CHAPTER EIGHT

The Green Grass Growing All Around[1]

A Philosophical Essay on Ethology and Individualism in Psychology, Part Two

In the last chapter, I claimed that behavior is the functional form of an animal's behavior. My job now is to spell out implications of this thesis for understanding mechanisms of behavior control. At the far end of the tunnel, I will emerge with a rough thesis concerning what it would be like to understand the role that intentional states--beliefs, desires, intentions, seeings, hopings, etc.--play in the control of human behaviors.

I can summarize the main points I have made and shall make in terms of the currently popular image of the organism as an input-output device, taking in stimulations and emitting behaviors. In the last chapter I argued that each organism emits an uncountable number of outputs each of which is describable in an uncountable number of ways. But the only output forms that are of interest for the study of the organism as a living system are those that have biological functions. The animals' outputs must be described according to their functional forms. Only these are forms that it is the business of any life science to explain.

The rest of the argument is roughly as follows. The functions of behaviors are, by definition, functions performed through mediation of the environment. Indeed, the functions that define behaviors often reach very far out into the environment, both in time and in space. So the behavioral output forms must be described in relation to the organism's environment, both its proximate environment and, sometimes, its very remote environment.

Similarly, the only inputs of interest among the possible stimulation patterns that might impinge on the organism are those that the organism is designed to use. Not only must these not break or jam the organism's system, they must be described not arbitrarily but in accordance with <u>their</u> functional forms, those forms that accord with the properly functioning organism's way of using its inputs. But the uses of these inputs are to help mould the forms of the organism's behaviors so as so have appropriate impacts on the environment, and to help determine proper placement of these behaviors in the environment such that their functions will be fulfilled. To understand what relevance the inputs have to success of the organism's behaviors, we must understand their normal environmental causes and accompaniments, both proximate and, sometimes, very remote.

Last, understanding how and why the mechanisms that mediate between perceptual input and behavioral output manage to contribute to the production of wellfunctioning behaviors involves understanding how these mechanisms themselves are normally related to the environment. For these mechanisms can adapt the organism's output to its environment only by varying their forms of activity as a function of the environment, both proximate and, sometimes, very remote.

I.

The first point that we need to grasp firmly is the difference between explaining the operations of a system in terms that refer to the functional forms of its inputs, outputs and mediating innards, and explaining its activities in other ways. Let me begin by exploiting the familiar analogy of an organism to a calculator or computer, the analogy responsible for the contemporary "input-output" view of organisms mentioned above.

First consider the analogy as it likens the animal to a computer. Dennett has persuasively argued that "an animal--in fact any fairly complicated object--can be a number of different Turing machines at once, depending on our choice of input, state descriptions, and so forth" (1978a p. 261) and that "[a]s a complicated chunk of the world [a man] will surely

[1] Special thanks to Colin Beer and Peter Brown for very helpful comments on an earlier draft of this essay.

qualify for any number of Turing machine characterizations" (p. 262). "No one of these," he says, "can be singled out on purely structural or mechanical grounds as the Turing machine interpretation of the animal. If we want to give some sense to that task, we must raise considerations of purpose and design" (p. 261). But in order to consider purpose and design, "[f]irst we have to decide which of the impingements on the animal count as input and which as interference" (p. 260) and "which features of the animal's physical constitution are working as they are designed to, as they were supposed to, and which are malfunctioning, misdesigned or merely fortuitous" (p. 261). These latter points are analogous to those I made in chapter 7 concerning what counts as what an animal is "doing" for purposes of behavioral science.

However, Dennett's claim that any complicated object can be a number of Turing machines at once suggests a further important point. If as Dennett (above) and I (chapters 1 and 2) have argued, the structure and dispositions of a chunk of matter do not alone determine its biological function, then of course biological function does not supervene in any simple way on physical structure. Whether the Paleontologist has found a tooth or a horn does not supervene just on the physical form of the object found. Whatever one thinks biological function does depend on then (and Dennett and I are not always in agreement here), the following point will be valid. If, as I now propose to argue, valid explanations of behavior must explain behaviors by reference to their functional forms, and if, at least in principle, functional forms can differ while physical structures remain identical, then the behaviors of identical physical structures might require to be given quite different explanations. Putting this under a familiar contemporary light, it is a mistake to think that because minutely physically identical "twins" would produce the same physical outputs under the same conditions that the explanations of their behaviors would have to be the same. Notice that this point is supported without yet having made any reference to intentional states. The very behaviors of such twins could, in principle, be different, and this could be so, in fact might more easily be so, if they were organisms too simple to have intentional states.

Now let us turn the animal-computer analogy over. A calculator can be likened to an organism in that (as Dennett also points out) it does both things that it is not designed to do and, if one is lucky, things that it is designed to do. I am remembering an enormous, ancient, Marchant desk calculator that chattered away in my father's study when I was small. It was powered by an electric motor and consisted otherwise mainly of rods, levers, gears and cams. It was designed to add, subtract, multiply and divide, carrying twelve figures. When in use, it often rattled the dishes in the kitchen and always scared the cat. These things it was not designed to do. Nor was it designed to take chewing gum dropped into its works as input, or such was my father's forceful opinion. One could do something like studying its physiological psychology, indeed I used to do so. One could try to figure out how the levers and gears were hooked up inside so as to effect its proper functions of addition, subtraction, etc..

Now imagine a hugely mechanically gifted child, not yet introduced to even the rudiments of arithmetic (recall Meno's slave boy) confronting such a calculator. After studying the mechanism for long enough, it might be that such a child could tell you, for any input to its keyboard that you described, what the corresponding output on its dial would be. He would probably also be able to tell you what would happen if you lodged some chewing gum just there in the mechanism, what would happen if you filed off tooth 9 of gear 129, and just which inputs would create large enough and continuous enough vibrations to shake some of the dishes onto the floor or to keep the cat under the bed for an hour. But would such a child command an understanding of the Marchant's psychology? Surely not, if he does not understand which are its legitimate inputs and outputs or, concerning these, that the outputs represent arithmetic functions of the inputs.

Surely not, if he cannot explain how the workings of its insides manage to add up, say, to its adding. Surely not, for example, if he does not realize that what gear 129 just did when it nudged gear 130 was to effect the operation of carrying one. Though he can predict, under some description, every relevant motion that it makes, he understands neither what the calculator is really doing nor, of course, how it does it. He knows, as it were, its function in extension, for he knows (among many other things) the value of its function for each argument, for each input. But he does not grasp, as it were, its function in intension, the function it is it's raison d'etre to exemplify, hence he does not understand its psychology.

But I need to be careful to make the point I intend here. In (1969) Dennett, using precisely the same analogy and nearly the same words, argues an importantly similar yet also importantly different point. It will be best to quote him at some length:

> If we...proceed on the assumption that human and animal behavioural control systems are only very complicated denizens of the physical universe, it follows that the events within them, characterized extensionally in the terms of physics or physiology, should be susceptible to explanation and prediction without any recourse to content, meaning, or Intentionality...If we had such a story we would have in one sense an extensional theory of behavior, for all the <u>motions</u> (extensionally characterized) of the animal...would be explicable and predictable in these extensional terms, but one thing such a story would say nothing about was <u>what the animal was doing</u>. This latter story can only be told in Intentional terms, but it is not a story about features of the world <u>in addition to</u> the features of the extensional story; it just describes what happens in a different way. Supposing one could have complete knowledge of the mechanics of a computer without the slightest inkling of the rationale of its construction, one would be in a similar situation...one would have nothing to say in this account about the logic of the operations...(p.78-9)[2]

[2] I was astonished belatedly to discover this passage of Dennett's some years after writing the first draft of this essay. The comparison between the uses that Dennett and I here make of the same analogy is the clearest and sharpest embodiment of the similarity yet contrast between our views of intentionality one could possibly imagine. The compression is nearly to a geometrical point.

When I said above "as it were, its function in extension" and "as it were, its function in intension" I did not mean to speak literally, nor did I intend to make any point here about intentionality, which is quite another (though certainly not unrelated) matter. Certainly, I do not wish to suggest that in order to "understand the psychology" of the calculator, the boy would have to speak in "intentional terms" or to take a different "stance" towards his subject matter (cf. Dennett 1978c, 1987). What he must understand is not anything of a different character from what he already does understand. It is just that he must focus on the physical patterns that show how <u>this</u> particular relation between input and output is achieved, the one the machine is designed to bring about, from among all the other relations there also are between the machine's various "inputs" and "outputs" when described in other ways. This will not require that he move to some further "interpretation" of the machine or to another level than the mechanical. But he must see how the patterns in the gears, cams and shafts, given certain inputs, are running isomorphic to the patterns in the mathematics.

<u>II.</u>

In fact, the analogy between calculator psychology and human psychology is importantly flawed in a way that may, precisely, prohibit giving an explanation of the calculator's workings by reference to intentional states. Notice that the calculator does not exhibit "behavior" in the sense we have defined (chapter 7). The calculator's outputs do not have functions that are fulfilled via mediation of the environment. Its environment is quite irrelevant to its proper functioning, so long as the environment doesn't destroy it. Mechanisms that calculate <u>real</u> behaviors, by contrast, are mechanisms that must take account of the environment every step of the way so that these behaviors will fit with the environment and be strategically placed within it. <u>Intentional</u> states are behavior-controlling states that require to map onto the world for all to go biologically properly and normally (see below, and see chapters 4-6). This is no time for a digression into the philosophy of mathematics, but it is not at all clear that there is some portion of reality external to the calculator that the calculator's states must map onto, one by one, in order for it to be doing its job.

But there is a far more important point that emerges from the fact that computers do not exhibit behaviors. Because it is not part of the proper functioning of a computer to effect environmental changes, obviously we cannot use the computer analogy to help us to understand how reference to the environment is needed in order to explain the mechanisms of behavior control. Employment of the computer analogy is bound, precisely, to blind us to the role of environment. It is time now to begin removing these blinders.

III.

Let us begin with walking--a very fundamental and ancient, yet rather complex sort of behavior, that requires to be executed and placed correctly in relation to the walking organism's environment. Compare with our uncomprehending child calculator whiz above an ethologist studying centipedes. Suppose that she progresses to the point that she can predict and "explain" the exact movement of each of the centipede's legs, given relevant input to its perceptual systems. Given certain input conditions, she knows that leg 16 will move at 10:27:06.23 and that leg 17 will move at 10:27:06.25 and so forth, and exactly how each will move. But although this is implied by what she knows, it has not occurred to her to notice that leg 17 will move just after leg 16 has moved and leg 16 just after leg 15. More generally, it has never occurred to her to notice how or wonder why the individual motions of the legs are related to one another or coordinated as they are, or what function relates the leg movements and the coordination among these to the location and properties of surfaces contiguous to the centipede. She has not noticed, for example, under what surface contact conditions these coordinations sometimes result in univocal movement of the whole centipede in a uniform direction. Though she may, after many calculations, notice the remarkable coincidence that the centipede's whole body is soon going to move all at once in a forward direction--or toward the kitchen clock, or that the legs are about to tap out Yankee Doodle--clearly she will not have done her job as an ethologist.

Just the ability to predict movements, even an understanding of why these movements occur, is not what causal explanation in ethology is about. The behavioral scientist must understand movements under descriptions that reveal their <u>functional</u> forms. And that and how the behavioral forms are functional can only be understood in relation to the environment through which they function. You cannot explain the walking behavior of the centipede without taking into account that its function is to move the whole centipede forward, or without taking into account, not just stimulations to its afferent nerves but relevant properties of the surface on which it walks. Not that one <u>couldn't</u> study the centipede just as an input-output device. Anything with a definite location and boundaries <u>could</u>, in principle, be studied as a mere input-output device. The heart or the kidney could, in principle, be studied that way, and so could half a heart or half a kidney or the right hand side of a computer. The wheel of the bicycle could be studied that way too, ignoring both the axle it is attached to and the surfaces it moves over, but no explanation of the role (apologies) of the wheel on the bicycle will come out of such a study.

<u>IV.</u>

So aspects of the proximal environment of the organism must certainly be taken into account in order to explain its behavior. Before arguing that aspects of its distal environment, even aspects of its very remote environment, may also have to be taken into account, I should like to exert some force to loosen the iron grip of the organism-environment dichotomy, which is quite generally and unreflectively assumed to be sharp and theoretically fast. It is a very serious error to think of the subject of the study of psychology/ethology as a system that is spatially contained within the shell or skin of an organism. What is inside the shell or skin of the organism is only <u>half</u> of a system; the rest, if the organism is lucky, is in the environment. The organismic system, especially (indeed, by definition) the behavioral systems, reach into the environment and are defined by what constitute proper or normal relations and interactions between structures in the organism and in the environment.

The line between organism and environment, as it is customarily drawn, is a useless one so far as the study of the organismic system is concerned. Consider some examples. Most crabs molt when about to grow out of their shells, secreting a substance that hardens to become a new and bigger shell. Birds, however, build their nests out of materials that they find in the environment, although some complete these nests by lining them with their own breast feathers. The crab's shell is considered to be part of the crab. Why is the bird's nest not considered part of the bird? Surely it is no less a part of the organismic system than the shell of the crab. That the bird uses its muscles rather than its glands in constructing its home clearly is not a relevant consideration. Is there a difference because the bird can leave its nest behind whereas the crab must remain with its shell? The nestling, however, cannot leave the nest behind. True, the nestling might happen into some substitute for a nest. But one can also imagine giving the crab a shell transplant. Is there a difference between nest and shell because the bird uses construction materials that it finds lying about rather that materials that it makes for its nest? But we don't claim that the rest of the bird's body is not part of the bird on the grounds that this body has been constructed out of materials the bird found lying around--seeds, berries, etc.. Besides, the bird does make the feathers that line the nest.

If the distinction between nest and shell still seems sharp to you, are you clear where to draw the organism-environment line in these intermediate cases? Some moth larvae secrete substances out of which they spin their cocoons. Other moth larvae use leaves, cementing these together with substances that they secrete. All will die if removed too soon from their cocoon shells. Hermit crabs find their shells ready made, conveniently left behind by dead snails, so that granted luck, the only thing they have to do to acquire a shell is to engage in searching behavior. Yet they are as defenseless without their shells as is any ordinary crab. There are many small marine invertebrates that take over holes in rock originally made by digger clams, growing into and conforming themselves to these homes such that they cannot survive removal. Is it clear in these cases where common sense draws the line between organism and environment? And if it is, is it also clear that the distinction between organism and environment so drawn is of principled biological significance?

The bird needs its nest in order to function properly in exactly the same way that it needs, on the one hand, its skin and feathers, on the other, its seeds. The nest, the feathers and the seeds are all part of the same organismic system. Conversely, the immune systems of the bird are designed to deal, precisely, with things spatially inside its body but that are not part of the biological system. The distinction between what is spatially "inside" and what is spatially "outside" the bird, simply as such, has no significance for the study of the avian biological <u>system.</u> The only interesting principled distinction that can be drawn between that portion of the organismic system that is the organism proper and that portion of it that is normal environment is not determined by a spatial boundary. It is a matter of degree--the degree of control that the system as a whole has over the production and maintenance of normal structure and normal states for its various portions. Let me clarify this.

Each of the various parts and subsystems within an organismic system has a normal environment, normal surroundings, in the absence of which it cannot perform all of its functions in a normal way. The lungs, for example, cannot perform their function of helping to supply the tissues with oxygen in a normal way unless encased in the airtight chest cavity above the diaphragm which is displaced periodically by certain muscles, unless the organism is surrounded by an atmosphere under a certain pressure and containing oxygen, unless next to a heart that is pumping blood through the pulmonary vessels, unless this blood contains sufficient hemoglobin, unless this whole complex is within a certain narrow range of temperature, and so forth. An organismic system involves a coordination among parts or subsystems, each of which requires that others of these parts or subsystems have normal structure and are functioning normally. Call those conditions without which a part or subsystem cannot function properly in accordance with a normal explanation "normal conditions for proper functioning" of the part or subsystem.

Normal conditions for proper functioning of a part or subsystem must not be confused with conditions, just, that the part or subsystem is usually in. Normal conditions are conditions that have historically figured in an explanation of how the part or subsystem has functioned properly <u>when</u> it has functioned properly. But, first, there are many parts or subsystems that are supposed to function only under quite special conditions. Thus the immune systems, the systems responsible for repair of damaged tissues, the vomiting reflex (designed, presumably, to rid the body of toxins) are only supposed to operate under certain conditions. Similarly, of course, many behavior patterns of simple animals are supposed to be triggered only under quite specific conditions. None of these conditions is a condition the animal or the functional part or subsystem is usually in.

Second, it is of paramount importance that not all parts and subsystems are such that they usually function properly. The function of the countershading on a caterpillar is to prevent it from being seen, hence from being eaten. But it may well be that the average caterpillar ends up being eaten anyway, the precise conditions needed for its disguise to work properly not being sufficiently prevalent.[3] Similarly, most baby fish get

[3] Matthew Kramer is concerned that I not leave a wrong impression about the ingenuity of caterpillar predators. Many predators use olfactory cues, and there are also caterpillar parasites. But the general point should be

eaten by bigger fish, despite many precautions taken by nature. Nor, of course, do the immune systems necessarily manage to perform their proper functions most of the time. Before modern medicine intervened, the average human died before reproducing, in civilized times most commonly from some kind of infection. This is because the immune systems depend upon certain accidental relations holding between antigens introduced and antibodies in the system. By "accidental", I mean that the organismic system has no control over whether these relations shall hold. Yet that they should hold is a normal condition for performance of the proper function of the immune systems. Similarly, rehearsing again my favorite example, the function of a sperm's tail is to propel it to an ovum, but very few sperm find themselves under normal conditions for proper performance of the tail: for most, no ovum chances to lie dead center in the path of their random swim. Thus normal conditions for proper performance of an item often are not average conditions but, rather, ideal conditions. Sometimes they are very lucky conditions.[4]

As we move closer to the spatial center of any organism, however, we find a greater proportion of parts and systems whose normal conditions for proper functioning it is the job of some <u>other</u> part or parts of the system, or of the whole system, to maintain. For example, most parts well inside of a mammal require for proper operation to be at a certain normal temperature, and it is a proper function of other parts of the system--certain little cells in the hypothalamus, the sweat glands, etc.--to see that this normal condition is maintained. Similarly, presence of a normal heart is one normal condition for proper performance of the lungs, and there are numerous organs and systems within the body that have as part of their jobs to help maintain a normal heart. Toward the periphery of the body, however, normal conditions for proper functioning tend to be less under the system's control. For example, the countershading on a caterpillar performs its proper function in accordance with a normal explanation only if the caterpillar orients itself correctly in relation to the light, but also only if the lighting conditions are favorable, and only if the predator's perceptual systems are not set to make sufficiently fine discriminations. Over the latter two conditions the caterpillar has no control. Similarly, the sweat glands can perform their proper function of cooling the body only if the humidity outside is not too high. True, if it is too high, other systems of the body may become engaged in the activity of seeking a less humid or cooler spot, or in the activity of constructing one. But as we move out from the spatial center of an organism, the tendency is for the method of maintaining normal conditions to become less a making and more a seeking or a fitting in. At the outer limit, normal conditions, normal surroundings for portions of the organismic system, are simply there or not there, maintenance of these conditions being completely beyond the system's control.

But even what is entirely beyond the system's control is not as such <u>outside the system.</u> Why should the fact that a part of a system is neither made nor maintained by the rest of the system disqualify it <u>as</u> part of the system? On the contrary, destruction of the ocean of air that the bird flies in and breathes the oxygen from, of the seeds and berries that it eats, of the twigs and grasses from which it builds its nest, as well as of the nest itself or of the bird's skin and feathers, would not merely cause but would <u>constitute</u> destruction of part of the avian system. To say that a part or subsystem is in "normal conditions" is just another way of saying that it is part of a wider <u>intact</u> system, that the <u>rest</u> of the system to

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plain enough.

[4] The importance of this point will be discussed at more length in chapter 9.

which it belongs is in place.

It is the ethologist's job to study the behavioral dispositions of chunks of avian matter as part of this system. This study is continuous with study of the development of the bird's behavioral systems and with the study of embryology. Ethology is just one more aspect of the study of how the various parts of the avian system develop or are put in place. To study the bird's bodily behavior apart from its normal environment would be exactly like trying to study the embryological development of its wings without taking account of the wings' normal connections to other body parts or without taking account of properties of the egg white and shell within which it develops.

The ethologist must study the mechanisms of organism-environment interaction that hold when the whole system operates properly, that is, when conditions for avian survival and proliferation are normal. Coordinately, unless she is interested in pathology, she need have no direct concern for what the bird does when conditions for its survival and proliferation are not normal, when the wider avian system is not intact, not whole. Accordingly, the ethologist must produce a theory about what conditions are normal for proper operation of the organism, about what relations normally, ideally, hold between organism and environment, or between various states of the organism and states of its environment. That is, she must produce a theory about the constitution of those parts of the system that lie beyond the organism's body, and about what relations hold between the parts and states within and the parts and states without when the whole system is operating properly.

V.

With this perspective in mind, let us return once more to the question, what is behavior? In the last chapter we said that behavior is the functional form of external change or activity on the part of an organism, the functions in question being mediated by the environment. We also drew or at least tolerated the drawing of a distinction between body motions and the functional effects of these. But from our present perspective there is no principled distinction between organism and normal aspects of the environment, unless it is the graded distinction between parts of the normal organismic system that are controlled or put in place by the rest of the system and those that are not. Under this light, behavior emerges as the functional form of the wider organismic process; functional changes usually considered to be in "non-body" parts of the system have exactly the same status as changes in "body" parts. All are equally just functional changes within the system. What the organism maintains, modifies, or puts in place through the activity of its "body" is just part of the developing wider organismic system. Behavior, then, is just the functional form of the widest organismic process. Physiology now becomes the study of behaviors occurring within the "body"; behavioral science becomes the study of the forms of functional processes occurring outside the "body". Traditionally, behavioral science includes also the study of those parts inside the "body" that control functional processes occurring outside; it includes physiological psychology, for example. For these are parts of the same systems whose outsides are studied by behavioral scientists--"same systems" in the sense that the lungs and diaphragm are parts of one system while the stomach and intestines are parts of another.

Turning now from birds to beavers, the entire process of building a beaver dam and of using the fruits of having built it are thus, strictly speaking, part of beaver behavior. What the beaver does is not just to move its muscles or to put sticks down where water trickles, but to build a dam and to create a pond. To understand beaver behavior is to understand how this entire process is accomplished, not just how the muscles happen to become contracted. The ethologist is of course interested in the fact that the beaver reacts to the sound of trickling water by dumping any available materials on top of it. But the interest lies in seeing how this reaction, combined with various other instinctive and/or learned beaver responses, contributes, when all goes normally (ideally), to creating a beaver pond. That certain sounds cause a certain reaction in the beaver is of interest because in the beaver's normal (ideal) environment, such sounds are caused by running water, and the beaver's reaction to these sounds helps to cause beaver dams which in turn cause beaver ponds to form. What the ethologist is studying here is beaver-system development, wider beaver embryology. Similarly, ethologists would love to know, but don't yet know, exactly what stimulations cause what responses in mound-building termites so as to produce the typical shape, size and structure of the mound.

Ethologists are interested in the reaction of ants to oleic acid, but not in their reaction to ammonia or citric acid. This is because the ants' response to oleic acid, a substance secreted by dead ants, is to drag the acid-tainted item out of the nest, thus contributing to sanitation. But ammonia and citric acid are not (to my knowledge) normal in the ants' environment. The ethologist is also interested in what causes bees to dance, but not just in what all can or might cause this. Of interest is what triggers and controls the dances such that, given normal conditions for proper operation of the dance-making systems, the dance maps a location of nectar correctly by beemese semantic rules. The ethologist is interested in how the dance gets placed correctly in the bees' environment so as to constitute, along with the nectar, a normally formed part of the wider organismic system of the bee. She is interested in wider bee embryology.

These principles are pretty obvious when articulated for non-human ethology. They should be equally obvious when applied to human ethology. Put (an analogue of) the bee dance inside the body so that it mediates between two parts of the same organism and you have, I have argued (chapters 3-6), an inner representation. Mechanisms that control complex and flexible behaviors are, in general, guided by inner representations (chapter 5). The ethology of humans, in so far as it deals with these systems, is called "cognitive psychology". The job of cognitive psychology is to find out how the systems regulating complex flexible human behaviors are guided by perception such that, given a normal (ideal) environment, they effect formation and placement of beneficial behaviors in the environment.

The physiological part of this task must involve a description of the relations that inner representations normally (ideally) bear to the environment such as to make this formation and placement possible. The behaviors to be explained are wide behaviors, like making dams and ponds, or making symphonies or friends or revolutions or money. What must be explained is the whole ideal process of perception, concept formation, belief and intention formation, how the intentions become imbued with (biological) reasonableness, and how they get themselves fulfilled. What must be explained, that is, is what the various inner cognitive mechanisms do when all goes swimmingly such to account for their continued proliferation in the species. Also, just as the physiologist studies methods of recovery from disease and injury, the cognitive psychologist will study methods of recovery from false beliefs and harmful desires, and methods of detecting and jettisoning confused concepts (chapter 14, Millikan forthcoming). That completes the big picture. Let me now sketch some details.

VI.

In chapters 4 to 6, I sketched some details for a theory of "indicative" inner representations--those inner representations that are designed to mirror an organism's world. Here I must say more about "imperative" inner representations, for it is the functions of these representations that connect most directly with behavior. Indicative representations are maps of what is, while imperative representations are blueprints for what is to be done. The simplest representations are undifferentiated between these two moods, as are bee dances, which tell the bees both where the nectar is and where to go. Perhaps we understand the idiom "what one does" in this undifferentiated fashion. Also, perhaps formed intentions, as distinct from mere desires, are undifferentiated between these two moods, serving both as blueprints for action and as maps of things will be in the future. It seems likely that the development of organisms having the capacity sometimes to separate indicative from imperative representations was a major breakthrough in the evolutionary history of cognition.

Imperative representations are blueprints or plans for what is to be done. Their job is to guide the organism toward achievement of the ends they represent. As in the case of indicative representations, imperative representations are supposed to vary in parallel with how the world varies, but they are supposed to cause the world to vary as they vary, rather than being caused to reflect the world's variations.

I have suggested that desires are such blueprints. That is, one proper function of a desire is to help cause its own fulfillment. Jerry Fodor is distressed by this suggestion. He does not see how there could possibly be any sense of "normally" in which desires are normally fulfilled (Fodor 1990, p.85). Although "desires are normally fulfilled" isn't exactly how I would prefer to use the term "normally" (see chapter 6), still I think Fodor is rather too fainthearted. Desires could be said to be normally fulfilled--and sperm normally to reach ova--in a sense of normal very close to the one we have been employing, where the normal is what conforms to a biological norm or ideal. Here is the argument.

Presumably the biological point of the capacity to represent goals to oneself is to make it possible to vary them, to evaluate them, to arrive at them rationally, and to arrive at rational means of fulfilling them. It is not, then, that one first has a goal and then represents it; representing it must be a way of having it. But the function of a goal, obviously, is to be fulfilled. Representations of goals are supposed to help guide the organism toward their own fulfillment. Desires, on the other hand, might be thought of as competing with one another for allocation of resources which, once allocated, turn them into goals, then perhaps later, when belief in their impending fulfillment is warranted, into intentions. The capacity to have desires is maintained in the species, then, only in so far as some desires become goals, then intentions, and finally are fulfilled. Hence one of the functions of desires, too, is guide the organism towards their own fulfillment. Indeed, their function is to get themselves fulfilled even when they are contradictory, or when their fulfillment would be devastating to the organism that harbors them. Let me explain.

To see this, we concentrate on relational rather than categorial descriptions of the functional aspects of representations, as follows. We think of indicative representations, or indicative intentional icons (see chapter 5, section 2), not as corresponding one by one, each to a separate normal condition for proper performance of its (inner) users. Rather, think of each as requiring the same normal condition as every other indicative representation occurring in the same inner representational system. This condition is described relationally. It is the condition that there be an aspect of the environment bearing a specified projection relation to the icon. The imperative representation or icon should be thought of the same way. Compare: the function of a blueprint showing a building with structure A is best thought of not as that of guiding the builder so that he builds a building with structure A. Its function, described relationally, is to guide the builder in building a building that accords with the blueprint by certain standard rules of projection--one that bears a specified relation to the blueprint. Similarly for the desire, goal or intention to build A. This latter way of thinking makes it less mystifying how each new desire or intention apparently manages to have a brand new biological function. The function isn't really new, it is just relational (LTOBC chapters 1 and 2).

Imagine now a builder with a blueprint in hand that, due to some mistake, shows a building in an impossible space (in the style, say, of M. Escher). The builder tries to follow the blueprint and of course it is the function of blueprints generally, hence of this blueprint, to be followed. Exactly so, a person can intend to square the circle, or to trisect the angle, or to find the last prime number. A person can desire not only what is impossible, but what they know quite well to be impossible, or to be completely beyond their control. That a desire cannot bear fruit, or cannot bear fruit in a normal way, no more cancels that bearing fruit is its function, than the fact that one is tied down under water cancels the function one's breathing has. To think otherwise is to confuse having a function with actually serving or being able to serve that function (see chapter 1). Of course one might suppose that if humans were better designed they would cease desiring what they know they can't achieve. Most of us are designed pretty much that way, in fact. But if what the desire purposes is something extremely important, perhaps it is well if the desire does not retreat as soon as its fulfillment is judged impossible. For such judgments can be wrong.

That desires can be for things that are biologically harmful or useless is no mystery either. Surely it is a function of the bee dance to lead the watching bees to the indicated nectar, even if it is poisoned. Prior to that, it is a function of the dance to lead them to a certain location, even if someone has taken the nectar away or replaced it with a trap. Similarly, suppose that a bee makes a mistake and dances a dance that's just wrong, either because the bee is not normal or because environmental conditions are not as required for it's accurate functioning. In either case, a function of the dance is still to lead the watching bees to where the dance says the nectar is. (If I pick up an awl mistaking it for a screwdriver, its function remains that of an awl.) Similar points apply to desires and intentions. The fact that if I go on the plane to Chicago I will be poisoned there, or that the plane will in fact never reach Chicago, does not cancel that the biological function of my intention to take the plane to Chicago is to get me to Chicago. Nor do misconceived or unhealthy desires cease to have fulfillment as their function just because they are misconceived or unhealthy.

(A similar point about belief is that believing truths can sometimes be fatal while believing falsehoods may sometimes save lives. But it is not, of course, <u>due</u> to their truth or falsity that these beliefs have these properties, but for entirely incidental reasons. It certainly doesn't follow that it is not a proper function of the belief fixing mechanisms to fix true beliefs. Jerry Fodor has suggested that we may be equipped with mechanisms designed exactly to <u>keep</u> us from believing truths when these would be unbearable (Fodor 1987, pp. 106-7). It would be odd indeed, however, if these mechanisms were designed such as to condone unbearable false beliefs. Better to call them overriding mechanisms that prohibit the formation, just, of unbearable beliefs, truth and falsity having nothing to do with the matter.)

VII.

All this has been to make plain how a person's goals and plans can be understood to coincide with biological functions of their activities. Thus it is that a person's behaviors are largely defined by the person's goals and intentions in so far as these are realized. "Jane pointed to the red block", "Jane said that she was ill" and even "Jane got herself an AB degree", when these describe intentional actions, are pure descriptions of behavior in exactly the same sense that "the eye closed", said of a reflex eyeblink, is a pure description of behavior. By contrast, "Jane held her index finger out at a 57 degree angle to the floor", "Jane (made sounds that) caused the wine glass to vibrate" and "Jane increased textbook company profits", said of the same activities fail to be descriptions of behaviors for exactly the same reason that "swiftly the upper eyelashes pointed toward the toes" fails to be a description of the proper structure of the eyeblink reflex.

Turning this around, the essence of intentional action is the fulfillment of a certain kind of biological function, the function of an imperative or goal representation. More carefully, it is the fulfillment of this kind of biological function in accordance with a biologically normal explanation, rather than by some accidental means.[5] But while all of a person's intentional actions are behaviors, of course not all of a person's behaviors are intentional actions. Eyeblinks and ducking reflexes, for example, and once learned but now automatic patterns and responses, are not intentional actions, these not being guided or being no longer guided, we can speculate, by goal representations.

To explain behaviors requires explaining how functional coordinations between body movements and features of the environment are achieved. The centipede walks <u>on the floor</u>, the chameleon turns <u>the same color as what it sits on</u>, Amos runs <u>from the cat</u>, and Rattus presses <u>the bar down in response to the bell</u>. The behavioral scientist must explain, for example, how Amos' movements coordinate with those of the cat (though not of the clock) so that a distance is maintained between them, and she must explain the principles in accordance with which the bell comes to produce not just a movement of the paws away from the nose in Rattus, but just that response that will effect the arrival of food. Especially in the case of those behaviors that are intentional actions, reference to mechanisms of inner representation will play a large role in this kind of explanation. The purpose of this reference will be to explain how intentional behaviors are formed and appropriately placed in the environment. An examination of normal (ideal) relations between the environment and coordinated cognitive structures in the organism, and of how in normal (ideal) conditions these relations are put in place (wider developmental psychology), is a central part of this explanatory task: How are adequate concepts developed and true beliefs formed, and how do healthy desires arise out of experience and

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[5] For the mirror image interpretation of what knowledge is, see chapter 12.

become realized?

Individualists in the philosophy of psychology have expressed incredulity that true and false beliefs might be treated differently for purposes of psychological explanation. They suppose that the truth or falsity of a belief has no effect on the operations of the cognitive systems. Their error is to suppose that the cognitive systems are located inside people's heads. Rather, the cognitive systems are largely in the world. I no more carry my complete cognitive systems around with me as I walk from place to place than I carry the United States' currency system about with me when I walk with a dime in my pocket. If I don't know that Alice is wrong that the bus leaves her corner at 7:37, how will I explain why she breaks her promise to meet me at 8:00.?

In sum, predictions of the motions of individual heaps of human cells under random conditions obviously is not what human psychology is about. It is about the proper (wider) development and operation of the human behavioral systems under conditions normal for carrying out their biological functions.

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