in space and time, is the *key* – not only to singling out individuals when identical replicas are present – but also to the appreciation of objects' history and meaning in a broader sense (Mammen and Mironenko, 2015). In summary, the results from these studies suggest that children appear to be sensitive to the basic building block of what Mammen and Mironenko (2015) describe as objects' history.

3. Spatiotemporal information has primacy in infancy

When attempting to investigate the cognitive abilities in infants, researchers are confronted with the problem that infants are unable to respond verbally. As a consequence the tasks are typically somewhat simpler and can only be based on behavioral responses from the infants. Although these methodological constraints prevail, infants' ability to use featural and spatiotemporal information has actually also been contrasted in infants. These studies have especially been conducted under the header 'object individuation'. Object individuation refers to the ability to decide the number of distinct objects present in a given event (for a review, see Krøjgaard, 2004). Note that given this definition, object individuation is a necessary, but not a sufficient, requirement in order to single out individuals. A considerable number of studies have been conducted within this area, but for the sake of comparison, I will here only focus on those studies within the field of object individuation that have specifically contrasted infants' use of featural and spatiotemporal information when attempting to individuate objects.

In a now seminal study, Xu and Carey (1996) directly compared infants' use of featural and spatiotemporal information in an object individuation study by means of the Violation-of-Expectation paradigm. Ten-month-old infants watched a basic scenario in which two differently looking objects (e.g., a duck and a ball) moved in and out behind a center placed occluder: One of the objects (e.g., the duck) came out from the occluder on, say, the left side; it paused for a few seconds, then returned behind the occluder from which a differently looking object (e.g., the ball) now came out on the right side. This encoding sequence was repeated. The infants had been allocated to one out of two different conditions: A property/kind condition and a spatiotemporal condition. The two conditions differed with regards to the initial phase of the encoding procedure: In the property/kind condition the two objects (e.g., a duck and the ball) were never visible at the same time during encoding. In contrast, in the spatiotemporal condition, the encoding session began by showing both the duck and the ball *simultaneously* on each side of the occluder. Thus, whereas the infants in the property/kind condition had to rely on featural/kind information in order to decide the number of objects present in the event, the infants in the spatiotemporal condition were initially presented with unambiguous spatiotemporal information showing that (at least) two numerically distinct objects were present. After the encoding procedure where each object had been shown repeatedly a test followed: At a time when both objects had moved behind the occluder, the screen was removed revealing either one of the objects (the unexpected

outcome) or both objects (the expected outcome). The infants' reactions were assessed by means of looking time measures to the two possible outcomes relative to a baseline measure. The results revealed that whereas the ten-month-old infants in the spatiotemporal condition reacted with surprise (i.e., looked relatively longer) when shown only a single object behind the screen (the unexpected outcome), their peers in the property/kind condition did not (Xu & Carey, 1996). Thus, the results show that ten-month-old infants have difficulties deciding the number of objects present when spatiotemporal information is ambiguous and the infants have to base their decision on property/kind information. However, when given unequivocal spatiotemporal information that two distinct objects are present, they react with surprise if one of these objects is found missing during the test.

This basic pattern of results has been replicated in a number of studies using both similar designs (Bonatti, Frot, Zangl, & Mehler, 2002, Exp. 3; Krøjgaard, 2000, 2003; Wilcox and Baillargeon, 1998, Exp. 2), with younger infants in simpler version of the design where the cognitive load was reduced (Krøjgaard, 2007, 2009b), as well as in a manual search paradigm where the dependent variable was search behavior instead of looking time (Van de Walle, Carey, & Prevor, 2000). Taken together these results suggest infants are sensitive to spatiotemporal information and that spatiotemporal information has primacy relative to featural information when infants attempt to individuate objects.² Note again, that this sensitivity towards objects' whereabouts in space and time cannot be reduced to, or derived from, the ability to discriminate the featural information of the objects. Rather, it is the basic requirement in order to single out specific objects and hence to grasp their history (cf. the previously cited quote from Mammen and Mironenko, 2015, pp. 703-704), at least within a restricted time frame.

4. Development of episodic memory

Whereas the previous examples concerned aspects of our relationship with physical objects in the world, we now turn to episodic memories, that is, our *remembered* specific encounters with the real world. The reader might wonder what this should have to do with the duality of the relationship with the surrounding world as proposed by Mammen and

² When employing the so-called wide-screen/narrow-screen design (which is a simpler design where the cognitive load to the infants is reduced considerably), younger infants appear to be able to individuate objects based on their properties (Wilcox & Baillargeon, 1998a, 1998b; but see Krøjgaard, Kingo, & Staugaard, 2013, for only a partial replication and an alternative interpretation). However, the wide-screen/narrow-screen design does not allow for a direct comparison of object individuation by means of either features or spatiotemporal information and is therefore not discussed further in the present context.

Mironenko (2015). I shall attempt to argue that the very existence of episodic memories rely on the assumption that we, as human beings, are capable of traveling mentally in time to unique, previously experienced episodes, and that this ability necessitates a cognitive self, that cannot be reduced to a set of qualitative features, but in addition has a unique and continuous history. Thus, if we were *insensitive* to history, we would have no episodic memories.

Tulving (1972) introduced the distinction between episodic and semantic memories. When the term was introduced, episodic memories referred to specific, personally experienced events that had occurred a certain place at a certain time, which emphasized the 'what', 'where', and 'when' dimensions of episodic remembering (Tulving, 1972). However, it turned out that one potential problem with Tulving's (1972) original definition of episodic memories was that if one had sufficiently detailed semantic information about each of the 'what', 'where', and 'when' components, then one could in principle re-construct an episodic memory *without* actually remembering the given episode as such. An often used and illustrative example is, that whereas most of us have fairly detailed semantic knowledge about that we were born ('what') in a certain city ('where') on a specific day ('when'), very few of us (if any) can actually remember our own birth (Columbo & Hayne, 2010).

In order to counter this criticism Tulving (1985) later changed the definition. Episodic memory was now tied closely to so-called *autonoetic consciousness* (Tulving, 1985, 2005), referring to the actual sense of (re)-experiencing yourself being present at the very time the to-be-remembered event took place. This change in the definition of episodic memories seems to have had both positive and negative consequences. For those who study the development of episodic memories in the ontogenesis, the new definition in which episodic memories are closely tied to autonoetic consciousness may have the drawback that episodic memories become difficult to examine in individuals without language (i.e., infants and non-human animals). On the positive side the new definition may provide more face-value regarding how episodic memories are experienced in adults (Dahl, Sonne, Kingo, & Krøjgaard, 2013). In the present context, I will argue that with the latest and most constraining definition (Tulving, 2005), where the re-experience of previously experienced unique episodes requires traveling mentally back in time, a sense of *history* for the traveling 'me' must be a necessary pre-requisite. When I recall a specific episode from my life (e.g., the birth of my first child), it is an extract from a coherent, extended sequence in time, in which *I* took part. And if I am not aware that it was *me* that took part in this episode, then the

memory of this episode would not have the same phenomenological quality. In Tulving's (2005, pp. 14-15) own words:

[...] episodic memory differs from other kinds of memory in that its operations require a self. It is the self that engages in the mental activity that is referred to as mental time travel: there can be no travel without a traveler.

Thus, episodic memory may be the only kind of memory that requires a 'self', and this self cannot be reduced to a set of qualitative features, but relies on the existence of a stable and continuous anchor point for one's experiences.

This line of argument is underscored by evidence from episodic memory development. In order to be able to remember at given episode, a large number of cognitive capacities are required, and in the present context, I do not have space to outline these (for reviews, see Bauer, 2007; Howe, 2011). I will only point to one of these necessary requirements: The development of a cognitive self. In developmental psychology the *cognitive self* is typically understood as the 'me' component in William James' self. Although not exhaustive, this 'me' is typically assessed by means of the mirror-self recognition test. In the mirror-self recognition test you covertly put a spot of rouge on the infants' nose while for instance pretending to dry the infants' nose. After a distracter task, the infant is placed in front of a mirror and encouraged to look into the mirror. If the infant touches his or her nose, then you assume that the infant has a self-concept, whereas if the infant does not, you do not. Whereas only a fraction of 15-month-olds point to their nose when exposed to the mirror-self recognition task, literally all healthy 24-month-olds do. Howe and his colleagues (Howe, 2003, 2011; Howe & Courage, 1997; Howe, Courage, & Edison, 2003) have argued that the development of a cognitive self is a necessary requirement in order to have episodic memories. Before the infant understands him- or herself as an agent and acknowledges that what they experience happens to 'them', it would not be possible to refer new experiences to the catalogue of personally experienced memories. Thus, the cognitive self establishes a reference point for which the personal experiences can be related, and hereby paving the way for continuity – or personal history – in our lives.

Howe's (2003, 2011) claim that the cognitive self is a necessary pre-requisite in order to have episodic memories has also been supported empirically. Besides being tested in the mirror-self recognition test, infants in age groups between 15-23 months of age were

exposed to a hiding game where they were putting teddies to bed in drawers in a lab room (Howe, Courage, & Edison, 2003). Across different retention intervals (3, 6, and 12 months) the infants were subsequently tested regarding the ability to remember where the teddies had been put to bed. The results revealed that the infants' ability to recognize themselves in the mirror at the first session could reliably predict the children's ability to remember where the teddies had been put to bed (Howe et al., 2003). Thus, not only is there from a theoretical point of view reason to believe that the development of the cognitive self as a reference point for your experiences serves as a necessary precondition in order to establish episodic memories; individual differences regarding the on-set of this ability can, at least under some circumstances, reliably predict subsequent episodic memory performance in children.

5. Discussion

In their paper, Mammen and Mironenko (2015) argue convincingly, in my opinion, for the importance of the human ability to keep track of individuals. Further, they argue that this crucial ability has been overlooked or even neglected in much of contemporary psychology, and that a new duality incorporating *both* modes of engagement (acknowledging both featural and spatiotemporal information) towards objects in the world is warranted. In the sections above, I have sketched out some of the evidence from children and infants which seem to suggest that some of these aspects have actually been investigated, although the terminology used at times have been somewhat different from the one used by Mammen and Mironenko (2015).

In my opinion the evidence presented regarding children suggests that children are indeed sensitive towards the duality in the relationship between human beings and objects in the surrounding world: Children appear to be sensitive to the history of objects; they endow ownership, and they distinguish, at least in some cases, between originals and exact replicas. Considering the fact that Mammen and Mironenko (2015) argue in favor of a new *ontology*, we may ask how the empirical findings are conceptualized by Gelman and her collaborators. Interestingly, it seems like Gelman may have changed her view over the years in this regard. In her state of the art review on essentialism in children from 2004, Gelman (2004) cautiously described essentialism as only being a 'cognitive bias' or a 'reasoning heuristic', whereas she refrained from making claims regarding the possible ontology on essentialism. In a more recent paper (Gelman, 2013, p. 458, italics added) this may have changed as she now wrote:

I suggest that attention to object history is a domain-general *capacity* that serves as one of the foundations for psychological essentialism of animal kinds as well as in concepts of individual artifacts [...].

Thus, in her recent writings Gelman no longer describes essentialism as being a 'cognitive bias' or a 'reasoning heuristic', but considers it to be a 'domain-general capacity', which may imply a stronger emphasis on what may be characterized as an inherent, biologically based ability.

According to Gelman (2013) this broader conceptualization also affects how we should understand what she calls 'artifact concepts' (i.e., concepts of man-made objects as opposed to natural kinds). Gelman (2013, p. 458) wrote:

[...] artifact concepts cannot be contained in a theoretical framework that focuses exclusively on similarity [...], nor even on function. Artifact concepts extend beyond the bounds of the physical objects themselves – they carry traces of their history. Standard accounts on artifact concepts do not consider historical information, and thus simply exclude such features from consideration on both a theoretical and a methodological level (e.g. Mervis & Rosch, 1981). For example, when participants are asked to categorize a set of items and are provided exclusively with shape, color, texture, and size as cues, there is no opportunity to demonstrate the importance of historical features.

Thus, Gelman (2013) states that standard accounts on concept formation do not consider historical information and that this is unfortunate. This line of argument is, as I see it, very much in line with the argumentation put forth by Mammen and Mironenko (2015). Is it problematic that Gelman on the one hand and Mammen and Mironenko on the other use somewhat different terminologies? Although it makes a direct comparison more difficult, I do not consider it to be a substantial problem. As stated by Mammen and Mironenko (2015) in their closing paragraph, we first of all need what they call an 'ontological openness' in order to open the field of psychology to its possible domain. Along these lines it should be the quality of the analysis and the strength of the obtained evidence that count, not the terminology used. As such I see the contributions from Gelman and her collaborators as compelling empirical exemplifications indicating that children are indeed sensitive to the individual objects and their history. Note further that since Gelman in her recent writings

describes the children's attention to object history as a domain-general capacity, the empirical evidence obtained should hardly be considered as epi-phenomena, but is more likely to reflect real and genuine aspects of the children's psychological world. It is part of their ontology.

Pursuing the origin of the ability to track individuals through space and time, the results obtained in infant research on object individuation may be even more thought provoking. The main argument is that spatiotemporal information appears to have primacy relative to featural information – especially in *young* infants – suggesting, that the sensitivity to spatiotemporal information is indeed a basic competence. The results from research with young infants raise the question regarding whether this sensitivity to, and preference for, spatiotemporal information may be part of the inherent cognitive architecture in human beings as has been proposed by some infant researchers (e.g., Spelke, Kestenbaum, Simons, & Wein, 1995). This question regarding innateness cannot, however, be resolved by investigating still younger infants by means of methodologies relying on presenting information *visually* to infants (e.g., the Violation-of-Expectation paradigm, see Baillargeon, 2004), as this paradigm is probably not suitable for infants below 2½ months of age (e.g., Arguiar & Baillargeon, 1999), due to lack of maturation of the infants' visual system prior to this age. In this respect we may here, at least for the time being, be confronted with an *epistemological* limitation, not necessarily an ontological threshold.

I have tried to argue that the human sensitivity towards a historical level may also manifest itself when we consider the development of the ability to remember specific episodes from our lives. More specifically, I proposed that the emergence of the cognitive self in the second year of life, which is a crucial pre-requisite in order to be able to refer specific experiences to 'me', constitutes another example of being sensitive to a historical dimension in our lives that has been investigated and documented empirically in the memory development literature. Given that the terminology is different in the two domains, one might again ask whether the phenomena described in one domain are actually comparable to the ones outlined in another domain. My response is the same: If we are to take the 'ontological openness' proposed by Mammen and Mironenko (2015) seriously (and I think we should), then the crucial test regarding whether insights from episodic memory development can be taken as evidence for the presence already in early childhood for an emergent understanding of a historical dimension in our lives, is not necessarily one regarding terminology, but rather to consider whether the presented theoretical and empirical

evidence actually inform us about children's sensitivity to this historical layer in the world. As I see it, this may very well be the case. When children begin to report episodic memories from their lives verbally (typically around 3-5 years of age; e.g., Nelson & Fivush, 2004) it presupposes, that the children have a cognitive self which serve as a relatively stable and continuous reference for their experiences. Thus, without such a historically based anchor point for their experiences, the very existence of episodic memories would remain a mystery. Note again, that whereas our sense of self, that is, who we are, is clearly influenced by the features we display (e.g., gender, abilities, looks etc.), we cannot reduce our sense of self to these features, but must also consider the specific experiences each of us have encountered through our lives, in short, our unique history. For instance, although adult identical twins probably share many features (in the broadest sense), I am quite certain that as senior adults their sense of self will differ, at least somewhat, due to each single individual's unique history.

The human ability to keep track of individuals and being sensitive to the historical depth in our relationship to the surrounding world may have been somewhat overlooked and at times even neglected in much of contemporary psychology as argued by Mammen and Mironenko (2015). However, from a developmental perspective and across age groups and different domains, I have attempted to show that some research concerning these important questions have actually been conducted, although the terminologies used have been different. Basically, the evidence reviewed from developmental psychology seems to be in accordance with the assumptions presented by Mammen and Mironenko (2015), which, in my view, only underscores the relevance and importance of the issues raised by Mammen and Mironenko (2015).

Are infants' and children's sensitivity towards objects' history the same as the one we find in adults? No, it is not. For instance, I doubt that infants or young children understand concepts like the division of labour or similar; concepts that among other aspects reflect the understanding that artifacts typically have a use beyond the individual. In order to understand the benefit of (mass) production of artefacts, one needs to encompass the *prior intentions* (Searle, 1983) of the manufacturer, that is, the intentions present in an agent's mind before conducting an act (i.e., in this case: putting a new cell phone into production). Such complicated and long-term intentional activity would clearly be beyond the scope of infants' and young children's understanding. What I *do* claim is that the experimental evidence from developmental psychology presented here, suggests that infants to some

extent and children (more so) display the basic requirement of being sensitive, at least in restricted time spans, to specific objects' whereabouts across space and time.

Another argument for pursuing the developmental origins of the human ability to keep track of individuals is of a more principal nature: Typically, a given topic is not understood in its entirety unless the development of the phenomena is sketched out (Krøjgaard, 2005).

In one of the closing sections of their paper, Mammen and Mironenko (2015) refer to a generalized description by one of the authors of the new duality in the form of a formal model presented in an axiomatic format based on set theoretical topology (Mammen, 1996). An obvious next step would be to see this formal system unfolded. By means of describing the new duality in a formal language, the proposed duality would be legitimized substantially and would lend further support to the importance and relevance of the human ability to single out and track specific object through space and time. I sincerely hope that this axiomatic system will become available to a broader community of researchers and can only encourage the author to make sure it will.

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