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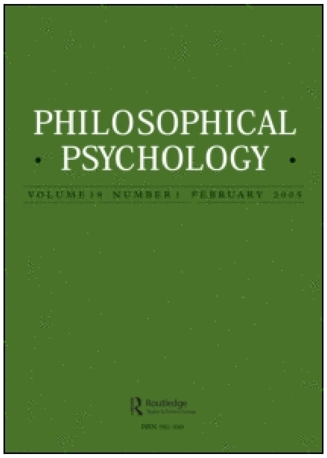

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Animal Minds and the Possession of Concepts

Albert Newen and Andreas Bartels

In the recent literature on concepts, two extreme positions concerning animal minds are predominant: the one that animals possess neither concepts nor beliefs, and the one that some animals possess concepts as well as beliefs. A characteristic feature of this controversy is the lack of consensus on the criteria for possessing a concept or having a belief. Addressing this deficit, we propose a new theory of concepts which takes recent case studies of complex animal behavior into account. The main aim of the paper is to present an epistemic theory of concepts and to defend a detailed theory of criteria for having concepts. The distinction between nonconceptual, conceptual, and propositional representations is inherent to this theory. Accordingly, it can be reasonably argued that some animals, e.g., grey parrots and apes, operate on conceptual representations.

Keywords: Animal Minds; Concepts; Conceptual Representation; Epistemic Theory of Concepts; Levels of Representation; Nonconceptual Representation; Propositional Representation

1. Introduction

It is a widely debated issue whether animals with complex behavioral capacities possess concepts and beliefs. The question whether animals possess concepts or beliefs and master basic language skills in a way fundamentally similar to humans is the basis for intense interdisciplinary controversy: Philosophers' interest in this matter primarily derives from the conviction that concepts are a key factor distinguishing human beings from nonhuman animals. This cognitive difference is then exploited to justify important distinctions in the ethical status of human beings as opposed to that of other animals. Psychologists (as well as philosophers of mind)

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wish to discover how the human mind works and how it differs from that of animals. Linguists (as well as philosophers of language) investigate whether the capacity to form concepts and beliefs is limited to humans and whether this capacity can be seen as the basis for language competence. Animal researchers aim at understanding the causal processes underlying the astonishing cognitive abilities of rats, birds and monkeys and aim to clarify how these causal processes relate to human cognitive abilities. All these approaches presuppose some notion of concepts and often lead to different claims concerning the key question: Do animals possess concepts or beliefs?

2. The Methodological Background

Our background paradigm is a representational theory of concepts distinguishing between types and tokens: Tokens of concepts are mental representations. Concepts as types of mental representations are individuated by their content. The content of a mental representation is determined by the mental capacities of the cognitive system having the representation, and can be spelled out in terms of functional roles. Our aim is to grasp the *nature* of concepts, and not only the conditions of ascribing them, in a sufficiently fine-grained manner. We believe that the best way to reach this goal is to analyze the mental capacities of cognitive systems. Thus, we presuppose an epistemic theory of concepts in accordance with Christopher Peacocke (1992), who suggests that analyzing the possession conditions is the ultimate key to the nature of concepts:

> There can be nothing more to the nature of a concept than is determined by a correct account of the capacity of a thinker who has mastered the concept to have propositional attitudes to contents containing that concept (a correct account of "grasping the concept"). (p. 5)[1]

This contrasts sharply with Fodor (1998) who claims that there are no metaphysically necessary connections between concepts and epistemic capacities:

> I'm going to argue for a very strong version of psychological atomism; one according to which what concepts you have is conceptually and metaphysically independent of what epistemic capacities you have. If this is so, then patently concepts couldn't *be* epistemic capacities. (p. 6)

We will show that individuating concepts by epistemic capacities is a very fruitful strategy with great explanatory value. To avoid misunderstandings: We are not claiming that concepts are epistemic capacities but that they are individuated by them. Concepts are types of mental representations constituted by epistemic capacities.

One further remark concerning mental representations is in need here: We take mental representations to be representations of systems displaying a minimal complexity of behavior in order to exclude primitive representational systems such as thermostats.[2] Mental representations have a representational content defined by specific functional roles (in the relevant contexts).[3] Mental representations have functional roles that are realized as brain states in human beings (in the relevant contexts). On the basis of this functionalist stance, the aim of this article is to discuss the central question: What are the criteria for the possession of a perception-based concept?

We develop epistemic criteria by discussing paradigmatic cases of complex animal behavior, especially the behavioral capacities of the bird Alex (Pepperberg, 1999) and the ape (bonobo) Kanzi (Savage-Rumbaugh, Shanker, & Taylor, 1998). As a result of this discussion, we present criteria for having different kinds of representations: (a) nonconceptual, (b) conceptual, and (c) propositional representations. We don't take this distinction to be strongly correlated with types of mental phenomena, e.g., perceptual contents can sometimes be represented nonconceptually, sometimes conceptually. In principle, we have to distinguish between mental phenomena as understood by folk psychology, on the one hand, and kinds of mental representations, on the other hand. Folk psychological mental phenomena are perceptions, emotions, beliefs, desires, etc. The general notion we prefer as a background theory and for which some more evidence is presented in this paper, is the view that we can distinguish different kinds of representations such that it is possible to have different kinds of mental representations of the same folk-psychological mental phenomenon. Animals, for example, often only have a nonconceptual representation of a perceptual content while adult human beings often have a conceptual representation of the perceptual content. In the end, this will give us a satisfactory framework for categorizing the behavioral capacities of animals as well as human beings.

3. Outline of the Recent Debate

3.1. Discriminatory Abilities, Causality and Stimulus Generalization

Because of the intimate connection between language and human concepts, it is often denied that concepts can be ascribed to animals. For example, Chater and Heyes (1994) claim that "no clear sense has been provided for the claim that nonlinguistic animals have concepts" (p. 237). According to these authors, the question whether animals can possess concepts may only be answered in the affirmative if the characteristics of conceptual capacities—as described by the theories of *human* concepts—could be also applied to nonlinguistic animals. Of the three main theories of concepts—the definitional, exemplar, and prototype theories—"only the prototype view can be formulated nonlinguistically" (p. 212). Since the prototype view does not allow distinguishing between the capacity of stimulus generalization and genuine conceptual capacities (p. 218), according to Chater and Heyes, even that theory cannot provide a basis to apply concepts to animals.

Note, however, that this last consideration does not imply that animals are unable to have concepts. In contrast, what Chater and Heyes argue for is that the prototype theory does not lead to a clear demarcation of conceptual capacities from the capacity of stimulus generalization. Thus, their criticism—far from excluding the possibility of applying concepts to animals—indicates that the demarcation mentioned above has to be accounted for by any general theory of concepts which can be applied to humans and to animals. The underlying general observation is that even a system relying only on a red light detector already involves some stimulus generalization insofar as it distinguishes red-situations from non-red-situations. However, to speak of conceptual representations in such cases is superfluous and therefore implausible because we can explain the functioning of red light detectors entirely without presupposing concepts. So, what exactly are the criteria for distinguishing cases of stimulus generalization from cases of conceptual representation?

Fred Dretske (1999) suggests an account which characterizes conceptual content by means of *causal correlations* to some real entities and its *causal relevance* to the behavior of the system. For example, Dretske argues that some birds have beliefs (and, according to his view, *a fortiori* concepts): Some birds learn to avoid eating a certain type of butterfly (Monarch), since it is not digestible to the bird. Furthermore, it can be observed that those birds also avoid butterflies which mimic the appearance of Monarch butterflies. According to Dretske, this is sufficient to claim that the birds have concepts and beliefs. The relevant feature of the meaning (content) of the bird's internal representation is "directly relevant to its behavior" (p. 29): If the content of a representation is causally relevant to the behavior of a system, then, according to Dretske, the system possesses concepts and beliefs.[4] In contrast to the bird case, we find causal mechanisms *without* causally relevant contents, which are thus *not conceptual*, in the case of certain plants: The plant Scarlet Gilia changes its color, depending on the season, in order to attract pollinators occurring only in the corresponding season. Although the state of the plant varies systematically with the changes in its environment, the plant does not have any concepts because representational content does not play a causal role. In the case of the birds, the content of the representation is causally relevant since the "memory about some previously experienced object is so obviously implicated in why the bird behaves the way it does" (p. 28). Thus, Dretske proposes that the central feature of cognitive behavior which includes the possession of concepts and beliefs is the fact that the internal representation which causes the actual behavior involves memory traces of the relevant stimuli. If we accepted the involvement of memory not only as necessary but as sufficient, we would have to classify any rigid stimulus-response (S-R) behavior involving memory capacities as conceptually mediated cognitive behavior. Such a liberal notion of concepts is inadequate: In order to explain rigid S-R behavior, we can rely on simple mechanistic or teleofunctional explanations, even if memory traces of the relevant stimuli are involved. For instance, in a match-to-sample experiment with animals, causal traces of the presentation of the sample are directly involved in the actual matching behavior. Dretske would have to classify such clear cases of rigid S-R-behavior as conceptually mediated—which we think is empirically unnecessary. To generalize our considerations so far, we do not need conceptual representations to explain any form of rigid behavior. Therefore, a minimal criterion for concept possession is flexible response behavior in one and the same stimulus situation. So, how can we characterize a representation that allows minimally flexible response behavior?

The account provided by Allen and Hauser (1991) and Allen (1999) can be seen as a proposal to answer this question. According to them, the attribution of genuine concepts is justified "if there is evidence supporting the presence of a mental representation that is independent of solely perceptual information" (Allen & Hauser, 1991, p. 231). In a negative characterization, independence in this sense entails that the responses of the animal to a certain stimulus are not just "driven by" that stimulus, and are also not to be explained as cases of stimulus-generalization, i.e., discrimination by a mechanism responsive to a single basic stimulus (e.g., an infrared-light detector, a noise detector). Positively characterized, genuine concepts necessarily presuppose an integration of more than one source of information in order to modify the behavior which is the response to a given stimulus. Rigid behavior is often caused by a simple S-R mechanism that is based on only one kind of stimuli. Ants, for example, show rigid behavior in reaction to the presence of acidic byproducts of the decomposition of dead conspecifics; in tests they rigidly remove anything from the nest that is painted with oleic acid: Even when they get information indicating that the objects are not dead, their behavior will not be modified by this information. They remove even living ants painted with oleic acid. Thus, it is inadequate to assume that ants operate on the concept DEATH:

> An organism whose internal representations are conceptlike should be able to generalize information obtained from a variety of perceptual inputs and use that information in a range of behavioral situations.... The ability to use an independent representation of death (a concept of death) to guide behavior would be advantageous if it allowed rapid modification of behavior in a wide variety of situations. (Allen & Hauser, 1991, pp. 232–234)

Allen's discussion of the case of ants can be understood as an application of the criterion of *informational plastici*ty used by Pylyshyn (1990) to discriminate representations governing flexible behavior from parts of a rigid functional architecture.[5] The former is present "whenever behaviour is sufficiently plastic and stimulus-independent" (p. 42). "For example, seeing that the building you are in is on fire, smelling smoke coming in through the ventilation duct, or being told by telephone that the building is on fire, can all lead to similar behaviour, and this behaviour might be radically different if you believed yourself to be performing in a play at the time" (p. 43). According to Pylyshyn, it is essential for conceptual representations that the relation between stimuli and behavior is many to one (the same behavior can be produced by different sorts of stimuli), and that the kind of response to the perceptual input (e.g., the smell of smoke) depends crucially on "other sources of information" (e.g., whether you are informed that the smoke is only caused by a small and controlled fire which is part of a performance). It is precisely this possibility of the *modification* of a response in the light of additional information, called the "*transcendence of particular stimuli*" by Allen (1990), which ants are missing. For this reason, it is plausible to argue that they do not have the concept DEATH. Although we accept that stimulus independence in the sense of sensitivity of a cognitive system for more than one stimulus is a necessary condition for possessing concepts, we will argue that it is still not sufficient.

The plurality of informational input channels can lead to a reidentification of single objects without the ability to form classes of objects. The recent study of the collie Rico (Kaminski, Call, & Fischer, 2004) nicely illustrates that naming competence does not presuppose conceptual representations: Systematic tests show that Rico is able to understand 200 acoustic signals (“names”) of individual things, mostly toys and balls. Rico can bring an object when his owner utters the name Rico learned for it. Furthermore, it is shown that Rico can learn new names for new things by excluding the objects he already knows by name: To illustrate this, a new item was placed in a room together with seven familiar items. When a new name is introduced, Rico is able to bring the new object in seven out of ten cases. This shows that Rico can associate the new name with the new object by exclusion learning. It has also been shown that Rico can remember 50% of seven new names after four weeks. Our analysis of this astonishing performance runs as follows: Naming individual objects presupposes the identification and reidentification of objects on the basis of multiple stimulus generalizations, especially of smell and appearance. But discriminating individual objects is not the same as classifying them according to conceptual categories. Since Rico is dealing with names as acoustic signals of single objects we can exactly describe what is missing: If a cognitive system is able to deal with acoustic signals it should be able to have such signals not only for individual objects but also for classes of objects. In the case of Rico, it was not and—due to the *retirement* of the animal—can no longer be checked whether he is able to deal with signals of classes.[6] According to our analysis, identification and reidentification of single objects presupposes multiple stimulus generalization, but it need not include the competence to identify and reidentify classes of objects. But that is exactly the core competence that justifies the ascription of conceptual representations. What kind of representation underlies the latter competence? Can a cognitive system have such a competence without at the same time relying on a natural language that includes the normative dimension of concepts and beliefs, i.e., without having the dimension of correct or incorrect use of linguistic symbols?

3.2. The Normative Dimension of Conceptual Representations

Davidson (1999) is the most prominent representative of a negative answer. In the most radical form, as proposed by him, the normative dimension of concepts and beliefs seems to exclude nonhumans completely from possessing concepts and beliefs: According to Davidson, a person can have neither beliefs nor concepts[7] without having the concept BELIEF, and this means that the person must have some beliefs about beliefs, at least the most crucial belief that beliefs can be right or wrong:

> A person cannot just believe that he or she is seeing a cat: in order to believe this, one must know what a cat is, what seeing is, and above all, one must recognize the possibility, however remote, that one may be wrong. Some people suppose that

> a dog might have such an isolated belief, but it seems to me, for the very reasons I am now rehearsing, that dogs do not have beliefs, or any other propositional attitudes. They do not form judgments. (Davidson, 1999, p. 8)

However, even if we agreed that in order to believe one is seeing a cat, the person must know what a cat is (i.e., must possess the concept CAT), it is much more debatable whether the person must also know what a belief is (in particular, that beliefs can be right or wrong). We agree with Davidson's (1999) claim that "a creature does not have the concept of a cat merely because it can discriminate cats from other things in its environment" (p. 8). But Davidson does not present a convincing argument for the radical claim that a cognitive system must have the concept BELIEF in order to have any concept at all. Let us briefly summarize his main arguments and the replies (for an extended discussion see Glock, 2000): Davidson argues that to have a concept one must be able to "make sense of the idea of misapplying the concept." In order to have, for example, the concept CAT one must have the concept of applying the concept CAT correctly, and the concept of applying it incorrectly, i.e., to form a *false* belief by misrepresenting a thing as a cat.

Davidson is right in insisting that conceptual representations, like all cognition-based representations, presuppose the possibility of *misrepresentation*, but he is wrong in thinking that misrepresentations can only occur in cognitive systems in which the concept HAVING A FALSE BELIEF may occur. If all cases of misrepresentation were characterized as cases in which the concept of HAVING A FALSE BELIEF occurs, then representation would be restricted to cognitive systems with second-order conceptual capacities from the beginning. There is empirical evidence against the claim that having concepts presupposes having the concept BELIEF, including the capacity to ascribe false beliefs to others: Linguistic communication (including the competence of having concepts) is possible with young and autistic children who cannot ascribe false beliefs to others. A *fortiori* they do not have the concept BELIEF (they do not have a so-called "theory of mind": Baron-Cohen, Leslie, & Frith, 1985; Wimmer & Perner, 1983) and hence lack the concept ERROR —at least in the case of beliefs (Glock, 2000, p. 57). Davidson has stressed correctly that conceptual representations constitute a normative dimension. Since it is not constituted by having the concept BELIEF, the question remains: How is the normative dimension constituted?

Let us evaluate a proposal by Allen, who suggests that the normative dimension is introduced by special learning abilities of a cognitive system. According to his proposal (Allen, 1999, p. 37), an organism *O* can be attributed to have a concept *X* whenever:

(i) *O* systematically discriminates some *X*s from some non-*X*s; and
(ii) *O* is capable of detecting some of its own discrimination errors between *X*s and non-*X*s; and
(iii) *O* is capable of learning to better discriminate *X*s from non-*X*s as a consequence of this capacity (ii).

The statements (i)–(iii) do not claim to define concept *possession* but first of all to provide conditions for reasonably *attributing* concepts.[8] Nevertheless, we want to discuss these conditions as a systematic proposal in order to show that they—interpreted this way—are a good start but do not lead to an adequate set of criteria for concept possession.

A nice example of animal behavior fulfilling Allen's criterion (ii) for the possession of concepts is the alarm calls of vervet monkey populations, which Seyfarth, Cheney, and Marler (1980) examined in a 14-month field study in Ambroseli National Park, Kenya. The animals use different alarm calls when different predators—e.g., leopards, eagles, pythons, and baboons—are approaching. Thus, we may classify the alarm calls as leopard-alarms, eagle-alarms, python-alarms, and baboon-alarms. If a monkey gives an eagle alarm call, the vervets look up to the sky and escape, if necessary, into leafy bushes. Upon hearing a leopard alarm call, vervets flee to nearby trees where they are safe from leopards. This behavior indicates that criterion (i) is fulfilled. The monkeys are not only able to understand a certain alarm call (e.g., eagle-alarm) as a warning with respect to a special predator, but they also modify their reaction if some other stimulus appears in their proximity which indicates that the alarm call was incorrect (e.g., if there is an indication of leopards, but no further sign of leopards in the immediate environment). The authors comment that "the monkeys did make what might be termed 'mistakes', by giving alarms to non-predators that posed no apparent danger to them. Most 'mistakes' of this sort were made by juveniles and infants" (Seyfarth et al., 1980, p. 1071). We can interpret this behavior to the effect that some alarm calls are misrepresentations and can be discovered by the vervets as misrepresentations. Analogously, the monkey who calls the eagle alarm can modify it into a leopard alarm in the case of new evidence. Thus, criterion (ii) is fulfilled as well. In contrast, it is an open systematic question whether concept possession should presuppose capacity (iii), and it is an open empirical question whether the vervets have this capacity.[9] So we concentrate on criterion (ii) which introduces a very fruitful way of accounting for the normative dimension of conceptual representations.

Thus, Allen's more modest way of including normativity in his account of concepts seems to be preferable to Davidson's proposal. To clarify the comparison: Although both proposals include the idea of a capacity to recognize errors, Davidson's proposal implies that a cognitive system can only have concepts if it already has second-order concepts (at least) including the concept BELIEF; in contrast, Allen's proposal only presupposes an internal standard of comparison which enables the system to recognize and correct errors given additional inputs. It is empirically evident that animals are able to correct errors. The main empirical evidence of this competence is surprise behavior, which is a sort of behavior that can often be observed in animals (see Glock, 2000).

However, Allen's conception has to be weakened as well. According to him, the evaluation process that leads to a conceptual classification of the perceptual input must be able to register errors and hence has to be "a representation system that compares the perceptual content with an independent representation of what the perception is supposed to represent" (Allen, 1999, p. 39). Certainly, concepts are internal states including a representation of the "organism's world independently of its perceptual representation at any given moment" (p. 39). But such a representation does not have to be an "internal standard of comparison" for the perceptual input. It suffices that the internal states are such that they allow the systematic evaluation of different stimuli of the same object: The evaluation might rely on the influence of an alternative perceptual source, and this may lead to the correction of perceptual results obtained from another channel. In more elaborated cases there might also be a self-monitoring function which leads to the correction of perceptual results by means of some internal "standard." But, in contrast to Allen's condition (ii), we defend the intuition that the capacity of correcting one's own errors is not necessary for having concepts even if it may be sufficient: If conceptual abilities were performed on the basis of practically incorrigible perceptual comparisons (such that, for example, an animal cannot distinguish between two objects *being* the same and two objects *appearing* the same), the underlying representations may nevertheless be conceptual. In such cases we presuppose that the responses—to which the representations lead by triggering some ability—are not the result of a rigid stimulus-dependent causation, but come about by some sort of *evaluation process* performed on the perceptual input and governed by a (relatively) stimulus-independent mechanism, which extracts *classes* out of the perceptual data according to particular features instantiated by them.

In the next section we will introduce the features that constitute *the extraction of classes out of perceptual data*. Is it possible to describe paradigmatic animal behavior in detail that fits our intuitions about conceptual representations? Is there an animal that is indisputably able to:

- extract *classes* out of the perceptual data,
- use the underlying representations to trigger a flexible pattern of behavior, especially in new situations, and
- show surprise as a sign of registering misrepresentations?

4. Developing New Criteria for Having Concepts: The Alex Studies

The following case study is a central example of an animal that fulfils our criteria and should be classified as having conceptual representations. We begin with the intuition that the bird Alex has concepts and try to establish the general criteria for having concepts in accordance with this example and the discussion of the criteria presented so far. The underlying methodology is the following one: The case study provides impressive evidence for an animal's possessing concepts. On this basis we develop four criteria of concept possession. The empirical study has the advantage that the relevant criteria are already systematically distinguished and empirically investigated. The four criteria are then defended by arguing that they represent minimal criteria for having concepts on the basis of general considerations. This allows us to establish a standard for talking about concept possession that is independent of linguistic competence, and is empirically anchored; it also provides a way of characterizing an early stage in the ontogenesis of human beings that is prior to the development of linguistic competence.

Some of the most interesting material concerning our leading question can be found in the Alex studies of Irene Pepperberg (1999). Simple match-to-sample and non-match-to-sample experiments—which show whether an animal can choose something as being the same as or different from a given sample—are very difficult to evaluate with regard to whether the animal performs only on the ground of *stimulus generalization* or already displays the ability of *concept formation*. *Stimulus generalization is the process of generalizing stimuli into perceptual equivalence classes* such that responses to new stimuli may be based on the failure to discriminate between the reference stimulus and new stimuli (Pepperberg, 1999, p. 53). Do the animal's responses, for instance, show that it builds the class BIRD, or are its responses based simply on the presence or absence of beaks (p. 53)? In the light of these difficulties, Pepperberg decided to develop an experimental design that would allow more definite inferences concerning the conceptual abilities of animals:

> I needed to determine if he [Alex, an African Grey Parrot] could respond not only to specific properties or patterns of stimuli . . . but also to classes or categories to which these specific properties or patterns belong . . . Could he, for example, go beyond recognizing what is or is not 'green' to recognizing the nature of the *relationship* between a green pen and a blade of grass? (p. 52)

Recognizing the nature of this relationship results in having the concept GREEN by representing green as a color. In order to test Alex' conceptual abilities, Pepperberg had to teach Alex "... to recognize and respond differently to queries of 'What color?' versus 'What shape?' when presented with colored *and* shaped objects (e.g., a blue wooden square)?" (p. 54). Thus, Alex had to learn specific color labels and shape labels during learning sessions in which he could observe a human model responding to Pepperberg's queries. Occasionally, category labels (color, shape) were introduced during the sessions. In this way, Alex learned to respond correctly to the queries 'What color?' and 'What shape?'. By alternating the questions 'What color?' and 'What shape?' with familiar questions such as 'What's this?', a particular emphasis on the test objects or the test questions was avoided because this would have favored a rigid stimuli-governed conditioning. Also, by requiring that the same object would have to be categorized with respect to color in one test and with respect to shape in another, Alex was forced to attend to the *type* of question the trainers asked.

In 170 tests on the queries 'What color?' and 'What shape?' some new objects and unlearned colors and shapes were introduced. Alex had to respond to objects that embodied five different colors, four different shapes, and three different materials. His accuracy was better than 80%. Pepperberg comments as follows:

> These results suggested that Alex had mastered the task I had devised. After viewing an item that could be described with respect to color *and* shape, he could

> determine from our question which category was being targeted, and then produce, based on this question, the appropriate instance of the category. (p. 58)

According to our view, the most important aspect of this study is that it clearly shows that the animal is able to represent the same property while dealing with different objects and is also able to represent different properties while having only one and the same visual input of an object. The animal is able to deal with a systematic object-property-representation and this seems to be the core basis for any conceptual representation. To focus on this capacity is fruitful because it is carefully investigated in the human ontogenesis by developmental psychology. This provides us with an empirically useful criterion.

To verify that Alex had learned to *understand* categorical labels, it was particularly important that he was able to switch back and forth numerous times while correctly classifying the same object (e.g., a blue wooden square) according to its color and its shape. Based on Alex's possession of these categories, Pepperberg proceeded to test the capacity to classify properties according to sameness and difference. In contrast to pure match-to-sample experiments which can only test abilities of responding to overall perceptual similarity/difference of a visually presented object against some sample (and perhaps the transfer to novel sorts of similarities), Pepperberg presented a test that presupposes the ability to identify sameness and difference *in a particular respect as opposed to another*:

> Alex would be presented with two objects that could differ with respect to three categories: color, shape, or material . . . He would then be queried "What's same?" or "What's different?" The correct response would be the label of the appropriate *category* . . . Therefore, to be correct, Alex would have to (1) attend to multiple aspects of two different objects; (2) determine, from a vocal question, if the response was to be based on similarity or difference; (3) determine, for the items he was shown, what was "same" or "different" . . . and then (4) to produce, vocally, the label for this particular category. (Pepperberg, 1999, p. 66)

By some very careful methodological precautions, Pepperberg excluded the possibility that Alex produced his reactions only by activation of some memory traces of the learning sequence. For instance, the test was designed so as to alternate the questions 'What's same' or 'What's different' with some questions of quite different dimensions, e.g., 'How many?', 'What color?', 'What's this?' etc.; thus, Alex was forced to focus on the particular *content* of the corresponding question, and he would have to switch among different stimulus domains. Furthermore, the test also included entirely new tokens of colors, shapes and materials which were unknown to Alex. Therefore, Alex would have to recognize that two novel objects, for example, "differed with respect to the category 'color' even though the colors were untrained and the specific combinations of color, shape, and material for each item, as well as for the pair, had never before been seen on a test" (Pepperberg, 1999, p. 68). Thus, Alex would have to apply his conceptual abilities right from the start in every instance, without being able to rely on former objects, labels, or his own former responses. The guiding intuition is that concepts are at least partly interconnected such that in order to have one concept you should have a minimal semantic net including that concept: To have a concept of red, a cognitive system must have a stable property representation not only of being red but also of at least one further (contrast) color. Additionally, it must have at least two further property representations of a different dimension, e.g., being round (belonging to the dimension shape) and the contrast property of being square. Again, these criteria do not presuppose a human natural language competence. The criteria count as satisfied if the behavior of a cognitive system can be explained in the most fruitful way by attributing the cognitive abilities described above.

Alex's test scores are impressive, particularly when he performed with novel objects, indicating his ability to transfer his knowledge to new situations (scores of 85% on all trials, 82.3% on first trials). Given the methodological precautions taken in the tests, these results indicate that Alex learned to react by using concepts and not simply on the basis of perceptual similarity or of acquaintance with the objects presented.

It is important to note that the criteria are not only useful for animals which are trained to deal with linguistic symbols. We will argue in the next section that conceptual representations can be found in animals if their behavior is such that the best way to describe it presupposes an object-property representation (reidentifying objects and distinguishing different properties of one and the same object), a relative stimulus-independence of the representation, as well as a systematic connection of representations in a minimal semantic net. This can be tested without using linguistic symbols and it can be realized in animals that do not have linguistic symbols.[10]

5. Kinds of Representations: Nonconceptual, Conceptual and Propositional

According to the conception developed in this paper, possession of concepts is not an either–or question, but something that develops gradually. So, in practice we will have many borderline-cases where we cannot decide whether the conditions of concept possession are already satisfied. Nevertheless, we shall try to characterize adequate criteria for having concepts in a full sense. Starting from this general background, three different kinds of cognitive capacities can be distinguished constituting *nonconceptual representations*, *conceptual representations* (or concepts) and *propositional representations*.

Before characterizing these forms of representation in detail, we want to exclude *noncognitive* information processes. These are defined as processes which do not involve minimally stable representations. Although these representations may be initiated by some key stimulus to trigger a behavioral reaction, they are essentially unstable. This can be illustrated by an example: Sea bacteria have the ability to discriminate water regions with high oxygen concentration. This capacity is always initiated by one kind of physical stimulus and always immediately produces the same standard behavioral result, i.e., moving in the direction of high oxygen water. But there is no stable representation involved which is established in one context and can be used in a different context. In contrast, the homing behavior of an ant is realized by *cognitive* information processes. The interesting phenomenon is that an ant is able to go back to its nest in a straight line after a relatively long and unsystematic search for food on a tortuous path. The spatial orientation of the ant is based on registering the position of the sun and registering the movements of its own legs. The combination of both indicators enables the ant to register its spatial location relative to its nest. Furthermore, the ant builds a stable representation. If you transfer the ant to a new location at the moment it finds some food, it will start to run in the direction that would have been the right one given its previous location. The representation of the location relative to its nest that is built in one context is also used in a new context eventhough it leads to an inadequate result. This indicates that the ant has built a stable representation of its spatial relation to the nest. For further illustration of the difference between noncognitive and cognitive information processing, consider the rigid behavioral routine of the wasp *Sphex*. This example illustrates that even complex routines can be noncognitive:

> . . . the Wasp's routine is to bring the paralyzed cricket to the burrow, leave it on the threshold, go inside to see that all is well, emerge, and then drag the cricket in. If the cricket is moved a few inches away while the wasp is inside making her preliminary inspection, the wasp, on emerging from the burrow, will bring the cricket back to the threshold, but not inside, and will then repeat the preparatory procedure of entering the burrow to see that everything is all right. (Wooldridge, 1963, p. 82; as cited in Dennett, 1984, p. 11)

The wasp Sphex continuously repeats this behavior rendering it senseless, even though the routine is part of an evolutionarily very important and effective process[11] as becomes clear when the process is not interrupted. This example illustrates that the behavior is noncognitive although it is a complex routine. The important feature rendering it noncognitive is that there is no new stable representation established during the behavior. Only a rigid program that can be restarted at different stages is triggered.[12]

Thus, the central criterion for cognitive information processing is that the behavioral system is able to build a new stable representation during the behavioral process. Furthermore, although the homing behavior is rather flexible compared to the behavior of sea bacteria, it is nevertheless essentially dependent on key stimuli and is not based on the capacity of object identification. The lack of object representations is the main reason to claim that, in the case of the ant, the underlying representation is only a nonconceptual one, a stimulus generalization creating an input-dependent stable representation on the basis of key stimuli.

Conceptual representations gradually emerge on the basis of nonconceptual representations. Conceptual representation systems must have at least three features: (1) the capacity to identify and reidentify objects and properties, (2) the (relative) independence of stimuli, and (3) the fact that an adequate level of abstraction is involved in the classification (a classification that is not only based on the simple stimulus generalization, which is characteristic of nonconceptual representations, but involves class formation). This fact implies the existence of minimal semantic nets.

In order to define the possession of concepts in more detail, we start with some common sense intuitions: A concept is used to classify an object as having a property—this seems to be true at least for concepts based on standard perception in everyday situations. Therefore, a conceptual representation involves object identification (or reidentification) and the differentiation of a property belonging to that object. To develop the conditions of having a conceptual representation in more detail, the example of the concept RED is used. A cognitive system can have the concept RED only:

C_1. If the system has a stable representation of the property of being red while dealing with very different red objects, and

C_2. If the system can not only represent the property of being red but also some other properties of the same object.

The underlying intuitions are the following: If a system can only represent the redness of one kind of object—e.g., of cars but not of tables, chairs, houses, etc.—then it is not able to classify the property of being red, and can only discriminate red-car-situations. Furthermore, if the cognitive system can only discriminate the property of redness of a car but cannot distinguish some other property of the same object—e.g., having wheels, having a special form, being (mainly) made of metal—then it makes no sense to claim that the system is able to classify an object. A fortiori it cannot represent red as the property of that object but only the appearance of a red-situation. Although the system may be able to discriminate red-situations from non-red-situations, this is not sufficient for having the capacity of classifying objects as being red but only for detecting redness when involved in certain situations. While a nonconceptual representation of redness is already employed by a detection mechanism that can distinguish situations involving redness from situations that do not, a conceptual representation additionally involves object and property identification such that the object is classified as being red (besides having other properties).

Although conditions (C_1) and (C_2) are necessary, they are not sufficient. There are two further intuitions: Concepts can be used in new situations and they are at least partly interconnected such that there is not only represented one relevant property but at least some contrasting properties. To account for that we have to add two conditions: the idea of relative stimulus independence and the idea of an interdependence of concepts constituting a minimal semantic net. A cognitive system can have the concept RED only:

C_3. If we have relative stimulus independence such that it depends on some additional mechanism—which detects and weighs stimuli other than the key stimulus of redness—to determine that the system focuses on redness while perceiving a red square, in contrast to some other property; a relevant independent stimulus could be, e.g., a learned acoustic signal which demands focusing on the color instead of the shape of the object; and

C_4. If the property of being red is represented in a minimal semantic net: the property *red* is represented as an instance of the dimension color—not as an instance of an incorrect dimension (e.g., danger).

The fact that a property is represented in a system "as" an instance of a (different) higher-level property is a special case of realizing the fact that the cognitive system has a minimal semantic net such that each cluster of properties constitutes a conceptual dimension which may be called a conceptual space (Gärdenfors, 2000). A sufficient behavioral criterion demands that the system be able to recognize sameness or difference of perceived objects with respect to the relevant higher-level property. The correct instances–dimension relation is partly constituted by the interdependence with other categories in a minimal semantic net.[13]

Condition (C_3) is based on the intuition that a conceptual representation can be used in novel situations with a variety of stimuli. Conceptual representations therefore have to be stimulus-independent at least in such a way that the cognitive system can learn to introduce a neutral signal as an important part of a complete stimulus of the relevant representation. Furthermore, the final condition is based on the intuition that it is not adequate to speak of a concept *F* unless there is a categorization of the relevant property of being *F* in a minimal semantic net determining an adequate integration and separation of *F*. The property *red* has to be represented as an instance of the category *color*, being categorically different from other categories (e.g., *shape*, *material*, and *location*). If the property of redness is adequately distinguished from other properties while dealing with different objects, and the cognitive system is not able to classify the cases of redness *as instances of the dimension of color* (yet recognizes them as instances of, e.g., red-object-attacks), then this is not a conceptual representation of redness but of red-object-attacks. This criterion is a requirement that takes an important intuition from the philosophy of language into account: To have a concept of red, a cognitive system must have a representation of the extensional as well as the intensional features of the concept of redness. The central intensional feature of redness is the fact that it is part of an adequate minimal semantic net determining it to be an instance of the dimension color.

There is an additional argument for (C_4) being a necessary component of an adequate definition: Relying only on criteria (C_1)–(C_3) leads to the representational competence of naming individuals which is clearly distinct from and not sufficient for having concepts. Empirical evidence for naming competence in the realm of animals has been presented above by the story of the collie Rico (Kaminski et al., 2004). Our analysis of Rico's astonishing performance runs as follows: Naming individual objects presupposes the identification and reidentification of objects on the basis of properties. Although the tests that have been made with the dog so far do not show that the dog's performance relies on the capacities described in (C_1) and (C_2), it is nevertheless plausible to presuppose that Rico fulfils these conditions. For the sake of argument we are simply presupposing that the dog has an object-property-representation as demanded in conditions (C_1) and (C_2). The relative stimulus independence described in (C_3) is clearly fulfilled because the utterances of the owner are neutral stimuli that the dog can understand in order to single out one familiar object out of a group of ten which are given as basic sensory stimuli. The important point is that there is no evidence to support, and it is unnecessary to assume, that the dog's naming competence relies on condition (C_4). Naming individual objects does not presuppose that the object can be classified under conceptual categories. It is sufficient if the object can be discriminated from others by relying on stimulus generalization. Discriminating individual objects is not the same as classifying them according to conceptual categories. What is missing is the cognitive capacity characterized in condition (C_4): To classify objects under a perception-based concept, a cognitive system must be able to classify objects according to a property which itself is represented as belonging to a minimal semantic net, e.g., the property red must be represented as a color distinct from blue and yellow. It is constitutive for a concept that there are at least some relevant "contrastive concepts", which are constitutive for each of the concepts. Concepts only evolve in a minimal semantic net by classifying the objects in contrastive classes.

To outline our general view, we continue by briefly characterizing propositional representations as a distinct higher-level class of representations. Representations are *propositional* if they are constituted by the combination of at least two concepts and if they are strongly stimulus-independent. While a classification of a perceptual input by one concept—according to the conditions described above—is a conceptual representation, a propositional representation is based on the combination of at least two concepts (and these are concepts which are not related to each other in the way a dimension/determinable and its instances/determinates are): The combination of the concepts RED and BALL constitutes the compositional representation that the ball is red.[14] An additional feature must also be satisfied to make it a paradigmatic case of a propositional representation: the *strong stimulus independence of the representation*. This feature is closely connected with the so-called "Generality Constraint" (Evans, 1982):

> If a cognitive system has two concepts *F* and *G* and can represent two objects o_1 and o_2 then it is able to classify (a) object o_1 as having the property *F*, (b) object o_1 as having property *G*, (c) o_2 as having property *F*, and (d) o_2 as having property *G*.[15]

If a cognitive system is able to represent the fact that the ball is red on the basis of perception, and if it has the concepts BLUE and YELLOW at its disposal, then it must also be able to represent that the ball is blue, as well as that the ball is yellow, even if it is neither the case that the ball is yellow nor that the ball is blue. If the other systematically possible representations can only be formed when the relevant perception is available, then the representation is not propositional. This kind of stimulus dependence is evidence that the cognitive system does not have a structured representation relying on two concepts, but only an unstructured representation of the perceptually given situation.[16] Propositional representations are defined as a combination of at least two concepts (not related as dimension and instance to each other) while the composition of the concepts is systematic (according to the generality constraint), productive (it can be used to produce new combinations) and independent of any characteristic stimuli (strong stimulus-independence). Although there is no agreement about defining a basic natural language, we suggest that just these criteria can be used for a minimal definition of a basic natural language: A system of symbols constitutes a basic natural language if the symbols are conceptual representations and if they are combined according to the principles of compositionality, systematicity and productivity and if, furthermore, the symbols are usable independent of any characteristic stimuli. We are not arguing that these criteria are sufficient but it is obvious that they are at least necessary and central criteria for a basic natural language (Fodor, 1987). Propositional representations are part of a symbolic system that at least satisfies the central criteria of a basic natural language and may constitute one.

Let us summarize the varieties of cognitive representations: First, there are nonconceptual representations, which are constituted by stimulus generalizations but remain strongly stimulus-dependent. Second, there are conceptual representations, defined by the four criteria presented above, i.e., essentially involving an object-property-structure, a relative stimulus independence as well as a minimal semantic net. Finally, there are propositional representations that can be characterized by a composition of concepts enabling an animal to entertain and re-evaluate persisting beliefs.

6. The Advantages of the Theory

6.1. Evaluating Case Studies

After this outline of propositional representations, we would like to evaluate the central proposal concerning conceptual representations. The main advantage of the proposal is that we have a clear characterization of conceptual representations which is independent of specific human capacities such as having a natural language. This satisfies a requirement of cognitive biology and allows us to study the questions (1) whether animals are capable of having concepts and (2) whether computers or robots are capable of having concepts.

The criteria are such that the grey parrot Alex can be characterized as having concepts: He is able to discriminate the property of being red in very different objects, while also being able to distinguish different properties of one and the same object, e.g., being wooden, being a square. The condition of relative stimulus independence is fulfilled because the representation is no longer simply triggered by perception. To characterize Alex's representation of being red and his correct vocalization we cannot simply rely on the perceptual presentation of the red object. We have to add the question 'What color?' Without the question, the parrot does not know which property we expect him to focus on. This additional neutral stimulus is essential for triggering the representation of redness. Finally, Alex is representing red explicitly as an instantiation of the dimension color, which he at least distinguishes from shape and material. This is demonstrated by the fact that Alex has acoustic labels for the categories *color*, *shape*, and *material*. The representation of red is part of a minimal semantic net distinguishing different color representations, shape representations and material representations. Therefore, Alex has the concept RED.

Our criteria are not adequate to decide whether Alex has the concept of color itself. We suggest that this is not a primitive perception-based concept but is a concept based on the availability of propositional representations (see §5). I will call this sort of concept a *sentence-based concept* in the following. In order to have them, one must be able to represent information in a sentence-structure including implication relations. This constitutes the difference between concepts which are perception-based (like RED) and concepts which are sentence-based (like COLOR). So far, we have no sufficient evidence that Alex is able to build representations with a sentence-structure. Probably, he does not have the concept COLOR.

For the same reason, he definitely has neither the concept SAMENESS nor the concept of DIFFERENCE[17] nor the concept PROPERTY. According to our theory, it is clear that, e.g., he does not have the concept PROPERTY because then he would need to be able to distinguish properties from objects and events to have an adequate minimal semantic net. Here, it seems rather clear that in order to have such complex concepts, a cognitive system must have special propositional knowledge. This implies that such complex notions can only be learned in a holistic way by acquiring the relevant propositional knowledge.

Since the criteria for having concepts are essentially inspired by Alex's case study, it is not surprising that he fits the criteria. But, as we have noted before (see §4), it is important to notice that the criteria are not only useful for animals which are trained to deal with linguistic symbols. In the animal kingdom you find many communicative interactions which are essential for arranging sexual exchange and group organization. Nevertheless, often these communicative interactions are only constituted by simple S-R mechanisms not involving conceptual representations. We have characterized propositional representations roughly as systematic combinations of conceptual representations and we illustrate in the following that the bonobo Kanzi has propositional representations. There is even evidence that his symbolic system is a basic natural language.

The bonobo Kanzi learned many (roughly 250) abstract symbols (Savage-Rumbaugh et al., 1998, p. 63) and is able to use them in new situations and to combine them in new ways that he has not been taught before. By using combined symbols, Kanzi is able to describe events that took place in the morning when the listener was not there and able to clearly express a desire, e.g., to walk through the forest by taking a specific route. He learned 16 symbols for places in the forest and is able to use them for describing the route which he wished to take.

> After all, Kanzi had learned to comprehend and use printed symbols on his own without special training. He had also learned to understand many *spoken* words, even though he himself could not speak. He knew that words could be used to communicate about things he wanted or intended to do, even though those actions were not happening at the time of the communication. He could also purposefully combine symbols to tell us something (for example, something that had happened earlier in the day, when we were not present) we would have had no way of knowing otherwise. He recognized that two symbols could be combined to form meanings that neither symbol in isolation could ever convey. He used this skill to

communicate completely novel ideas that were his own and had never been talked about with him. (Savage-Rumbaugh et al., 1998, p. 63)

There is some debate as to whether the description of Kanzi's capabilities is adequate since many of the described observations are not the product of systematic tests but rather of individual observations. Assuming, however, that the description of Kanzi's capabilities is essentially correct, Kanzi is a paradigmatic case of an animal that has propositional representations because he has conceptual representations (which can be verified by his capabilities) and he produces compositional representations for describing events or for expressing his desires. Moreover, there is evidence that his symbolic system forms a basic natural language, partly because he can understand human natural language to a remarkable degree.[18] If we accept the empirical description of his capacities, then his case indicates that basic propositional representations seem to be essentially connected to basic natural language understanding.[19] Nevertheless, conceptual representations as well as nonconceptual ones remain independent of linguistic competence.

It is in agreement with our intuitions that Alex can be characterized as possessing conceptual representations and Kanzi as having propositional representations, and that both kinds of representations can be distinguished from nonconceptual representations. Furthermore, we can account for many important and complex types of behavior in biological systems. Sometimes this seems to be based on cognitive information processing, however, it can be shown to be based on noncognitive processes alone—e.g., the spatial orientation of sea bacteria and the complex behavior of the wasp *Sphex* while preparing a nest for its eggs. Our theory can account for the assessment that in these cases it only appears as if complex cognition is present, while in fact merely noncognitive processes are executed. Yet these noncognitive processes can be distinguished from cognitive processes involving nonconceptual representations, such as those underlying the homing behavior of ants by which a stable representation is established.

Furthermore, if a robot had the same capacity as the parrot Alex, it would not make sense to claim that Alex has concepts but the robot does not. Such a claim could only be defended on the basis that Alex is a biological system and that the robot is not. This seems to be a consideration based merely on prejudice.

6.2. Searching for the Minimal Level of Concepts

The ascription of conceptual representations would be superfluous if we were able to explain the behavior of cognitive systems without relying on the possession of concepts. Therefore, it is inadequate to speak of concepts on the level of rigid representational mechanisms. The explanatory value of such a use of concepts—let us call it the *nomic theory of concepts*—is not very high because they can be substituted by nomic mind–world relations which we use anyway in theories of sensory discrimination.[20] Therefore we had to look for more demanding criteria. Peacocke's criteria (1992) are too strong. He connects the possession of concepts with the possession of a representational structure as rich as natural language. All concepts would be sentence-based (thought-based) representations. There is empirical evidence that perception-based concepts are more primitive in structure and that it is fruitful to speak of perception-based concepts in explaining animal behavior. Furthermore, Carey (1985) and Keil (1989) claim that concepts are mini-theories or constituents of mini-theories. But this view leads to an infinite regress: How are concepts related to mini-theories? Of course, we must already have concepts to have a mini-theory. We do not find a plausible answer to the question of how to define the possession of concepts in the recent debate.

We want to suggest a middle way between the nomic theory and Peacocke's position: Concept possession presupposes a representational capacity that involves distinguishing stable objects with varying properties and a capacity of generalizing and systematizing the categorization (stimulus generalization, registering the relevant dimension, having a minimal semantic net). This level is the intuitive *locus* of conceptual representations and this level is of particular explanatory interest: Theories of perception-based concepts can explain a level of representation that is more elaborated than perceptual discriminations and more basic than language(-like) representations.

So far, we have presented criteria for the possession of perception-based concepts. Now, we will shortly outline how these concepts are related to all the other concepts we have. On the basis of perception-based concepts, humans have established sentence-based concepts, e.g., logical concepts like AND and OR. You can only have one of these concepts if you are able to deal with sentences involving them and draw correct inferences. Furthermore, we can distinguish theory-based concepts like ATOM and ELECTRON. One can only possess such a concept if one associates some mini-theory with the category (even though such a mini-theory may contain false beliefs). Acquiring concepts from an ontogenetic as well as from a phylogenetic perspective is a process of first acquiring perception-based concepts, then sentence-based and finally theory-based concepts. This multiple-level view of concepts is an essential feature of our view that is radically different from the theory of concepts proposed by Jesse Prinz (2002). He claims that "concepts are proxytypes, whereas proxytypes are perceptually derived representations that can be recruited by working memory to represent a category" (p. 149). One core feature of this view is that all concepts are perceptually derived. This is a very implausible claim: it leads to the consequence that negation is not a concept at all since it has to be explained as "a special way of measuring similarities between sets of features" (p. 183). Prinz, of course, has the same problems that Hume had explaining the concepts EXISTENCE, CAUSATION, QUANTIFICATION, etc. According to our view, what Prinz illustrates in his chapter 7 is a perception-based concept (e.g., SIMILARITY OF FEATURES with respect to the perception-based concept REGULARITY) which is the precursor of the theory-based concept NEGATION with respect to CAUSALITY.

Finally, it can be argued that our distinction between perception-based concepts, on the one hand, and theory-based concepts which are defined by their role in public language, on the other, helps us to explain the semantic flexibility of some words. We can easily understand the following utterances: 'Walfische sind keine Fische', 'Vegetarian sausages are not sausages', 'Some women [transvestites] are not women'. Why are none of these utterances contradictory? We can now offer the following explanation: The underlying structure is always the same. The claim is that the objects falling under a perception-based concept are not part of the extension of the theory-based concept.

7. Replies to Prima Facie Criticism

We face two related paths of criticism: The first concerns whether our theory creates an infinite regress by claiming that having a perception-based concept C requires having the capacity to discriminate the higher-level (relevant) dimension (or category) D_1 from other dimensions D_2, D_3, etc. To illustrate the point: To have the concept RED, a cognitive system must be able to discriminate the relevant dimension of color from space, material, etc., because our theory demands that it represents redness as a color by constituting an adequate minimal semantic net. We have already argued that discriminating color and material does not imply possessing the concepts COLOR and MATERIAL. Is there still a threat of an infinite regress?

No, because our theory is only a theory of perception-based concepts. Abstract concepts, such as PROPERTY, EVENT or OBJECT cannot be and need not be characterized by the discrimination of a dimension. Sometimes they do not have any dimension, e.g., the philosophical concept ENTITY. In general, abstract concepts need no dimension because we can presuppose that a cognitive system already has many concepts based on perception. Abstract concepts can then be introduced via propositional representations that are based on the concepts the system already possesses. A system has a relevant abstract concept if it has mastered most of the characteristic propositional representations. The abstract concept is determined by some holistically interdependent propositional representations.

Prima facie, our theory seems to imply that the object–property distinction is relevant for all conceptual representations. This seems to be implausible because some concepts seem to classify events (or other entities). We reply to this in the following way: (a) perception-based concepts can classify events but these can also be adequately characterized as a classification of some related objects;[21] (b) the concept of an object is sometimes determined by holistic propositional representations—as mentioned above—and, in general, most scientific concepts are determined in this holistic way. Our theory accounts for this fact by granting that it only describes the basic conditions for having perceptually based concepts. All the other concepts we possess are developed on the basis of a corpus of perceptually dependent concepts by introducing holistically interdependent propositional representations.

Furthermore, it may be argued that these criteria are only usable for linguistically competent animals like Alex and Kanzi. But, as we already mentioned above, this is not true: The theory demands that to have the concept RED, a cognitive system must not only be able to *discriminate* red objects but must also be able to *discriminate* the category of color itself. The ability to make this discrimination neither includes linguistic competence nor the possession of the concept COLOR. Any behavioral competence which demonstrates that the cognitive system not only distinguishes instances of colors, but also discriminates the category *color* from the category *material* is sufficient to show that the fourth condition of concept possession is fulfilled. Let us return to the vervet monkeys. So far, no systematic test has been conducted to explore whether they have stable representations of objects and properties. But this is not so important. The relevant entities in this case are not objects and properties, but *events* and properties. The monkeys are able to discriminate types of events and to make the adequate alarm calls and the other monkeys respond appropriately to different types of alarm calls without seeing a predator. First, this gives evidence for a stimulus-dependent ability of the monkeys to discriminate between different sorts of situations that require distinct behavioral responses. But the response behavior of the animals has been observed to depend on further "neutral" stimuli like the caller's reliability; for instance, there is significantly more attendance to the calls of older, experienced animals (Seyfarth et al., 1980). There is even evidence that alarm signals can be used for deception in rare cases: When two groups of vervets were in a territorial fight and one was about to lose, a member of the inferior group gave a leopard-alarm, with the consequence that the fight was immediately terminated and the territorial hierarchy of the groups remained unchanged. These cases nicely demonstrate the stimulus-independent use of alarm calls and the best way to describe their behavior is to presuppose that they systematically classify events according to the properties involved. Since their alarm system constitutes a minimal semantic net we have some evidence that they have the perception-based concepts EAGLE-ATTACK, LEOPARD-ATTACK, PYTHON-ATTACK, and BABOON-ATTACK. An important generalization here is that the first two conditions of concept possession may not always involve an object–property structure but sometimes an event–property structure.

Last, but not least, worries arise that animal concepts are principally different from human concepts, and that we are relying on an uncritical and problematic anthropomorphism when ascribing our concepts to animals. First of all, we are defending an epistemic theory of having and ascribing (perception-based) concepts by presupposing that we already have the adequate candidate for concept ascription. We are not discussing the question which of two closely related concepts can be ascribed to an animal, but whether an animal displaying systematic and complex behavior has concepts at all. Secondly, we admit that we must be careful in ascribing human concepts to animals. Whether this is adequate or not is an entirely empirical question: If we have evidence that the perceptual system of an animal is organized very similarly to ours, then it is plausible to ascribe our concept RED to it as long as its behavior supports the assumption that the animal is making this classification, thereby relying on the criteria of having concepts that were developed above. On the other hand, given our ability-based approach of concept possession, it seems to be very unlikely that even different human beings share exactly the same concept RED. Thus, to speak of "our concept RED" can be understood only with a grain of salt.

8. Generalizing the Theory for Perception-Based Concepts

We can summarize our theory of concepts by generalizing the conditions a cognitive system must satisfy in order to have *perception-based conceptual* representations: A cognitive system has a representational concept of the perception-based property A_1 if and only if:

(i) the system has a stable representation of A_1 while dealing with very different objects (or events);
(ii) the system represents not only the property A_1 but also some (but at least one) other properties, $A_2, \ldots, A_n$, of the same object (or event)—while the other properties are not the dimension or general categories under which the property A_1 can be subsumed;
(iii) there is a relative stimulus independence such that the representation of A_1 is not automatically produced by characteristic stimuli, but rather that the information processing that depends on learned neutral stimuli and which is started by the perception of an object having property A_1 can produce a representation which focuses on another property of the perceived object; and
(iv) the property of A_1 is represented in a minimal semantic net, i.e., the content of the representation is partly constituted by the relevant interrelations with other property representations. In some cases this is can be spelled out as demanding that A_1 is represented as an instance of the correct dimension/determinable *B*—not as an instance of an incorrect dimension.

With this theory of concepts in hand, we conclude that some animals have concepts. Moreover, we are able to systematically investigate and answer the question whether nonlinguistic cognitive systems such as young children or robots have concepts.

Notes

[1] Peacocke (1992) labels this the "principle of dependence." It is a general methodological principle that is motivated by an analogous view on meaning which relies on understanding: "As a theory of meaning should be a theory of understanding, so a theory of concepts should be a theory of concept possession" (p. 5).
[2] From our point of view, it is inadequate to assume that a thermostat has concepts because it would be completely superfluous for the explanation of its behavior. It can be explained entirely by simple mechanisms including representations of the external world but without presupposing any concepts that characterize the content of these representations. To suppose concepts in the case of thermostats is just as inadequate and superfluous as it would be to try to explain the fact that a table remains in the middle of the room by assuming that it has an intention to do so.
[3] Since the representational content is often context-dependent we implicitly assume that representational contents are defined by functional roles in the relevant contexts.

The question of the context-dependency of representational contents will not be discussed in this paper.

[4] The fact that the content is causally relevant seems obvious because the bird does not only have representations of Monarch butterflies but also of other kinds of butterflies.

[5] By referring to Pylyshyn's account of plasticity, we do not subscribe to his general account of cognition as symbol manipulation.

[6] According to personal communication with Julia Fischer, one of the leading experimenters dealing with Rico, there was only one test in which they started to deal with categories. This unpublished test gave evidence that Rico was principally able to learn the categorization of balls as a class even if the dog seems not to rely on this more complex ability when he identifies single objects.

[7] According to Davidson, one cannot have a concept without having a belief, since concepts come only as parts of beliefs.

[8] "Meeting conditions (i)–(iii) above may provide good grounds for attributing concepts to animals, even though these conditions need to be neither necessary nor sufficient for concept possession" (Allen, 1999, p. 37).

[9] Although improvements in the accuracy of the alarm calls during the development of vervets have been observed, it is an open question whether these are caused by a capacity to detect their own discrimination errors.

[10] It is possible to test different levels of discrimination competences without using acoustic labels. In the first part of a test, monkeys were shown a pair of objects (e.g., two identical cups). Then they were shown two pairs of objects, one identical with the first pair and a different pair (e.g., two identical balls). By giving positive or negative feedback, the monkeys can be easily trained to always discriminate the identical pair of objects but also to always discriminate the different pair of objects. In a more advanced test, they were shown first either a pair of two identical objects representing the sameness relation (two identical cups) or a pair of two different objects representing the difference relation (a ball and a shoe). Then they were shown two pairs of novel objects, e.g., two identical puppets and a second pair consisting of a puppet and a radio. The monkey then had to choose which pair of objects is also representing the sameness relation (or the difference relation) as presented in the first case. This kind of strategy was also used to illustrate that monkeys can be trained to distinguish food and nonfood on the conceptual level because they have to evaluate a banana and an apple as instantiating sameness (belonging to the same category) but banana and cup as instantiating difference (belonging to different categories). These kinds of tests nicely allow us to distinguish perceptual sameness/difference from conceptual sameness/difference (Bovet & Vauclair, 2001). In an analogous line of nonlinguistic tests, it can in principle be checked which discrimination abilities a cognitive system has.

[11] The wasp—not being disturbed—"drags the cricket in the burrow, lays her eggs alongside, closes the burrow, and flies away, never to return. In due course, the eggs hatch and the wasp grubs feed off the paralysed cricket" (Wooldridge, 1963, p. 82).

[12] In recent work it is questioned whether the description of the behavior of the *Sphex* is adequately evaluated as a rigid behavioral program (Keijzer, 2001). But even if that example cannot play its role here the general idea is clear enough.

[13] One can also characterize these interrelations by inferential relations, e.g., what is green is not red. But of course a cognitive system having perception-based concepts need not be able to construct explicitly such propositional inferences as indicated above. These inferential relations are implicit in the representation of properties as belonging to the same dimension. Concerning the distinction of implicit and explicit representations see Dienes and Perner (1999).

[14] According to this definition, the classification adequately expressed by the demonstrative utterance 'This is a ball' is only a conceptual but not a propositional representation. This seems implausible at first glance because the philosophy of language defines

propositional contents as contents of that-clauses. Looking at the mental representation, this is no longer implausible. The classification of an object as a ball relies—in the basic case—on a sensory representation of the object and the conceptual representation of the property *being a ball*. The sensory representation is not already a conceptual one. To put it in other words: A demonstrative identification is not per se a conceptual one. Therefore, the utterance 'This is a ball' is an adequate expression of a conceptual representation (but not a propositional representation) in such a basic case of mental fixation of the reference.

[15] The classifications may only be available in different situations but, nevertheless, they are in principle available (Newen & Vogeley, 2003, p. 534).

[16] We only mention that we additionally distinguish metarepresentations, i.e., a representational form that includes an intentional system, an attitude and a propositional content. Metarepresentations have the logical structure that is necessary for an explicit representation of propositional attitudes. Although there is a debate on whether or not animals have metarepresentations, there is no conclusive evidence available at the moment. It is only clear that normal four-year-old children are able to use metarepresentations. In this paper we are not contributing to this debate concerning theory of mind (instead, see Newen & Vogeley, 2003).

[17] Here our evaluation differs from that of Pepperberg (1999), who claims that the capacity of answering the questions 'What's same?' and 'What's different?' implies that Alex has both concepts (p. 64).

[18] Kanzi is able to understand complex unusual and untrained sentences like 'Can you put the ball on the pine needles?' His understanding was tested by presenting him many things including a ball and pine needles and Kanzi was able to do what he was expected to do (Savage-Rumbaugh et al., 1998, pp. 58–62).

[19] We suggest that a basic natural language competence is defined by using stimulus-independent representations that can be systematically combined such that compositionality, productivity and systematicity are fulfilled.

[20] Despite important differences, Barsalou (1999), Fodor (1998), and Prinz (2002) offer theories of concepts which essentially rely on nomic mind–world relations. These theories therefore have the disadvantage mentioned above.

[21] The concept EXPLOSION as a type of event is equivalent to the concept BEING AN EXPLOSION used to classify situations which can be treated as complex objects.

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