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Monsieur le Représentant du Ministre de la Recherche et de l'Enseignement Supérieur
Madame le Président,
Messieurs les membres du Conseil d'Administration et du Conseil Scientifique,
Chers Amis, Chers Collègues,
Mesdames, Messieurs,

WHY ARE PEOPLE SMARTER THAN ANIMALS : OBJECT, CAUSE AND INTENTION

Of the three notions that lie at the foundation of human thought - object, cause and intention - object is the most central; it is presupposed by both cause and intention, neither of which can be stated without referring to object. For instance, Michotte (19) showed many years ago that the human perception of cause is brought about by a relation between objects, a relation that can be described in strictly physical terms. More recently, Verena Dasser, Ib Ulbeck and I have shown that apparently a similar condition holds for the human perception of intention; it too is caused by a relation between objects, one that can be stated in strictly physical terms (submitted). Specifically, given the concept of object, time and distance are the only dimensions one needs in order to state, on the one hand, the specific relation between objects that gives rise to the perception of cause, and on the other, the specific (and different) relation between objects that gives rise to the perception of intention. That being so, let us first settle the matter of object, and then move on to the more perplexing matters of cause and intention.

What is an object, or rather what is it that a human perceives as an object ? Quine who, like Piaget, is basically a constructionist, treats the notion of object as a human invention. Experience, as Quine reminds us, is afterall nothing more than a succession of "surface scratchings", stimulations of the sensory receptors (Quine 19). Suppose that an individual, having experienced a succession of such scratchings, discovers that some of them are the same; how could he account for this ? By inventing the concept of object; this is the answer, in so many words, given by both Quine and Piaget. For both these writers, then, there is a point in ontogenetic and phylogenetic time when the human (or proto-human) did not have the concept of object. We are invited, in effect, by this constructionist account to picture a series of mentalities. First, a mentality that experienced many surface scratchings but did not detect their similarities; second, one that recognized the similarities but simply suffered them, not being led to ask for an explanation of them; third, one that did ask for an explanation but lacked the mental power to find one, and finally the human case, a mentality that not only sought an explanation but had the mental power to find one. I suggest that this whole account is misleading.

Consider as an alternative that object is not a learned concept. The concept was neither invented at some point in prehistory, nor is it one that is constructed by the infant in the course of its development. An object is two things First, it is an item that, when moved, retains its volume, though not necessarily its shape (for there are nonrigid objects). Second, it is continuous in time as well as space. The first property, which appears to have been proposed originally by Von Uxkell ("an object is an entity that moves in unison", 18) has recently been studied most extensively by Spelke and her associates. If part of a figure is occluded, what assumptions if any does the human infant make about the part that it cannot see ? None, is the finding of Spelke et al. Suppose the figure is moved (in either the frontal, vertical or horizontal plane); what assumption if any does the infant then make about the occluded part ? The infant assumes that the figure is continuous. Suppose the figure is not moved but the infant is moved relative to the figure ? The infant distinguishes the two cases and assumes continuity (of the occluded part) only in one case, when the figure is moved. Suppose the figure is not actually moved but the infant is shown a succession of pictures depicting the successive positions the figure would take were it moved. What then ? When the picture-series fulfills certain parameters the infant treats them as it does actual movement, assuming that the figure is continuous; if the series defaults on these parameters, the infant makes no assumptions about the unseen continuity of the figure (Kellman et al 1987). By this series of painstaking and ingenious studies, Spelke, Kellman and their associates have contributed strikingly to defining the conditions under which an infant perceives a figure to be continuous. In essence, they have confirmed Von Uxkell's original insight - an object is an item that moves in unison - adding immeasurably to the refinement of this intuition.

The conditions that lead the infant to assume continuity in space is one thing. What of the conditions that lead it to assume continuity in time ? We need both kinds of information for, as we may all agree, an object is not only continuous in space - no more than we accept, say, spatially discontinuous trees (whose branches or leaves float or are unattached) - do we accept temporally discontinuous trees - trees that exist one moment and not the next. We may thank Renee Baillargeon and her associates for a series of experiments concerning the infant's assumptions about the continuity of objects in time. Here are two examples from the series, both of which convey the logic of the approach.

An infant is first shown a toy car at one location, after which the car is moved along a track to a second location. The car and its movement are shown to the infant on several occasions. Then a block is placed squarely on the track in one case, off to the side of the track in a second case. An occluder is then placed between the infant and the track, and when it is removed 5 to 10 sec later, the car is to be seen at the opposite end of the track. Of these two conditions - track blocked/not blocked - one causes the infant to look decidedly longer than the other; it is the condition in which the track was blocked. A similar outcome was obtained in another experiment where two toy animals were moved from one location to another. In both cases, the animals were passed behind an occluder so that the infant could not see their actual movement. One animal was short enough to make the trip without appearing above the occluder; but the other was too tall for this to be the case. Yet both animals made the move without appearing behind the occluder. When the occluder was removed and the infant found standing at the opposite end of the path the tall animal it looked far longer than when it found the shorter animal in the same position.

These results can be most sensibly interpreted by assuming that infants make assumptions about the temporal continuity of objects that they cannot see. In the first case, the infants evidently assumed that the block which they saw placed on the track remained on the track during the 5 to 10 sec in which they were unable to see it. Similarly, in the second case they evidently assumed that the tall rabbit retained its height during the time in which they could not observe it. These results also indicate that infants make assumptions beyond that of the mere temporal continuity of objects. For instance, they appear to assume that two objects cannot occupy the same location at the same time, and that an object retains its height (and perhaps other properties) when moved. They also eliminate other more fanciful alternatives. For example, infants might assume that unobserved objects not only undergo classical disappearance but other more interesting transformations such as spontaneous disassembly and reassembly, and the like. But if objects, on the infant's view, did so behave then objects should easily overcome blocks, short occludes and other physically impossible conditions, and infants should not be surprised by objects that do appear to behave in this manner.

Even though the experiments by Baillargeon could be profitably extended in a number of ways, the information already provided by these experiments combined with that from Spelke et al enable us to see that infants make several assumptions about the continuity of objects in both space and time. Since, however, these assumptions are derived necessarily from habituation-dishabituation data, it is difficult, perhaps impossible, to make final claims about the interpretation the infant places on "object". Although the data are compatible with the adult concept of object, they do not strictly compell that concept, i.e., compell attributing the concept to the infant. Perhaps the infant has no more than a perceptual "sensitivity" to certain physical relations, and makes no conceptual interpretation of those relations. This distinction can be made clearer in the case of cause and intention, and we will delay dealing with it further until turning to those cases.

Cause

Michotte showed that when one object launches another, provided the launching observes certain conditions, primarily temporal and spatial contiguity, the human adult has the perception of causality. More recently, Leslie and (198) showed that infants perceive the Michotte configuration in a unique way, different from that in which they perceive noncausal interactions. No work of this kind has been done with animals, though there is no reason why it could not be. Let us assume for the sake of discussion that the habituation-dishabituation data for infants and animals would not differ. What interpretation can we place upon such data ? Can we claim that infants and animals have the concept of causality ?

Indeed, let us assume a comparable outcome for both infants and animals in the case of an experiment that has yet to be done. In this experiment, rather than contrast causal with noncausal relations, we violate causality and examine the effect of the violation on the individuals in question. Specifically, we arrange a collision between two objects which, despite perfect spatial and temporal contiguity, does not result in a launching. Suppose our subjects are surprised, evidence protracted looking, as the infants did on the occasion of an earlier violation, when one rigid object appeared to pass through the space occupied by another such object. Can we take the fact of this surprise to indicate that the individuals have the concept of causality ?

Surprise, indicating the disconfirmation of an expectancy, is a primitive phenomenon, demonstrable, for example, in dogs. We accustom a dog to the beat of a metronome and then skip a beat; the dog's ears prick up, indicating surprise or disconfirmation of an expectancy. The dog's disconfirmation differs from that of the infant in one important respect. Although the dog's expectancy is obviously based on experience, the infant's probably is not. There is the excellent possibility that the infant enters the world with the expectancy that if the conditions Michotte described are met, there will be a launching (the infant may require some exemplars in order to activate the expectancy, but that is different from the learning that is the basis of the dog's expectancy). In the infant, we are probably disconfirming a wired-in expectancy not an acquired one.

What is the exact nature of the infant's expectancy and how does it compare with the adult concept of causality ? The expectancy could be stated in the form of a simple rule : if X and Y, then Z, where X and Y refer to temporal and spatial contiguity, and Z to an outcome, such as launching, which is appropriate to the terms of the case. Does this rule exhaust the human concept of causality ?

The rule is weaker than the concept on at least two grounds. First, the rule does not commit itself as to the occasion or scope of its applicability. The human adult believes that the world has a thoroughly causal structure - that there are no uncaused changes. But the rule says only that if X and Y occur, then Z; it does not say, if X and Y do not occur, then Z will not occur. Second, the human adult is inclined to believe that observed causal cases will repeat themselves.

He does not believe merely that, having seen A cause B, should A occur again it will cause B. He tends to believe that A will occur again and thus cause B; or at the least, that only with human intervention can the repetition of A be prevented. The rule is only a part of the adult concept of causality.

Moreover, we know that the ability to detect a distinction, as shown by habituation-dishabituation, does not assure that the individual can make use of the distinction, i.e., use the distinction as the basis of judgment or choice (Premack in press). We could expand this to say that perceptual sensitivity shown by habituation-dishabituation is not equivalent to belief; from such data we do not know what the individual believes.

Is speech or language the only basis on which we can claim that the individual is not only perceptually sensitive to the same relation between objects as we are but also makes a conceptual interpretation of these relations, either the same or different one we make ? If language is the only basis for this decision then we shall be locked in a permanent ignorance with regard to most of the world's creatures. But this assumption is unwarranted on several grounds.

First, language is not the source of concepts, at least not basic concepts; it is the other way around. If the individual has a concept, it is then possible to teach him a name for it. The fact that children do learn the words cause and effect indicates that at some point children do possess the concepts; they are not merely perceptually sensitive to the physical relations. Second, the fact that animals do not, in the normal course of events, learn names does not mean that they lack the underlying concepts.

Suppose an individual was perceptually sensitive to the physical relations that comprise the syntax of cause and intention; but did not take the next step, make a conceptual interpretation of these relations. Could such an individual be taught a name for the perceptual class ? That is difficult to answer. Except for the limited language work with apes, humans alone learn names, and human names presumably are based on conceptual interpretations. Is this so from the beginning ? For example, perhaps the word "tomatoe" is to begin with strictly the name of a physical object - a red globe - and only later the name of a vegetable, of a food that forms a sandwich when combined with other foods, was once considered an aphrodisiac, can be stuffed with tuna salad, etc. Do children's words undergo any such transition ? ("Tomatoe", of course, could just as well begin as a taste (still a physical relation) and only later turn into a geometrical form).

Basically, we are on the lookout for procedures, nonverbal ones, that can tell us when a mind has made the transition from syntax to semantics, from perceptual sensitivity to conceptual interpretation. So far we have largely bypassed or chosen to downplay two possibilities : (1) the individual can use the distinction, not only detect it, use it as the basis for judgment or choice; (2) the individual can be taught a name for the distinction (this would be more helpful if we were more clear as to what a name is). Both of these achievements do go beyond habituation-dishabituation and perhaps they are a sufficient basis for claiming conceptual interpretation. But I would be hesitant to make such a claim. For the moment, let us treat these possibilities as necessary but not sufficient conditions, and continue our search for procedures in which we can have greater confidence.

Consider now some nonverbal tests we have made for causality in one case and intention in another in both apes and young children. In the matter of cause, we left off with a direct attack and turned to a side matter. We turned to action, on the grounds that action is an expression of causality. By action we had in mind simple physical transformation of objects (again "object", the inescapable basic concept). The cutting, wetting and marking of an object were our original examples. We represented them and all other actions in a three element sequence : object in its base state and in its transformed state, with the instrument that could account for the transition standing between. For example, apple, knife, cut apple; sponge, water, wet sponge; paper, pen, marked paper.

To convert these representations of action into a test of another individual's possible grasp of the concept of action we omitted one item in the sequence, either the instrument or the terminal state, and required the child or ape to select the missing element from a set of alternatives. For instance, we presented, in one format, apple, knife, blank, with cut apple, cut orange, and apple pierced as by a nail as alternatives; and in the other format, apple, blank, cut apple, with knife, container of water and marking instrument as alternatives. Notice that both these sequences are totally arbitrary, subject to indefinitely many interpretations. That is, they need not be interpreted as asking the question what caused this change ? how do we get from an intact apple to a severed one ? If we apply a knife to an apple, what will the result be ? The sequences can just as reasonably be read as : one, blank, two; red, blank, red; edible, nonedible, blank, etc.

Could an individual consistently select the correct alternative if he did not read the sequence in the appropriate fashion ? Suppose he could not (as indeed I believe is the case provided the necessary controls are run). Then we could argue that any creature which consistently selects the correct alternative does so by merit of assigning the right (i.e. causal) interpretation to the sequence. This is more than we had bargained for. We set out only to find a procedure that could give results warranting the claim of conceptual interpretation. As it turns out, we appear to get not only interpretation but correct interpretation - one that agrees with our own.

The test is an example of our main procedure for uncovering the interpretations that nonverbal creatures may assign. It is a nonverbal form of interrogation. Normal interrogation relies on sentences, of course, sentences whose interrogative nature derives from the fact that they are incomplete. For instance, "Where is John ?", "Who was the first President of the United States ?", "How old are you ?" can be rewritten so as to make their incompleteness explicit. "John is ____", "___ was the first President of the United States", "You are ___ years old", and so forth. To answer normal questions one must know the language in which the question is written. To answer nonverbal questions one must recognize the sequence as an incomplete version of a completable structure; this requires giving the sequence the right reading.

Both chimpanzees (with proper training) and young children evidently recognized the sequences in question as representations of action for they completed them successfully from the beginning. They succeeded not only with familiar cases but also unfamiliar and indeed anomalous cases - e.g., balls that were severed, apples that were written on, paper that was wetted - rejecting the instrument normally associated with the object (e.g., apple-knife, paper-pencil), and choosing instead the instrument associated with the transformation. In a first elaboration on this procedure we established that the animal could use temporal order. We presented the same elements, e.g., paper, blank, marked paper, in one case, vs. marked paper, blank, paper, in the other, requiring pencil as the answer in the first case, eraser in the second. In a further elaboration, we established that the animal could enter the problem at an arbitrary point, compute the difference between the initial and final transformation, and separate the instruments into two categories, those that did and did not participate in the transformation. For instance, the animal received marked-cut paper as the initial state, marked-cut-wet paper as the final state, and separated the alternatives appropriately, placing water in the relevant bin, pencil and scissor in the irrelevant.

Intention

We tested the chimpanzee's attribution of intention and other states of mind by a similar procedure, i.e., by presenting sequences that were incomplete, along with alternatives one of which would complete the sequence. Specifically, we showed the animal videotapes of a human actor confronting problems of various kind, e.g., jumping to reach inaccessible food, shivering alongside an unlighted heater, unable to escape from a locked room; and offered alternatives one of which constituted a solution to the actor's problem, e.g., stepping up onto a chair (to reach bananas overhead), a lighted wick (to restore the heater), etc. The animal chose the correct alternative in nearly all cases on the first trial.

Correct choice in this case too depending on reading the videotape in a particular way. The consistent choice of "solutions" presupposes the detection of "problems" and a "problem" is not physically instantiated in the videotape. A videotape is afterall a sequence of events; a problem depends on a reading of those events. For instance, to see the actor as not merely jumping up and down below a bunch of bananas, but as _wanting_ the bananas, _trying_ to reach them, _supposing_ that by doing so he might reach, one must attribute states of mind to the actor.

In another paradigm, the animal was required to choose between two containers one of which was baited. The animal could not observe the baiting but could observe that one of the two trainers standing nearby had a clear view of the baiting while the other did not. Before making its choice, the animal was allowed to solicite the aid of a trainer. Three of four juvenile chimpanzees consistently chose the seeing trainer from the outset, and two of the three consistently followed his advice. Thus the animal understands the conditions on which seeing depends, and attributes this state of mind to the trainer.

In sum, these results suggest that chimpanzees are not only perceptually sensitive to certain relations but also conceptually interpret them.