

COMMENTARIES

A welcome turn to meaning in infant development: commentary on Mandler's *The foundations of mind: Origins of conceptual thought*

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This is a commentary on Jean Mandler's *The foundations of mind: Origins of conceptual thought* (see Mandler, 2004).

Research in infant cognition has been fraught with controversial claims and competing theories for 30 years, in part in response to new data emanating from laboratories employing new technologies and in part contesting Piaget's foundational theories. It has been badly in need of a new theoretical approach that could reconcile contradictory findings. In *The foundations of mind: Origins of thought*, Jean Mandler has proposed such a theory, which has the potential for transforming our understanding of conceptual development, word learning and cognitive development in general. The book is, however, not just a theoretical proposal, but is solidly based on a broad swath of experimental findings from her laboratory and others, as well as on up-to-date cognitive and neuro-cognitive results from both infant and adult research.

The core of Mandler's original research is in her studies of infant categorization. These have significance beyond the controversies rampant in the field of infant development that support a set of related theoretical claims. Among the significant implications of this research are the following:

1. Conceptual and perceptual categories are based in different processes; both develop in infancy. Different tasks call on different categorization processes and must be distinguished as such when theoretical claims are made.
2. The initial conceptual categories are abstract and global. This is perhaps Mandler's most crucial and controversial claim; it contradicts the prevailing assumption that basic level categories are primary in development.
3. Conceptual categories are formed in the effort to establish meaning; thus the abstract basis for infant conceptual categories involves the role that objects play in events, a relational basis, not a static perceptual feature basis.
4. The conceptual process requires consciousness, unlike perceptual categorization revealed in habituation tasks. The distinctions between conscious and unconscious, implicit and explicit, procedural and declarative knowledge are critical to understanding the course of development in many domains, including language acquisition.

Mandler makes it clear that her theory has deep roots in Piaget's genetic epistemology, while rejecting his formulation of sensorimotor cognition in infancy. It also has strong connections to contemporary cognitive science and neuroscience.

The distinction between different kinds of categories and processes – implicit and explicit, procedural and declarative, perceptual and conceptual – is the centerpiece of this approach. It is bolstered by recent work in memory and learning, including research with amnesic adults, and it serves to reconcile competing claims about infant competence in categorization. Controversy swirls around this distinction between perceptual and conceptual categories, which contrasts with theories of conceptual development that assume that categorization on the basis of similarity of perceptual features is primary, and that only later do children learn to categorize on the basis of essential characteristics (Keil, 1989; Smith & Jones, 1993). It is also a challenge to Rosch's (1978) claim that there is a basic level of categorization

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of objects that is most 'natural' and that is acquired first by children. The global categories that children demonstrate first, such as *animate*, are abstract, not based on specific perceptual features, a finding that fits well with the claim that 'gist' memory predominates in the early years (Brainerd & Reyna, 1990).

It would be no service to Jean Mandler to pretend that I agree with all of her conclusions. For example, I would place more emphasis on the motor side of infancy, particularly on the infant's active participation in events, not simply on the perceptual observation of them. I would also question some of the clear distinctions made, for example, that imitation is meaningful while perception is unconscious. Is that always the case? I would urge more attention to the social figures in the infant's world with the suspicion that these are the first to be conceptualized. I would also debate issues of representation (although her expertise in this area is unassailable), such as the question of the representational status of the replicas that infants use in her tasks: Are they real? Symbols? Or both? How do they relate to later symbolic development, for example in DeLoache's (1990) work? And I would not reject the basic level of categorization, based not on similarity but on their common use as names, the basis of Brown's (1958) original observation of the most functional level of naming. These points of divergence do not in any major way conflict with Mandler's foundational theory, but might suggest places for further inquiry and testing of assumptions.

Up to now, consciousness and meaning have largely been missing from infant research and from the theoretical controversies swirling around it, lacunae that Mandler's work means to fill. Now that these have become acceptable constructs in studies of adult cognition, they

may also be welcomed in distinguishing among facts and fantasies of infant and child research. In emphasizing children's meaning-making, their interpretation of experience as the basis for conceptual development as well as for language, inductive reasoning and memory of the past, this theory provides an important bridge to post-infancy developments. Among other things, taking consciousness into account has enabled differentiating and integrating discrepant findings, in addition to formulating a developmental theory of differentiation and integration in the infant-child mind. This work thus paves the way for a fresh look at meaningful cognitive development as an overall process.

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Straddling the perception-conception boundary

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This is a commentary on Jean Mandler's *The foundations of mind: Origins of conceptual thought* (see Mandler, 2004).

Where does perception end and thinking begin? How do conscious cognitive processes differ from unconscious

ones? What is the relation between *knowing that* and *knowing how*? These difficult and endlessly engaging

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questions are raised most often in relation to the cognitive processes and experience of human adults. In *The foundations of mind: Origins of conceptual thought*, Jean Mandler asks us to consider these questions when we study human infants.

Mandler's mission is bold and challenging because infants have such limited means to communicate their concepts and experience to us. How can we know whether an infant has conscious, explicit, conceptual knowledge? Infants cannot put their beliefs and experiences into words, or use their knowledge to guide elaborate sequences of coordinated action. Can astute observers of infants' limited actions, and of ways in which their actions vary in accord with the objects and tasks that they face, shed light on their concepts and consciousness?

For 20 years, Mandler has argued that we can. Much of her research focuses on sorting tasks. In one such task, young children are given a collection of representational toys, such as toy animals or vehicles, and their sequential actions are recorded. In another task, infants are given a succession of representational toys, one at a time, and their attentive examination of each object is assessed. In the first case, under certain conditions, children will touch sequentially all the toys that depict objects in a single global category, such as all the animals. In the second case, infants who are allowed to examine each of a set of objects in a single category (e.g. animals) will subsequently scrutinize a test object more fully if the object lies outside that category (e.g. a vehicle). Both patterns provide evidence that children confer some similarity on all the animals or vehicles. Debate has raged over the nature of this similarity relation.

In *The foundations of mind: Origins of conceptual thought*, Mandler proposes that the basis of infants' response is conceptual: infants have a global category that includes all the toy animals and excludes all the vehicles, and the reverse. Her evidence is three-fold. First, infants categorize together objects that are featurally diverse (e.g. toy bears and toy seagulls) and categorize separately objects that are featurally similar (e.g. toy seagulls and toy airplanes). Second, infants often fail these categorization tasks when presented with perceptually well-defined categories of objects that fall within the same global category (e.g. toy dogs versus toy cats). Third, somewhat older infants act appropriately on objects in different global categories, using a key to pretend to activate a toy airplane but not a toy bear, and bringing the bear but not the airplane to a water bowl for pretend-drinking.

Mandler's most compelling argument, in our view, carries her beyond this evidence. She considers infants'

developing representations of objects in terms of the concepts and cognitive skills that older children must learn. In particular, children need conceptual representations, not just a perceptual quality space, to learn the terms and rules of a natural language. Natural languages are notoriously impervious to the appearances of things at the level both of words and of rules for forming complex expressions. The referent of a word like 'bear' or 'airplane' is not defined by its appearance but by its hidden, essential nature (e.g. Kelemen, 1999; Soja, Carey & Spelke, 1992). What makes an expression like 'x is on y' true of a pair of objects has little to do with their superficial spatial relation (what is common to the spatial relation of a cup on a saucer, a ring on a finger, a stain on a napkin and a fly on a ceiling?) and much to do with their non-obvious, mechanical relationship (e.g. Bowerman & Choi, 2003; see also Gelman & Wellman, 1991). Cognitive linguists explain these and other phenomena by proposing that language maps to mental representations structured by abstract concepts such as *agent* and *force* (e.g. Talmy, 1988). If such explanations are true, then the child who learns a language must somehow come to dispose of the abstract concepts on which language depends. The demands of language learning, together with the evidence from experiments on infants, make a strong case that infants attain a system of explicit concepts by the end of the first year.

Mandler's arguments for conceptual structures in infancy are compelling, but what are these structures? A major thesis of her book is that infants are endowed with two principal systems of knowledge: a perceptual system and a conceptual system. This thesis can explain a set of seemingly contradictory findings in the infant categorization literature. One line of research using a visual paired-comparison method suggests that infants as young as 3 months of age categorize objects at the basic level (e.g. cats versus dogs) more readily than at a more global level (e.g. animals versus furniture) (Quinn & Eimas, 1996; though cf. Behl-Chadha, 1996). A different line of research using the manual habituation method described above suggests that infants make global distinctions by 7 months of age but fail to make basic level distinctions until the end of the first year (Mandler & McDonough, 1998). Mandler suggests that the visual paired comparison method taps infants' implicit perceptual system of knowledge, whereas sorting methods tap infants' explicit system of conceptual knowledge.

The importance of Mandler's proposal may be judged from the vigor with which it is disputed. Some investigators have argued that a single system of knowledge, based ultimately on perception, underlies performance in all categorization tasks in infancy (e.g. Quinn & Eimas, 2000; Quinn *et al.*, 2000). We would offer a

different argument: perception and conception are not the products of two unitary, distinct systems. Instead, a larger collection of systems underlies infants' capacities to perceive and reason about entities in different conceptual domains such as objects, persons, space and number (e.g. Spelke, 2004). At least some of these systems, moreover, straddle the perception-cognition boundary.

Consider, for example, the system that underlies knowledge of objects. For infants and for adults, object representations appear to be achieved by mechanisms that are neither purely perceptual nor purely conceptual: mechanisms of mid-level vision (Carey & Xu, 2001; Leslie *et al.*, 1998; Spelke, 1988). These mechanisms, moreover, are sensitive to mechanical properties of objects that are deeply entrenched in the world's languages (Hespos & Spelke, 2004). As a second example, consider the systems that underlie knowledge of number. Although numerical cognition is a supremely conceptual achievement, it does not depend on a single system of representation but on multiple systems in adults (Dehaene & Cohen, 1997), infants (Spelke, 2000) and non-human primates (Hauser & Carey, 2003; Hauser & Spelke, *in press*). These findings suggest that the distinction between perceiving and conceptualizing the world is not as sharp as Mandler suggests.

Even if one grants that perceiving and conceptualizing are different, one may question Mandler's further thesis that some methods tap perceptual knowledge whereas others tap conceptual knowledge. Consider, for example, the habituation of looking time method. Mandler suggests that this method reveals perceptual knowledge, and we agree that sometimes it does. When a baby is habituated to a single object at different distances and dishabituates to a change in the object's size, the looking pattern provides evidence for size constancy: a perceptual capacity (Granrud, 1986; Slater, Mattock & Brown, 1990). Sometimes, however, the findings of preferential looking experiments strain intuitive notions of perception and its limits. For example, infants' looking time to a superficially ordinary event in which an object appears from behind a screen may depend on events that occurred more than a minute earlier and that render the event either consistent or inconsistent with the object's prior motion (Luo *et al.*, 2003). Moreover, infants' looking time sometimes depends on the goal of an agent's action (Woodward, 1998) or on the rationality of the action in relation both to the agent's goals and to contextual constraints (Gergely *et al.*, 1995). Just as adults may look at an object for many reasons – to take in its visible appearance, to determine who left it in its present position, or to see who is going to pick it up – so may infants. It is unlikely that preferential looking methods tap only perceptual capacities.

Mandler's studies of inductive generalization in infancy seem intuitively to bring us closer to infants' conceptual knowledge. In these studies, infants are shown an initial modeling event (e.g. the experimenter shows the infant a toy dog and demonstrates giving the dog a drink) and then are given a choice between two new objects (e.g. a bird and an airplane) on which to generalize the behavior (e.g. giving a drink). Infants generalize the behavior to the object that belongs to the same global category, even when the two test objects are very similar to one another and very different from the initial object.

Further evidence that perceptual categorization is not at work in inductive generalization tasks comes from experiments testing generalization at the basic level. When a behavior is initially modeled on a dog, for example, and infants are then encouraged to reproduce the behavior either on a new dog or on a cat (a basic-level distinction), they are equally likely to generalize the behavior to the cat as to the dog. On a perceptual categorization account, this finding seems strange because a dog is more similar to another dog than to a cat. Mandler takes this finding as evidence that infants represent the initial event at the global level: when babies see a dog being given a drink, they conceptualize the event as 'animal getting a drink.' A modified perceptual-categorization account could also explain these findings, however. For example, if infants perceive the initial event as 'thing with eyes and varied texture getting a drink,' this perception would support the same pattern of generalization.

Research similar to that of Johnson, Slaughter & Carey (1998) might serve to distinguish between these interpretations. Johnson and colleagues investigated whether 12-month-old infants would follow the gaze of a novel object whose morphology (face or no face) and behavior (contingent interaction with a human or non-contingent self-propelled motion and beeping) varied systematically. Infants followed the 'gaze' of an object that lacked a face as long it had interacted contingently in the familiarization period, but they did not follow the 'gaze' of the object that lacked a face and did not exhibit contingent interaction (even though it moved and beeped as much as in the contingent condition). Infants therefore treated the very same object differently depending on its past history as an agent or non-agent. Because morphological features were held constant, they could not have been the basis of the discrimination. If Mandler's imitation studies truly call upon a conceptual system of knowledge, therefore, infants should demonstrate domain-appropriate imitation even when static features are not present in the objects, as long as infants are given some evidence about the object's category membership. Just as in the Johnson study,

infants should treat the very same object differently depending on its history.

Methods developed by Keil and his colleagues for studies of categorization in older children (Keil *et al.*, 1998) provide another way to test Mandler's claims. Keil and his collaborators asked whether young children weight the same perceptual properties of objects differently depending on the global domain to which the objects belong (e.g. animals versus machines). They found that young children know (as adults do) that properties such as size and weight are important for reasoning about machines, whereas features such as shape and texture are critical for thinking about animals. We have begun a series of studies in our laboratory aimed at examining category-specific learning and generalization in infants. In these experiments, we teach infants something about a particular object and observe their generalization of this knowledge to new objects. In one set of experiments (Shutts & Markson, 2003), for example, infants were taught that a particular animal was self-propelled. In the test phase, infants generalized this learning to animals that shared the same shape (but not the same color) as the familiar animal. Infants' privileging of shape over color in the domain of animals is consistent with Keil's data on children and adults (Keil, 1995; Keil *et al.*, 1998). We are currently investigating whether infants show contrasting, domain-specific learning and generalization patterns for food objects, as do older children (Macario, 1991) and non-human primates (Santos, Hauser & Spelke, 2001).

Behind these suggested studies is a research strategy that may prove fruitful in investigations of infants' conceptual development. For any given conceptual domain, one first specifies a set of signature properties of learning and generalization by adults or older children, and then one tests for those signatures in infants. If the conceptual system underlying the performance of older children is present and functional in infants, then infants' performance should display the same signature properties and limits. This strategy already has proven fruitful in studies of infants' cognitive abilities in the domain of number (Carey, 2001; Feigenson, Dehaene & Spelke, 2004). As methods in developmental cognitive neuroscience uncover a richer array of signatures of mature cognitive processes, this strategy may become increasingly successful.

Whatever their methods and findings, future research on the nature and origins of concepts will owe a great deal to the research and thinking that animate Mandler's book. In *The foundations of mind: Origins of conceptual thought*, Mandler lays out fundamental questions about the emergence and development of human knowledge. She helps readers to think about current empirical and

theoretical work on this topic, and she inspires us to devise new ways to address the hardest questions in developmental cognitive science.

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Multiple sources of information and their integration, not dissociation, as an organizing framework for understanding infant concept formation

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This is a commentary on Jean Mandler's *The foundations of mind: Origins of conceptual thought* (see Mandler, 2004).

What is most characteristic of perceptual representation is that it is categorial in nature . . . We see triangles, lines, apples, people. (Bruner, 1957)

In *The foundations of mind: Origins of conceptual thought*, Jean Mandler articulately describes her theory of how infants form concepts. This provocative book

provides important reading for investigators of early cognitive development as well as cognitive scientists more generally interested in concepts and the role they play in related mental activities, such as the representation of objects and events, language and consciousness. Piaget's (1952) argument that symbolic knowledge emerges from the compilation of infant sensorimotor activity is the

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point of departure, and Mandler's alternative account has as its centerpiece the notion that the representation of procedural and declarative knowledge are dissociable and operative in parallel, possibly from the earliest beginnings of development.

Mandler's theoretical system operates by splitting concepts away from percepts (and perceptual categories) via a process of perceptual meaning analysis that allows infants in the second half of the first year of life (and perhaps sooner) to represent motion events in terms of image-schemas – discrete bits of knowledge that reflect conceptualization of events in terms of primitives such as *self-motion* and *link*. The extraction of such image-schemas can be used to construct global concepts (e.g. animal) that are accessible to conscious thought and eventually expressible in speech.

The process by which infants analyze motion events to produce image-schemas that are the building blocks of concepts, according to Mandler, needs to be dissociated from the process by which infants categorize realistic visual images depicting objects from different classes (e.g. cat versus dog). The latter is for Mandler more aptly conceived as perceptual schema formation, which is passive, automatic, non-analytic and non-conscious in nature.

Mandler is probably correct in suggesting that some of the findings on infant categorization of static visual images can be interpreted as evidence for the engagement of automatically deployed pattern-learning or prototype-abstraction mechanisms, particularly those that involve visual patterns that can simply be input (and superimposed) one after another into an averaging mechanism, e.g. two-dimensional dot patterns, schematic face patterns (Quinn, 1987; Strauss, 1979). However, the account may not fare as well when applied to data on how infants process realistic images of humans, non-human animals and artifacts (Quinn, 2002). For example, in the case of the contrast between various species of non-human animals, the animals are shown in a variety of poses (running versus standing versus sitting versus lying), directions (facing front versus to the left versus to the right), colors (e.g. black, white, orange, brown and gray) and textures (long-haired fur versus short-haired fur). Thus, if one were to enter the images from a common class directly into a prototype averaging system via superpositioning, the resulting summary image would be strange (e.g. two heads joined by a body with no tail, a body with two tails and no head). The point is that infant parsing of animal species as distinct from each other via summary representations may engage a sophisticated process, requiring some of the active comparison between exemplars and structural alignment that Gentner and colleagues have described (e.g. Gentner & Namy, 1999), as well as viewpoint-dependent object

recognition mechanisms of the sort discussed by Tarr and associates (Tarr & Kriegman, 2001).

It is also worth emphasizing that a number of looking-time studies of categorization in young infants used a paired preference procedure with two exemplars simultaneously presented on each trial. This procedure is likely to enhance comparison between exemplars from the same category during the familiarization trials and also requires infants to look at both the novel instance from the familiar category and the novel instance from the novel category during the preference test trials. In short, the infants demonstrate a preference for one stimulus over the other in a forced-choice situation. The looking is thus active and stands in contrast to the passive trance-like gaze that has been attributed to infants participating in serial habituation–dishabituation procedures where just a single stimulus is presented on each trial.

These stimulus and procedural considerations serve to raise the question of whether one should consider categorization of static visual images by infants as so clearly different from categorization of dynamic visual motion paths, with the former useful in only a limited way (e.g. for purposes of identification) and the latter useful in some deeper core sense (e.g. for purposes of thinking), towards the conceptualization of experience. Indeed, I do not believe that the way to handle the distinction between percepts and concepts is through a dual representational system. A different, more integrative interpretation of the data on infant concept formation might run as follows: Categorization is a core process that relies on the extraction of commonalities across changing exemplars, and may operate on static object images *or* dynamic motion events (Quinn & Eimas, 1996; 1997; 2000). Either source of information has the potential to contribute diagnostic information that will help the infant to construct an emerging concept of 'animal,' for example. In the case of processing static visual images, infants have been shown to form a category representation for humans that includes non-human animals as diverse as cats, horses and fish (Quinn & Eimas, 1998), thus implicating the extraction of something akin to a generic animal form in the linkage of such perceptually diverse exemplars, e.g. a head adjoined to an elongated body with skeletal appendages (Quinn, 2004). Likewise, in the case of processing dynamic motion events, extraction of such primitives as *self-motion* and *link* may simply form different sources of information for constructing a representation for 'animal.' While the two forms of extraction that operate on static versus dynamic inputs may tap different brain processes, that is, what versus where or how mechanisms (Mishkin, Ungerleider & Macko, 1983), the operation of categorization as a core process (e.g. the representation of consistent

structure that emerges against a backdrop of changing exemplars) remains the same in both cases. The static image and dynamic movement information that is acquired by the eye can be further enhanced during the preschool years by language – the actual event need not be seen. The consequence of this enrichment process is that a perceptual category becomes elaborated to form a higher-level concept that can drive complex thought.

In this view, motion is not the major force necessary to create concepts; rather, it is one of many sources that exist in the world and that can be acquired through the process of perception and other processes that permit associations and links. What becomes important, therefore, for describing the course of early concept development is an explication of the mechanisms by which infants: (1) integrate the static and dynamic bits of information that connect what a particular animal looks like with how it moves, and (2) incorporate both sources of information (along with information acquired by language) into a common representation that can be used for both identification and thinking.

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On the conceptual–perceptual divide in early concepts

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This is a commentary on Jean Mandler's *The foundations of mind: Origins of conceptual thought* (see Mandler, 2004).

One interesting aspect of Jean Mandler's book, *The foundations of mind: Origins of conceptual thought*, is that it places her well-known experimental research into

a broader theoretical framework of cognitive development. In particular, it was interesting to me to discover the strong influence of Piagetian theory on Mandler's

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thinking. Although she rejects a number of Piaget's claims about early thought, she accepts his basic distinction between sensorimotor and more truly cognitive processing, updating the former in light of recent research on procedural learning.

If one has the initial assumption that infants do not have true concepts but only operate at a sensorimotor or procedural level, then one can make good sense of the data. Findings that infants cannot do X but older children can are taken as evidence for the assumption: X must involve truly conceptual thought and so is not possible in infancy. Mandler's book presents this case quite cogently. However, for readers like me who do not begin with the assumption that there is a principled distinction between perceptual and conceptual concepts, the evidence does not suggest that conclusion. Although the evidence can be interpreted as consistent with Mandler's basic distinction, it is just as consistent with stories that lack such a distinction. In my view, the theories that do not make that distinction are simpler and avoid the main theoretical weakness of Mandler's proposal, explaining the transition from perceptual/procedural to conceptual concepts.

In the typical infant categorization experiment, babies view pictures of category members and then are tested to see if they can distinguish that category from a new one. It is well accepted that they can do so. However, what have the babies learned? Even researchers in this area seem to agree that the concepts may be purely perceptual (e.g. Quinn, Eimas & Rosenkrantz, 1993, p. 464). Such a claim might be consistent with Mandler's argument that such learning is purely procedural and with the proposal that babies make a transition from the perceptual to the conceptual when they develop more sophisticated concepts of different kinds of things.

But there is a fault in this interpretation, namely that the experiment only presented and tested perceptual information. If the stimuli presented to the child are photographs of birds, and if no other information about birds is presented, then the child can only form a concept based on perceptual information. That does not require a controversial distinction between two different kinds of concepts to explain – it simply reflects the logic of the experimental procedure. Indeed, if adults were tested in such an experiment with novel categories, they could only form perceptual categories as well.

However, I believe that Mandler is correct in asserting that infants do in fact have less conceptual knowledge than older children and adults do. This is because in order to learn abstract knowledge about a kind of object, one must first have other, more basic knowledge. In order to have some idea of what birds are, what they do, their habitats and their biological properties, one

must know a certain number of facts about birds and animals in general, be able to identify them reliably, be able to interpret their actions and so on. I would find it difficult to learn an advanced concept in accounting because I do not have enough of a background in accounting or business to be able to understand the parts of the concept, when it would apply, and what it refers to. This failure on my part (which I freely admit) is not due to a principled distinction between accounting and the other domains where I do happen to have some concepts. We do not need to invoke a multi-stage process in which I pass from a pre-accounting organism to a post-accounting organism. Instead, we need only to understand that some concepts presuppose others and work in coordination with them. You cannot learn everything at once, and there is a natural order of complexity that partly determines the order in which concepts are acquired. Indeed, such a progression is found in other areas of infant cognitive development, as Mandler describes, such as their learning the physical principles underlying object support (Baillargeon, 1998).

Thus, I do not see a compelling reason to propose a shift from purely perceptual/procedural to conceptual thought. Indeed, it is striking (when one looks for it), that Mandler does not provide specific evidence that infants do not in fact have conceptual representations of their early concepts. She does make comments such as infants having 'no ideas' about dogs when learning the category in an experimental situation. But what evidence from this paradigm shows that they have no ideas about them? In addition to learning abstract perceptual information, could they not also have the beginnings of a concept, thinking something like (in infant-thought), 'What *are* these things?' or 'They all seem furry' or 'These things look like they might move'? I do not know whether they have such ideas that contain the beginnings of kind concepts – I am only pointing out that there is nothing in the data that suggests that they do not think of them as kinds of entities. I think that Mandler has taken the fact that we only can be sure that babies have a perceptual category as actual evidence that babies in fact only have perceptual categories.

This example brings me to the advantage for not making the perceptual–conceptual distinction this way, namely that conceptual information is often *about* perceptual information. My concept of birds tells me what they look like, their behaviors, their habitats and so on. Much of those are perceptually available properties. I have a theory about how birds can fly that relates their perceptually evident properties of having wings and flying. If one examines the literature of the so-called *theory approach* to concept (Murphy, 2002, ch. 6), one will find numerous examples of underlying knowledge

being used to explain the superficial properties of the category. I do not have some deep theory of birds that says what they are independent of their properties. Thus, to distinguish perceptual concepts in the procedural system from 'conceptual' declarative concepts is to mischaracterize, in my view, the nature of the conceptual information. Without the surface features there is nothing to conceptualize.

Thus, even if children start out with purely perceptual categories of birds, when they form more conceptual categories of them they are integrating perceptual properties with one another and with the other kinds of entities they are learning about. But if perceptual learning were procedural, this integration would be impossible, and so it is hard to see what the conceptual categories would be formed from. Indeed, in spite of Mandler's valiant effort to explain the transition from procedural to symbolic thought via image-schemata, her story seems to me to assume the existence of symbolic-conceptual processes that operate on procedural representations, that is, assuming the processes whose development is being explained. Explaining the transition between qualitatively different cognitive stages is of course the *bête noire* of such stage theories and is one reason why they have become less popular as accounts of development in older children.

For both critics and adherents of the perceptual-conceptual divide, *The foundations of mind: Origins of*

conceptual thought provides a very readable and useful summary of the theoretical background and the empirical evidence for Mandler's position. If the book does not settle the debate, it does serve to vigorously present and defend one side of it.

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