CHAPTER SEVENTEEN
GENERATING GOAL-STATE REPRESENTATIONS

The picture that emerges from Chapter Sixteen is apparently very neat. If the animal has trained itself well, given the perception of an appropriate enabling affordance, the representation of a goal state becomes a representation of a predicted future state which, if no infelicities occur, is soon followed by a correlative perception of a current state. But these optimistic reflections leave an urgent question unanswered. The neat picture has a hole in the middle. Recall that the animal driven only by representations of affordances derives these representations, hence derives its motivations, from current perceptions of its environment. This is so even when current perception is supplemented or extended by stored knowledge of the spatial and temporal layout of currently unperceived parts of the animal's home domain (Chapter Fifteen). But where do the representations of projected gaol states come from? What is their origin; what prompts them? We have discovered some possible origins of detached representations of fact. But nothing has been said about the origins of detached representations of gaol states.

Recall, for example, the squirrel studying how to get to a bird feeder (Chapter One). I watched one recently trying to reach a feeder hanging on a chain from the eves overhanging the deck of our house. It studied the situation from under the feeder, then from one side of the deck, then from the other. It ran slowly along the deck railing, looking from one side, then from the other. It did this several times on several different days. Finally it took a run along the railing from one side, ricocheted off the screen of the door to the house, landed precariously with its front paws on the edge of the feeder and pulled itself up. Without doubt that squirrel had a goal in view the whole time, indeed, quite literally in view. It saw the bird feeder which afforded approaching and feeding from. The squirrel's difficulty was that it did not yet perceive any enabling relation to guide it to utilize that affordance. A complete affordance would have to include mediation by a path between the squirrel and the bird feeder. The squirrel's perception of a goal controlled its action as it moved from side to side trying to see a path. But this goal representation was probably the representation of a goal, not of a gaol state. It was a representation of something present, not future. The origin of this representation was perfectly plain. It derived directly from the squirrel's perception of its then current environment.

On the other hand, consider what it was for the squirrel to be "looking for" a path. Recall that even the pure pushmi-pullyu animal, if advanced at all, does not just happen to perceive hence to act on affordances. Depending on its current needs and on its current environment, it will be ready to act on certain affordances and not others. Moreover, as suggested in Chapter Thirteen, likely it is disposed to perceive only certain affordances and not others. Thinking of this on a connectionist model, its nervous system is primed to register certain kinds of inputs easily while registration of other kinds may be inhibited. Priming a certain perception is effected by partially activating the neuronal patterns whose full activation would constitute that perception. Thus the animal might envision ahead or "imagine." It is looking for something quite definite, or for something within a definite range. It knows or envisions, though guite abstractly, what it is looking for and is ready to respond appropriately when it finds it. Similarly, the squirrel may know or abstractly envision what it is looking for. It is envisioning some sort of path. It's visual system is primed to register paths. Will this priming or envisioning actually help to guide or control the squirrel's search, or will it merely shorten the response time by a few milliseconds if a path happens to be picked up by its visual systems?

There is a way, I believe, in which what it envisions will actually help to control its

search. It is primed to see paths, hence it will see partial paths too. It will concentrate on or visually explore paths from where it is to places nearer the feeder. And it will concentrate on or visually explore paths from places near the feeder to the feeder. Working both from where it is forward and from the feeder backward, by a trial and error process but one that is carefully directed or constrained, it may eventually discover a path all the way from where it is to the feeder.

If that is right, it is a process rather like practical reasoning. Practical reasoning is often described as reasoning in something like the form of a proof: I desire A, doing B will probably lead to A, therefore I will do B. But being more careful, that is not the way practical reasoning generally goes, but only the way practical conclusions are justified to other people. The core of a practical reasoning processes is a search for a proof. Just as in mathematical reasoning you are likely to start with something you would like to prove, in practical reasoning you begin with something you would like to do or to have done and then attempt to construct something like a proof, a path from premises you have to a conclusion you would like to reach. And you do this largely by controlled trial and error. You start with what you would like to prove and work backwards, trying to find plausible steps that might lead to that conclusion, and you start also with things you already know to be true and work forwards to see where these things might lead. You try to fill in the gap between what you find going forward and what you find going backward. The squirrel is like the practical reasoner in that its search for a path is actively controlled by a vision of its goal as well as by its perception of where it now is in relation to that goal. It differs from the practical reasoner in that its vision is of a currently existing goal object rather than of a future gaol state (Chapter Sixteen). Also, the path it is searching for will be discovered by perceiving a pattern in the actual current situation. This path is a configuration of objects, not a chain of possible future states of affairs leading to a gaol state.

Compare the squirrel looking for a path to the bird feeder with one of Köhler's famed chimpanzees that is looking for a way to reach a banana. A chimpanzee that has been allowed to play with boxes that can be stacked one on another will sometimes see that the way to reach a banana that is high overhead is to stack the boxes and climb up on them. The chimpanzee does not just look until it perceives an actual path. It looks, or thinks, puts representations together, until it sees how to construct a path. In this case it seems clear that the animal must be representing objective situations or states of affairs that would result from following certain affordances. Recall that what was missing in the pure pushmi-pullyu animal was that it did not represent to itself where the affordances it looks for lead, nor, of course, does it follow perceived affordances because it knows where they lead. The disposition to look for and follow an affordance comes first, having resulted from natural selection or from conditioning. The representation, if any, of expected results follows after. It is not what controls the behavior. The chimp, on the other hand, apparently not only sees the boxes as affording stacking, but knows from experience that the result of following this affordance is the creation of a path which can be climbed. Like the squirrel looking for a path from here to the food, it works from here to there and from there to here. From here it sees boxes that afford stacking which will result in a path that can be climbed. From there it is looking for a path to the bananas, a place from which it can reach the bananas. Following the stacking affordance will result in a complete path. Its representation of the result of following the box-stacking affordance now directs its activity

rather than following after. The chimp follows that affordance because it knows where it leads. Apparently we have here an animal capable of projecting gaol states and following affordances because it represents them as leading to these goal states. The result is what animal psychologist's call "insight" or "reasoning." And it is quite a bit like explicit human practical reasoning. It is a form of trial and error, an important part of which takes place in the head using representations of mere possibilities (Chapter One).

Less dramatic than the chimp's performance is the performance of the rats mentioned in Chapter Fourteen, who were conditioned to pull a chain to obtain sweetened water but who ignored the chain after experiencing nausea from drinking sweetened water in a different context. Apparently what the rats learned was that following the chain-pulling affordance results in the presence of sweetened water. When they were interested in what sweetened water affords, namely drinking, they pulled the chain. When they were no longer interested in what sweetened water affords, they were no longer interested in producing the result of chain-pulling, hence no longer interested in pulling the chain. The anticipated result of pulling the chain was in control of the rat's behavior. Before the rat had experienced the nausea, it was motivated perhaps by thirst, which arose from the current state of its body. The thirst primed it for perceiving drinking-affordances, among them the perception of sweetened water. It was thus looking for or had an eye open for sweetened water. Its perception of the chain-pulling affordance and its memory of the outcome of following this affordance then produced the representation of a complete path from where it was to drinking.

The squirrel, the chimp and the rat all differ from the pure pushmi-pullyu animal in this important way. Some of the affordances that they perceive are perceived as mere possibilities. They are not motivated by every affordance they perceive, but only by what they see as part of a complete path to a goal or gaol state they project. Though the squirrel may perceive many paths leading from here towards its goal, it does not follow most of these paths but rejects them when it cannot envisage their completion. Similarly, the chimp searching for a way to the bananas may perceive the boxes as affording things other than stacking, such as turning over and climbing inside or climbing up on without stacking. Searching systematically for a path may require following various leads merely far enough to form representations of where they are leading, then rejecting them. Similarly, the rat may perceive the chain-pulling affordance but rejects it. Nor need we suppose that the perception of a variety of possibilities is always serial. In describing the lattice hierarchy, Gallistel emphasized that many alternative behaviors may be potentiated at once by the same stimulus. Similarly, the animal that envisages the results of following various perceived affordances may be capable of representing a variety of branching possible futures in parallel and "deciding" among them.

In Chapter One I noted that there is a gap between a certain stimulus or experience acting as a reinforcer and one's awareness of what it is about that stimulus or experience that makes it reinforcing. Presumably this gap is not filled by the pure pushmi-pullyu animal for any of its reinforcers. We humans are not always aware of what it is that conditions our behavior either, and sometimes we are aware of aversions or attractions without knowing exactly what it is that averts or attracts (Chapter One). But the ability to represent causes of reinforcement or to represent situations offering affordances leading to B-affordance conditions (Chapter Thirteen) as objective situations or occurrences is prerequisite to projecting these as gaol-state occurrences.

You have to know what you want if you are to represent having it as a gaol state.

In Chapter Fourteen I remarked that the achievement of objective representation may allow the animal to analyze its various activities into distinct completion stages, its extended activities being grasped as a series of transitions from one objective situation into the next objective situation. The objective situations grasped were not merely factual situations but situations that afforded this or that. Thus the chimpanze might grasp a transition from the box being on the floor to its being on top of another box, or you might grasp a transition from the tea being in the pot to its being in the cup. The ability to carry out an extended activity from a starting point A through a series of transitions to B, then to C, and so forth, finally to D, where D is the presence of a B-affordance condition that was projected from the start as a gaol state, may be most likely to result from prior experience of having progressed first from C to D, then from B to C to D, then from A to B to C to D. Certainly that is the easiest way to teach an animal to progress through such a series of stages to reach a gaol state. But in considering Köhler's "insightful" chimpanzees, we looked at another kind of possibility. Köhler's chimps had experienced progressing from C to D, from being in a place where food was in sight, moving to a place where it was within reach, to procuring food. They had also experienced progressing from A to B, from being within reach of boxes, through stacking the boxes, to being in a place that afforded being within reach of things higher. Their accomplishment was to put these two partial paths together to make a full path to obtaining the banana. The difficult part, we can suppose, was not to see that if these two paths were joined they would lead to procuring a banana, but to happen to represent putting these two paths together. The difficulty was that not only the boxes but many other things in their cages afforded a great many alternative activities. To think of stacking the boxes might seem like happening on the needle in the haystack. Nor am I prepared to speculate by what mechanism the intelligent animal's search for the right combination proceeds in such cases. What does seem evident, however, is that if the animal needs to put together for the first time more links in a chain, more sections of a path that has never been traveled before, the problem of finding a correct linkage increases in difficulty exponentially. It should get harder and harder to happen to think of a combination that will work. And indeed, putting together several links in such a chain does seem to be something that perhaps only people can do.

How do people do it? Again, I am not prepared to speculate much on mechanisms. But first, it is worth pointing out that putting together such chains does often take considerable time and considerable concentration. Planning a trip, for example, can take many hours, not just collecting information, but figuring out how to put that information together to produce the desired result. Or suppose that I wish to communicate a message to Paula. Working backwards, I might think of doing this, say, by direct encounter, by phone, by e-mail, by letter, by messenger. Each of these possibilities may be considered. Do I know where Paula will be in the next day or two? Will I be in any of those places? Could I easily get to any of those places? Do I know anyone else who is going any of those places? Does Paula have a phone? Do I have her number? Do I know someone who knows her number? Will she be in the phone book under her own name or under her husbands? Do I know where there is a phone book? Do I know where there is a

phone? Does Paula have e-mail? Do I know her e-mail address? And so forth.

Perhaps more important, long range activities that we plan are never planned in detail. Planning and execution have a hierarchial structure. The plan is first filled in in chunks and then the details of the chunks are filled in as we proceed. When we carry out a long range project or action consciously and deliberately, what we explicitly intend to do at the start is represented very abstractly. Given our past experience, we know what general sorts of ends we are generally capable of achieving from what sorts of starting points. But the details of exactly how we will fulfill a particular intention in a particular case are represented only by the confidence, "I will know how to do that part when I get there." In order to attend a meeting, I plan very definitely to go to Boston on November 16th, knowing I am, in general, capable of getting to nearby cities, and from within them to designated hotels. But perhaps I do not know even what basic form of transportation I will take, let alone the thousand other details of my trip. These will depend on the details of circumstance that I encounter later or along the way, such as how much the university will reimburse me, whether the trains run there at reasonable hours, how close the train station is to the hotel, and whether it turns out to be raining that day. Similarly, how the chimp will move in proceeding to stack his boxes will depend on where they are currently placed in his cage, how heavy he finds them, how large they are compared to his arm length, and so forth. The chimp also projects ahead the result and the means of its planned labors only abstractly.[1]

FOOTNOTES

1. Here is Gallisel's description of how action is planned within the motor system:

> As a rule of thumb, the higher the level receiving a sensory input, the more global and diverse will be the possible effect of that stimulus on the animal's action. As one ascends the hierarchy, stimuli play more and more of a role in determining the general course of action and less and less of a role in determining the particular pattern of muscular activity used to pursue that course at a given moment. A correlary of this principle is that the higher one goes in the hierarchy the more elaborate the sensory/perceptual analysis of sensory signals; or, what is not quite the same thing, the more global the sensory factors that serve as inputs. The generals determine where the armies are to be deployed. In doing so, they must respond to the geography of the country and the deployment of the opposing armies. The lieutenants determine where the trenches are to be dug. In doing so, they must respond to the local topography and the

disposition of opposing forces in their locales. The sergeants determine where the latrines are to be dug. In doing so, they respond to the distribution of bushes in their immediate vicinities. (Gallistel 1980 p. 286)