A stroll in the park or What is a sociologist to do

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Written for Dr. Charles W. Tucker, Department of Sociology, University of South Carolina, and other PCTers interested in sociology, this essay reflects an effort to come up with ways for sociologists to make empirical tests of the workings of the proposed hierarchical PCT model. That was not my interest when I read it, and it may not be yours either. This essay filled me with a sense of wonder as I read the outline of the stroll through the park. (I have taken the liberty of adding that to the title). To me, this paper is an imaginative interpretation of the Perceptual Control Theory Hierarchy in action, something that is so very hard for students of PCT to visualize. As always, Runkel's writing is a delight, with his modesty and sly humor. Here is the essay, slightly edited by Runkel in April 2006. The cover letter to Dr. Tucker, below, has also been slightly edited.

Dag Forssell, April 2006

Dear Chuck:

On 17 October 1994, you wrote an e-mail to the CSGnet about empirical support for PCT. It referred to a previous posting of yours on 29 September. You sent e-mail to me on 18 November saying a few things about your struggle to explain your troubles (as a social scientist) to your friends in the CSGnet. I told you that I would send you my own thoughts on that matter before long. I began making some notes about what I would say to you. I moved my letter to you to the top of my list of things to write.

For many reasons, some known to me and some not, that letter to you took shape very slowly. Sometimes, too, its shape would slump like warm jello and I would find I had somehow lost track of the recipe. Sometimes I would have a feeling that I had seized upon a Truth, but when I sat down to write, the words would slither this way and that and refuse to hang together. I became embarrassed about my lack of progress. I believe I wrote you a brief apology, or I meant to do so.

Enclosed is the jello I have produced. Some of it has some shape, I think, but I don't think any of it is very solid. I hope that you (and others who are interested) will find some paragraphs worth reading. (If you all find the same paragraphs noteworthy, then I'll feel that I have surely hit upon at least one useful idea, though the remaining dozens of pages will have to go into the wastebasket. If you all choose different paragraphs to approve, then I'll feel that I have pleased a lot of people, each one by writing something the majority found uninspired. Such are the joys of authorship.)

I do hope you find something useful in the enclosed paper, even if it is only my sympathy. I have written it, of course, not only for you but also for me. For myself, I have discovered several domains of mystery. I have also found myself holding several opinions that seem to me wholly justifiable but which I am unhappy to have to hold—such as the opinion that it is impossible to model group action in the sense of asking a group of people to do something in an unrestricted environment and having a model in a computer that will mimic what the people did as a group—or will do.

Anyway, I have come to the point in my ruminations where I think I have gone as far with this topic as I can go, at least for this season. If you (or any of the others) want to reply to any of this, I'll be grateful, but I don't demand it. After all, I've taken more than a year to reply to *your* letter.

Sincerely
Philip J. Runkel

WHAT IS A SOCIOLOGIST TO DO?

I find it very difficult to think how one might, in an unrestricted environment, keep track of the match a person maintains between a perception and a particular reference signal. I agree, however, with Charles Tucker's opinion that the ability to keep track would be greatly prized by sociologists.

By an unrestricted environment, I mean an ordinary environment containing multiple opportunities for controlling several or even a great number of perceptions. Examples are the environments we deal with when buying groceries, depositing some money in the bank, visiting a sick friend, consulting with one's accountant, and exchanging political views with a group of colleagues. On such occasions, an action very rarely keeps only one perceived variable close to its standard (its reference signal). Rather, one action (or sequence) typically brings several (even many) variables closer to their standards or maintains them close, and one variable may hang unaffected through several (even many) actions until an action is taken that affects it. Opportunities for controlling a particular perceived variable come and go. Sometimes a person may take no action affecting a particular variable for many minutes, hours, days, months, even years; then at last the person may act to move the value of the variable closer to its standard. To the rest of us, the connection of the action to the variable may be hard to see.

Apparent Gaps in the Loop

When we must wait for an opportunity before we can act to change the value of a perceived variable, compensating for disturbances is slow. Internal standards high in the hierarchy are formed, I suppose, on a series of events that we perceive to have some similarity. Early in our lives, for example, we come to remember certain kinds of activities as obligatory, as not much fun, and as postponements of satisfying activities. We remember other kinds of activities as voluntary, fun, satisfying, and probably good in several further ways. Later, we may come to think of the first kind as "work" and the second kind as "play." That is, we form internal standards for "work" and "play." When we get to feeling that we are not playing enough, we can look for a time or place in the environment where we can carry out one of the kinds of activities we conceive as play. There may be, in brief, a gap between becoming conscious of a want of play and beginning to play. At a more encompassing level, we may come to feel it to be our duty, or perhaps just a good thing, to help children find pleasure in social recreations. Satisfying that more encompassing sort of principle also proceeds by sporadic action. That is obvious, too. I say it, however, so that I can put the matter more formally, like this: When an internal standard is high in the hierarchy of control, the standard is a specification of the relationships (or weightings) of what were once perceived as discrete events, and the feedback loop can be completed (as long as the weightings are not changed) only when events occur that are perceived to be the "same" as the events on which the higher-order standard was formed in the past. Maybe the formal way of saying it will remind us that the higher-order purposes that typically interest sociologists are those most likely to appear intermittently in ordinary life, those pursued through several sorts of actions that might simultaneously serve or disturb other purposes, and those likely to be very difficult to study off the computer screen.

Suppose, for example, you are having a conversation with several people, and as it goes along, you find yourself wishing that George would pay attention to what Barbara is saying. You might try to redirect George's attention by telling him you want him to pay attention to Barbara. But suppose that the next time Barbara speaks, George interrupts her and says something that has no connection to what Barbara has been saying. You might then ask Barbara to complete what she had been saying when she was interrupted, and you might then explain to George how what Barbara has said connects to an opinion George has expressed earlier. If at a later time Barbara speaks and George again gives no indication that he has heard her, you might ask George if he has anything to say about what Barbara has just said. And so on. You must wait for Barbara's remarks and George's responses (or lack thereof) before you can take action that you hope will bring you a perception that George's ears have opened to Barbara's remarks.

All this is part (just part) of what control theorists mean by the slower pace at which control must work at the "higher" reaches of the control hierarchy. (I like to think of the "levels" of system concepts and principles, for example, as "more encompassing" rather than "higher.") The formation of the highest standards is itself slow, since the categories, sequences, and programs they encompass (indirectly control) come to our experience irregularly and interspersed with many irrelevant categories, sequences, and programs. Your standard (reference value) for George's

attention to Barbara cannot come into being until you have experienced some extended conversation with both of them. The actions of George you will interpret as "paying attention" depend on nuances you will note as the conversations go along. And when the standard has become sufficiently well formed, the opportunities for acting to maintain it will usually occur at about the same rate as the events that enabled you to conceive it in the first place.

And how does this problem of tracking the controlled variable look to the other members of the discussion group? What can they infer about what I am trying to do? They might think that I am trying to attract Barbara's favorable attention to myself. Or that I am hoping to win an argument with George by showing that I have allies on my side—that he should give up because he is outnumbered. Or that I am trying to stir up an argument between George and Barbara for my own amusement. In trying to test any of those hypotheses, a member of the discussion would have to watch for any sign that my action has an effect on maintaining the condition that member thinks I am trying to maintain. Aside from the multitudinous actions and events and combinations of them, the complexity of the hypothesizer's task is exacerbated by the difficulty of defining; that is, of finding the boundaries of actions and events. To which part of my last 40-second remark should the hypothesizer attend? When Barbara shook her head, was that an event in itself, or a part of one, or a context? And so on.

The problem is like one the evolutionists have. In a chapter written in 1972, Eldredge and Gould said, "...new fossil species do not originate in the place where their ancestors lived. It is extremely improbable that we shall be able to trace the gradual splitting of a lineage merely by following a certain species up through a local rock column" (p. 94). And in 1982, Dawkins said, "... bursts of microevolution are usually completed too fast for palaeontologists to track them. All we can see is the state of the lineage before and after the new species is formed" (p. 102). Eldredge and Gould's idea of "punctuated equilibrium" becomes appealing—that in any lineage, long periods of stasis will be punctuated with brief spurts of change—periods when genes are being selected from generation to generation that can cope with a new environment or with a mutation in other genes. The evolutionists, too, must wonder about the boundaries of "events." Where does this species begin and end in morphology or in dates? The evolutionists are busy arguing about the best use to be made of the idea of punctuated equilibrium, but it seems to me that control of the "higher" or more encompassing variables must almost always be episodic, sporadic.

Maybe trying to track a controlled variable in a reasonably unrestricted environment is like trying to track a lineage that changes during a punctuation between periods of stasis. Maybe it will be at least as difficult. Actions to oppose disturbances are not only scattered irregularly in time, but are dispersed in space and are various in the features by which we can recognize them. To counter disturbances to a particular variable, a person may caress a cheek, buy a gun, go off by herself in a canoe, and watch a television documentary about fossils. How is the scientist to know where to be and when to look and in what direction to measure?

By now you may be saying, "So what? Maybe what we can do will be difficult, but what is it we can do, difficult or not?"

Here, therefore, I will take space to say what my conclusions will be about the kinds of work a sociologist can do, once he or she becomes infected with perceptual control theory, and can do without suffering inner conflicts about conscience, self-identity, maintaining the respect of colleagues, pleasing the Committee on Rank and Pay, and the like.

What Sociologists Can Do

At some early point, a sociologist must consciously choose a "problem" to investigate. Perceptual control theory can help by warning the sociologist away from unprofitable problems. The models of the individual provided by PCT will specify the kinds of influence among individuals that are possible and not possible. For example, control theory allows no possibility at all for one person to control directly the action of another except by overwhelming physical force in the manner used by a puppeteer. Control theory implies that no manner of influence can, in principle, reliably cause a particular act by another person. Reliably predicting a particular act requires very special circumstances: the person (or other animal) must be put in a drastically limited environment in a condition of strong need (large perceptual error), and the available resources for action in the environment that can reduce the need or error must be extremely limited. For example, a very hungry rat can be put in a box that has no features other than a lever and a small opening through which food pellets can be delivered. The rat, if sufficiently

hungry but still sufficiently mobile, will do nothing but hunt for something that might be food. Before long the rat bumps the lever and food appears. The rat can then be counted on to push (or pull, or bump) the lever until its hunger is satisfied. You can see that the necessary special circumstances will not last long, even in a restricted environment.

Given this corollary to control theory—that causing particular acts on the part of other people is in general not possible—the knowledgeable sociologist will never, for example, spend time searching for the irresistible mode of influence, the infallible method of leadership or management, the ideal five-year plan, the perfect form of government, or the perfect constitution for a democracy. The sociologist will know that the causal connections between what some people (such as leaders, managers, or teachers) do and what other people (such as followers, workers, or students) do are forever changing with the people acting, the resources available in the environment, and the causal connections among the resources in the environment. Furthermore, the criteria that leaders or scholars may choose with which to evaluate leadership, management, government, or democracy will change according to the values that they have adopted and that they find disturbed by the current social scene. In one period, good management may be judged by the amount of profit gained for stockholders; during wartime, it is more likely to be judged by the amount of well functioning product delivered. In still another period, managers may be judged by the steps they take to reduce the pollution of the environment or to improve the economic security or health of their employees. Similarly, the sociologist will not recommend long-term planning as a means of making sure of the actions others will take next month or next year or next decade. The sociologist will recommend planning, if it should be called that, as a way of discovering the personal goals of colleagues and as an opportunity for all concerned to anticipate conflicts and to discuss ways of avoiding them. You can think of numerous other kinds of fruitless problems sociologists do investigate but shouldn't.

In general, the sociologist espousing perceptual control theory will not try to predict particular actions by all people, by people "in general," or even by all of some subclass of people. They will give up hunting for "social laws"—for inevitable patterns of observable actions in collectivities. In studying the actions of living creatures, they will no longer hunt for independent and dependent variables. And they will jettison the idea of the operational definition (for reasons given on page 149 of *Casting Nets*).

Those are some goals and methods that sociologists and other social scientists may as well give up, because they cannot achieve them. That is the negative advice. What is the positive advice?

Scholars studying collectivities have been doing some useful things all along, and they can continue to do them. First, they can catalog the myriad ways people make use of their environments, physical and social, in pursuing their goals. To do that, and for the study to be useful, it is not necessary to know the goal each person is pursuing at all times or even at a particular time. It is sufficient to observe that people have declared a common goal or have declared themselves followers of a leader who has enunciated a particular goal. The scholar can then report, "Here are the courses of action we observed people to take who had declared themselves to aspire to goal X. If you want to achieve goal X (to reach a condition you think these words stand for), these are at least some of the courses of action you may find your comrades proposing, and some of the eventual outcomes of those actions." That is very useful information. It tells people likely things to look out for-outcomes of which they might not otherwise have thought. Note that useful information of that sort is better told as narrative than as tables of statistics (though tables can help).

Second, scholars studying collectivities can look for evidences of goals and values that come into play that differ from those publicly professed in a social enterprise. It is not necessary to know whether particular individuals harbor conflicting standards. It is enough to be able to warn onlookers that they may encounter contradictions when they deal with people in that enterprise. Muckraking is a valuable public service.

Third, scholars studying collectivities can estimate (here random sampling can be useful) the kinds of internal standards that are regularly disturbed by the events of everyday life in our society and in others. Cultural anthropologists, too, have delivered useful information of this sort. This sort of information can make us aware of *possibilities* that we would not otherwise have seen.

Fourth, scholars can look for ways that the presence or absence of opportunities in the physical environment affects social life. I am astonished, for example, at the frequency with which an agency such as the World Bank has funded projects that took no

account of the physical conditions in Third World countries. For example, the World Bank has more than once provided funds to build a factory or establish a farm that produced a product sorely needed by the people of a region, only to find the product lying rotting because the Bank had not thought whether there were roads, trucks, and communication networks that could distribute the product. Similar myopia occurs in the United States. Employers have advertised job openings they think will appeal to unemployed people without wondering what fraction of their possible employees buy newspapers to learn about the jobs or have cars or bus service that will take them to newspapers in libraries or to offices where they can apply for the jobs. Digging out this kind of interdependence requires the scholar to look into several disciplines; this sort of error often occurs because the designers do not think beyond their own specialties.

Another example of the importance of the opportunities in the environment is that of "enrichment" in schools. For a century or more (about the same period during which regimented schools for the masses have existed), educators here and there have understood the usefulness of the rich environment. That does not mean the number of books in the library, the number of courses in the curriculum, the number of field trips, or the prestige of the faculty. It means the varieties of experience available to the children at their fingertips at every moment, available without permission, without scheduling, without hindrance, without threat. Especially for very young children, objects intended for them to explore must be set out in plain sight where they can be used immediately, not put away behind cabinet doors. Books should not lie in a dark corner. An umbrella should not be available where opening it could easily poke the face of another child. The principle of richness has been used by Montessori schools, by the "corridor" schools in New York City, by the "brain-compatible" schools conducted according to the precepts of Leslie Hart, and by Head Start, all with good results in the knowledge and skill the children acquire, in the ability they develop to explore and learn, and in their enjoyment of doing those things.

As children learn more about finding materials, the materials can be stored farther from their fingertips, so to speak. When children have become acquainted with the idea of a library and have acquired some skill in using one, books for their use can be stored there—if they are freely allowed to go there. Availability for a college sophomore will look different from availability for a first-grader. I have heard of only one use of enrichment in this sense with college students; it was carried out by Robert E. Horn (1972).

Fifth, scholars can use the information got in those four ways I have mentioned so far, together with knowledge of the control of perception, to propose ways to alleviate social problems. To managers, administrators, politicians, teachers, theatrical directors, and any other sort of leader, scholars can propose designs for doing things that minimize the extent to which people interfere with the feedback loops of other people-the extent to which they cause strong disturbances for others or block others' sensing of variables the others want to control. To say it another way, scholars can offer designs for collective action in which the degrees of freedom for individuals are maximized. (See also pages 177–178 of *Casting Nets*.) And in giving advice to leaders of various sorts, it is important to say also what *not* to do. Saying what not to do is especially important when there is a plethora of wrong advice being bruited about. I will not take space to list here all the examples of wrong ideas that dirty the current intellectual atmosphere.

So far, I have written about activities that sound like mere compilations of facts or of statistics about single variables. But all these kinds of information-gathering are rife with opportunities for a sixth sort of activity—examining the commingling of variables. Given some knowledge of the culture, it is possible to hypothesize that certain kinds of action on the part of *some* persons A will offer opportunities for goal-seeking reactions on the part of *some* Bs. You cannot predict, of course, that everyone will use those opportunities for certain purposes, nor can you conclude, when some act, that everyone was "tending" to act that way. But it is useful to report that 60 percent of Bs took action of type X, 45 percent type Y, and 30 percent type Z. That will often be a surprise to people who would have expected other proportions, and will therefore be valuable information. That kind of hypothesis is common in social science, and it is useful if we do not claim that we are discovering universal laws—that we are finding secrets of the functioning of the human animal. It is useful if we claim only that we are finding what *can* happen to some important degree or frequency. Furthermore, there is considerable room for surprises if the hypotheses are made with control theory in mind. Much advice (to continue with my previous example) both in folklore and in scholarly writing, assumes that

it is possible for some people to control other people and, indeed, that society can be ordered satisfactorily only if some people *do* control other people. Since perceptual control theory assumes the opposite, some hypotheses can be asserted that now appear only rarely in the literature. I will leave the formulation of such hypotheses to the reader as an exercise.

You may be thinking, "How does he think I can get a paper published that merely reports percentages without tests of statistical significance?" Well, I don't say you must omit tests of significance. There are ways, I think, that you can do what you want while also doing what editors and committees want. For example, you might want to probe a hypothesis, as Robertson et alii (1988) did, that *everyone* in your experiment will act in a certain direction. You could include a test of statistical significance because it will seem reasonable to most readers, but you don't need to base your arguments on it. Most reviewers won't notice the lack of connection. As another example, you might offer the hypothesis that people in a group having controlled variables disturbed will act against the disturbance, but people in a group not controlling those variables will not act against disturbances to those variables. That hypothesis could be put into the ordinary language of independent and dependent variables and control groups: persons in Group A will on the average show greater opposition to a change in variable X than persons in Group B. Then if you want to show the editor and committee that you are following the time-honored canons of research method, go ahead and calculate the chance likelihood of the difference you get. From the PCT point of view, the "control group" would be superfluous, and you would be hoping that *everyone* in group A would oppose the disturbance. Your companions in the Control Systems Group will snicker at your inclusion of the "control group" and the statistical test, but you need not mention that to the editor or committee.

I have been trying to think of how to design an experiment that would be parallel to Robertson's but would use a different controlled variable other than self-concept. It seems to me that everyone maintains some sort of buffer zone—or several sorts. I mean what people call variously elbow room, freedom of action, keeping one's options open. The idea overlaps with building a strong castle, but also with striving to learn the features of the physical and social worlds that can help or hinder us. We react against disturbances by saying, "Don't crowd me" and "Don't fence me in," whether we are talking about physical space or about figurative space such as the freedom to go about one's job in one's own way. I think of all those manifestations as ways of maintaining room to maneuver, both physically and otherwise, when some unexpected threat occurs. I think of this internal standard as "free space."

I don't claim that everyone has the same standard for free space. I claim only that everyone has some standard—or more likely a cluster of standards—that serves the function of maintaining maneuverability. I am ready to be wrong. I know that it is dangerous, at this level of functioning among humans, to postulate that the same "thing" or even very similar things can be found in several persons. But maintaining free space seems to me sufficiently ubiquitous that it would serve in an experiment as an internal standard to be disturbed.

I have not, however, succeeded in inventing a design for an experiment using free space. People differ in the "amount" of free space they try to maintain. Some people want lots of physical distance between themselves and others, while other people seem to need little. Some people try to learn a great deal about their friends and co-workers, while others seem satisfied with whatever information others choose to give them. And wanting a lot of one kind of free space seems not to have an necessary relation to wanting a lot of another kind. So one would have to be ready, it seems to me, to disturb a wide variety of kinds of free space from one participant to the next. People differ, too, in the speed with which they react to disturbances of their freedom to act. And those "constants" or parameters in the equations will change, I think, as a person becomes more familiar with the sorts of disturbances (such as the approach of other persons) that frequently happen in a setting. So maybe the participants' characterizing constants would have to be repeatedly reevaluated. With all that, it seems to me that setting up such an experiment would be very perplexing and maybe very expensive. But I hope I am missing an essential simplicity. I hope someone else can see more clearly how to go about this.

I think that the six kinds of information I have described will be valuable not only to practical people, but also to scholars; the information will tell us about the capabilities and limitations of our society. But some readers, I am sure, will remonstrate. "That," they will say, "is not really science!"

I can offer comfort of three sorts to those remonstrants. First, many of the studies implied in what I have described will look, superficially, very much

like studies currently appearing in the journals we call scientific. You can look as much like a scientist as all those authors in those journals. But you may not be satisfied with that; you may want to get away entirely from the method of relative frequencies and work with the method of specimens; you may wish to do modeling. In that case, I offer a second choice: you will have to give up studying collectivities and turn to individuals. Then you will be doing studies that will probably cause a lot of others to think of you as a psychologist. But if you are an academician, you probably won't have to move to the psychology department as long as you put a paragraph in each research report purporting to show a connection between what you studied and a topic or two common in your department's discipline. Third, you can do studies that generate the kinds of information I described earlier, but cease thinking of yourself as a scientist. You can instead think of yourself as an engineer, a humanist, a folklorist, or journalist. All those are respectable occupations; their practitioners are berated no more by the public, I think, than are scientists.

Finally, you can resign yourself to being a maverick—or glory in it.

I return now to the gaps in the loop.

The Impatient Researcher

Sometimes excellent coordination in an organization can be achieved by learning a few ways to avoid disturbing a boss or two. Long and rewarding careers in bureaucracies have been achieved simply by learning how to avoid coming to the attention of bosses.

Sometimes we do try to discover the encompassing variables, or a few of them, or one of them that another person controls. We do this, typically, with persons with whom we expect to interact frequently—bosses or spouses, for example. When we do try to pin down an encompassing controlled perception such as a program, principle, or system concept, we usually find it difficult—sometimes a lifetime project. Because, however, of the scope and confusions of such a project, its lessons are difficult to transfer to science; it rarely teaches a researcher how to discover internal standards in time to satisfy the demands of a career or even to carry on helpful conversations with scientific colleagues.

All this is obvious, I know. I say it because most experimenters are impatient—those I have known, at least, including myself. Most experimenters want to collect enough data in a few days or weeks—or even a few hours—so that they can write and publish a report and look forward to getting admiring responses from readers (if any), perhaps including favorable responses from next year's meeting of the Committee on Rank and Pay.

What are we to do? Must we restrict ourselves, if we want quantitative results, to observing variables that can be kept under continuous control for a few minutes while we record the movements the person takes to oppose disturbances? Must we resign ourselves to observing the control of variables at "higher levels" by watching many aspects of a person's life over many years and guessing at the variables that might be under control in complex situations—a sort of biographical criticism? Must we give up modeling at the "higher levels"? One solution to this difficulty will come, I think, from examining the ways that time enters into the functioning of control.

The Timeless Loop

At a given "level" of the neural hierarchy, the neural net does not "know" that time is passing. The loop (or "system") that controls the position of my knee-joint is not a loop that controls my consciousness of the time that my knee-joint remains in a particular position. The loop that controls the rate of angular movement of my knee-joint is not the loop that controls my consciousness of that rate. I can change the angle of my knee-joint in walking and in other uses of my leg without being conscious of doing so.

Many of us are able to tell ourselves, when we go to sleep, the time at which we want to wake in the morning, and we almost always wake within a few minutes of that time. We do not consciously tick away the minutes of the night. The loop that counts off the minutes is not the loop that enables us to know consciously that the desired time has passed.

Suppose I walk to the library to look up an article that I think will give me an idea I can use in writing a book. As I walk along, I am controlling perceptions of the configurations and transitions of my legs. I bring those perceptions into a match with several sets of internal standards: some that specify the orientations and adjustments that will result in my remaining upright as I go along, some that specify the patterns of movements that comprise walking, some that specify whether I am going in a straight line and not veering off left or right, and so on. Some of the neural feedback loops ("systems") that control walking activate muscles that move my leg-bones. When a loop sets off a contraction of a leg muscle, there is no consciousness

in that loop of walking. That loop "knows" only that the error signal from the local comparator calls for the contraction of that muscle. (I am ignoring here the maintenance of tensions in the opposing muscles that aid the control of the first muscle.) The loop that sets off the contraction "knows" nothing about walking. And it "knows" nothing, between calls for contractions, about the passage of time. It does not "know" whether the last contraction occurred a second ago or whether I have been standing at a curb for three minutes waiting for a break in the traffic. The passage of time is "noted" in higher-order (more encompassing) loops that control the sequences and programs of walking—patterns in which the time-orders and time-intervals of events must be controlled. The passage of time in the loop that sets off the muscular contraction has no importance, no need, no effect, no relevance to the production of the contraction; when the comparator "says" to send the contraction signal, the loop does so. This is the sort of "opportunism" that occurs at all levels of coping with disturbances and of finding and retaining patterns of using the environment that will serve efficiently in counteracting disturbances. The efferent part of a feedback loop changes when the error signal increases. It changes when more encompassing loops recognize the availability of suitable features of the environment and not otherwise. This sort of opportunism—acting when the urge (the error signal) and the environmental wherewithal (the external path to controlling the perceived variable) are there—occurs throughout the neural hierarchy and, indeed, in the natural selection that evolution itself carries out.

Similarly, the loops that control my perceptions of progress toward the library set standards for the "lower" loops that control my walking. The loops for progress toward the library tell my walking loops to operate so that I see the sign for Fourth Street turning to my right as I pass it, so that I see the red brick walk under my feet and the large rhododendron bush to my left and the library doors straight ahead, and so on. Those loops also tell me that I am progressing toward my goal if I see the sign for Fourth Street before I see the rhododendron bush, but not vice versa.

(By the way, this example of layered control illustrates what we mean by "higher" or "more encompassing" in the control hierarchy: perceiving the sign for Fourth Street turning past my eye is necessary if I am eventually to perceive that I have reached the library, but having the goal of reaching the library is not necessary to my passing the sign for Fourth Street. The goal of reaching the library must set standards for the route and the walking if I am to get there successfully. But I need not set getting to the library as a goal to permit me to go walking or even to take that route; I could go on past the library to the drug store. So, since the goal of reaching the library must set those enabling goals, we call the library goal the "higher" or "more encompassing.")

While I am walking along, I do not think to myself that I must now angle my feet and lean to the left to make a successful left turn at Fourth Street. At the program level of finding my way to the library, I note that this is the place to turn left—and my body simply does so. At that point of turning, I may or may not consciously think, "This is the place to turn left." If I do think that, the loop that does the thinking is not the loop that calls for turning.

At some level, I may be conscious of the time that passes while I wait at the curb for the traffic to pass. But neither the loops that control walking nor those that control the choices along the route are the loops that can count the time or control my perception of its passing while I am waiting at the curb. The controls for perceiving walking and routing are suspended, inactive, out of operation during my time at the curb. Those controls are not disturbed, not interfered with, not altered; they are simply set aside, inoperative, not there. (So it seems to me. I hope readers who disagree will say so.) The controls for noting progress toward the library are perceiving my pause and sending signals for counteracting disturbances to my progress; they are telling me, for example, that I am getting "closer" by watching for a break in the traffic. Some part of my image of getting to the library specifies, also, the time I wish to arrive there. So some further control loops are noting the passage of time as I stand at the curb—and I am finding that smaller gaps in the traffic do not seem as dangerous now as they did earlier. But if a computer were drawing a trace of the stimuli to muscles that would produce walking patterns and route choices, the trace would lie flat at zero; no stimuli to control those perceptions would be emitted. Indeed, a trace of error signals from those programs would also lie flat at zero—not because walking and route choices are being ideally maintained, but because they are not being maintained at all. In effect, those cascades of control from higher levels are turned off.

How should we model getting to the library? In modeling the walking itself, I do not think that periods of not walking (as when waiting at the curb)

would be modeled as disturbances. Those periods are not disruptions to carrying out the program for walking; they do not interfere with swinging the legs or perceiving balance. They are simply periods when I am not walking—when muscles of legs and spine and so on are not being activated by loops that control the perceptions of walking but, instead, by loops that control standing, turning the head, and so on. They are periods when walking is not "on line." In modeling only the walking, we would want to simulate only the periods when I am walking and therefore perceiving my walking. The periods of standing at the curb could be omitted; they would simply not have existed as far as the controls for perceiving walking were concerned. But in modeling the progress toward the library, the periods of standing at the curb are periods of coping with the disturbance of the traffic in the street. The traffic has the effect of a wall-like barrier in which openings briefly appear. While waiting at the curb, the controls for perceiving progress are not set aside; they are not in abeyance. I continue to seek a way to move myself closer to the library; I watch the traffic and estimate my chances of getting safely through a gap in it. The modeling would somehow have to represent my efforts, some of them mental calculations, to counteract the traffic barrier.

But suppose I encounter a friend with whom I have been wanting to talk. I put aside progressing toward the library. I pursue another goal that I can pursue only by talking with my friend. What now? Are my standards for getting to the library now in conflict with my standards for companionship with my friend? Maybe so, maybe not. If I perceive my errand to the library to be urgent, and if I am also eager to converse with my friend, then I am likely to oscillate. I am likely to take a step away from my friend but then turn back to him. I am likely to start a topic of conversation with him, but then tell him I must get to the library before it closes. And so it will go until I tear myself away from my friend or give up getting to the library before it closes. In this case, the appearance of my friend becomes a disturbance to my perception of progress toward the library, and the persistence of my desire to be at the library is a disturbance to my goal of conversing with my friend.

Perhaps, on the other hand, I come to the opinion that my errand at the library will not be endangered if I get there later than I had planned when I set out. Perhaps the library will be open for some hours yet, or perhaps I can carry out my errand just as well tomorrow. It may be, in short, that I can suspend pursuing my goals at the library and, instead, pursue my goals with my friend. In that case, the controls for getting to the library could be set aside, put "off line," while I talk with my friend, just as the controls for walking were put in abeyance while I was waiting at the curb for a gap in the traffic.

The Timeless Loop, Continued

With goals that are more enduring than those I have so far been using for illustration, the same hierarchical organization occurs. I want to get to the library, yes, but getting there is a means to a further purpose. I want to find the journal article which, in turn, will help me write my book. And writing the book has gone on too many years and will probably go on still a few more. As I walk to the library, I am, to a tiny extent, drawing nearer to my goal of completing the book. And when I find the article and have made notes about it, I will feel myself still another tiny step closer. But then I will go home, eat dinner, and go to a concert. None of those last activities brings me closer to completing the book. The control loops for pursuing the book get put on hold, so to speak, while I walk home, eat, and listen to the music. The internal standard for progress toward the book is given a weight near zero by "higher" loops containing standards that give me principles about how to manage my life as a whole. This is not to say that my activities are neatly divided by hermetic boundaries. Sometimes I may put aside the book for a day or even two. But often I make tiny steps along the route while I am doing other things. While I am sitting at the dining table, I may think about the topics I might include in Chapter 3. Watching the conductor of the symphony orchestra waving her baton while, as far as I can tell, none of the musicians seems to be watching, I may find myself thinking about the topic of leadership.

At this "higher level" of organization, it seems to me, time gets a lot of attention. We use time in organizing action at any level from transitions upward, but time can figure in the feedback loops without our being conscious of it—without our giving it conscious attention. While engaging in activities governed by programs and principles, I am frequently conscious of the order in which I undertake activities and of the duration of them. But while I am engrossed in one activity, I am usually unconscious of the many activities I have postponed in devoting my attention to this one. I can usually listen to a symphony all the way through without thinking about the book I am fitfully writing.

The level of principle deals with intermittent patterns, averages, trends, priorities, policies, and similar long-term patterns of events. It selects strategies for attention and action that put values and preferences on available choices.

The perception of variables that is controlled at the level of principle must therefore include the perception of time-variables: orders, rates, changes in orders and rates, and so on. Interruptions in a series or events, therefore, are not necessarily disturbances to a perception being controlled at the level of principle. I have some esthetic preferences about the landscaping around my house, and one of the ways I act to maintain my perception of beauty around my house is to prune the bushes, pull the weeds, and so on. But as the seasons change and the time for these activities passes, I feel no disturbance. I feel no conflict as I turn to activities having nothing to do with the yard. On the other hand, as the seasons turn again and the time for pruning arrives, I seek to control not only the look of bushes and ground cover, but also the time at which I alter their look. I want to get the work done after the bushes bloom and before the weeds go to seed. With the time pressure, I do often feel some conflict between the various things I want to do. Shall I weed the vinca this morning, or turn to drafting Chapter 4?

Sometimes we can put one goal in abeyance while pursuing another and do so without incurring conflict. Sometimes goals interfere with each other, the pursuit of either disturbing the pursuit of the other. Obviously, these two conditions are not pure. A conflict can be slight or terrible. Or, as in my example of weeding, one can postpone a goal for a time with easy contentment, even relief, but as time goes on an error signal will begin its nibbling, and after a while that goal will be interfering with other goals. Sometimes we plan one path to a goal and wait patiently for the time to take each step. Perhaps I am on a journey, and the only way to traverse the leg from Cedar City to Carson City is by the train that leaves at four o'clock. Here I am at 3:20, sitting in the station at Cedar City. Am I sitting peacefully, without a care, reading a mystery novel? Or am I fidgeting and sweating with anxiety, looking repeatedly at the clock, asking the agent whether the train will be on time, and so on?

Whether a goal can be easily postponed or whether doing so brings conflict depends, for one thing, on the goals to which it is a subgoal. Perhaps my wife lies ill in Carson City, and I want to perceive that she knows I am near and ready to care for her. And perhaps I have heard some worrying news about my place of work in Carson City, and I want to get there to find out the truth of the matter. Let us say, too, that I do not want to think of myself as a person who would let his wife lie ill, unattended by her husband. Nor do I want to think of myself as a person who would be careless and unthinking about coordinating his tasks with those of others at his workplace. All that churns in my mind, and I find it impossible to sit quietly while waiting for the four o'clock train.

The simple matter of whether a goal serves supragoals, however, is not sufficient to explain the onset of conflict.

When I walk toward the library, my walking serves numerous goals—getting there, getting some exercise, finding the journal article, finding out whether there is an idea there I can use, getting on with my book, improving my chances for a promotion or an increase in salary, attracting the admiration of my colleagues and my wife, making some money, laying away some money for the old age of my wife and me, and so on. Yet I do not fret and run back and forth as I stand at the curb waiting for the traffic to break. Or I do not, anyway, fret and fidget until the wait becomes too long. Similarly, while I am walking, I am holding in abeyance the sequences and programs for moving my muscles in the ways necessary to take notes, but I do not wiggle my fingers or fuss with my pen as I walk along. Or I do not, anyway, until I walk and wait too long.

Throughout these examples, there are periods when the outputs of some higher feedback loops to some lower loops go to zero or close to zero—the outputs that set the reference values of the lower loops. While I am walking, for example, a reference signal for transition is telling me that I ought to see the street scene passing me from front to back. But when I come to the cross-street, that particular transition signal drops out—is overridden; the speed at which I want to see the street scene passing by drops to zero. Is that the way to say it? Is it equivalent to say that the weighting of the output from transition control goes to zero? The reference signal or internal standard for walking is set by the sum of weighted outputs from higher loops that control perceptions of progress toward the library, accumulation of fatigue in the muscles, obstacles in my path, and other conditions. When I encounter other pedestrians and bumps in the sidewalk, I steer past them without slowing, but when I encounter the cross-street, going around or over becomes much too costly or even unimaginable, and the loops that control my perceptions of proper

distance from large onrushing objects bring me to a stop. They do so, it seems to me, by changing to zero the weighting of my preferred perception of walking speed that comes from my control loops for getting to the library. This description of what goes on internally is somewhat fanciful, and my language is too anthropomorphic, but it will have to do for now.

Anesthesia

I had an interesting experience in September of 1995 when I underwent some dental surgery. The surgeon and a couple of other people were fussing around me as I lay back in the dental chair. The surgeon inserted a needle into my arm. He said, "Now we are beginning the medication." Then I opened my eyes and discovered that all the people had vanished from the room. The only evidence I had, whatsoever, that time had passed was the absence of the people who had been there only an eye-blink (so it seemed) ago.

All my functions that might have required consciousness were in abeyance during my anesthetically induced period of unconsciousness. My nervous system did whatever it did to cope with the surgical invasion, but it did nothing consciously. The purposes I could pursue by sitting in the chair, talking, and obeying were put on full hold during the period I was unconscious; they came back into action when I awoke. I did not need to go back and retrace anything. I did not need to make any physiological adjustments of the sort one does, for example, with jet lag. I simply asked what had occurred while I wasn't looking, and we went on from there.

One of the attendants told me she had been at the surgery of a woman who was in the middle of a sentence when the anesthetic took hold. When the woman awoke, she went right on to complete the sentence. That seems a very dramatic demonstration of the suspension of the effect of one internal standard (or some) while the "attention" goes to others—a demonstration, that is, of the timelessness of the neural loop.

Perhaps the anesthetic stops the functioning of circuits required for consciousness, but not those required for maintaining bodily life-support functions. But consciously relinquishing one or some goals in favor of others must function in much the same way in regard to putting control into abeyance.

Recapitulation

The point of these examples is this. In research on control of perception, we do not always need to know all the perceptual variables that the person may be controlling while we record the actions the person takes to control one variable. When we record the movements a person makes with a computer-mouse to follow a cursor on the screen, we do not need to know whether the person wants to learn something about control theory or whether the person wants to please Richard S. Marken. And if the person holding the mouse leaves it to go to lunch and then comes back to follow the cursor again, we do not need to count the period while the computer is turned off as a period of hopelessly inaccurate tracking. Nor, unless we want to test a model for controlling the feeling of hunger, need we follow the person to lunch. (For the researcher examining a tracking task, is going to lunch equivalent to anesthesia?)

But following the cursor on the screen can, while maintaining the intended distance between two cursors, also offer the person some information about control theory and also please Richard S. Marken. Often, higher-order goals can hold a person in a place where it is convenient for us to observe the person's behavior. But what can we do when the goals do not all pull in the same direction? How can we model my behavior when, on my way to the library, I stop to talk with a friend? How can we model the control of hunger by a person who loves to track cursors?

One thing we can do is this. We can construct a simulation that does not attempt to duplicate the control of a variable by an actual person or persons, but only to show verisimilitude. McPhail, Powers, and Tucker (1992) did that with a computer model of the movements of people across an open space, some of them heading for particular places or for particular moving people. Those authors assessed the goodness of their model not by testing its closeness to the movements of a particular collection of a couple of hundred people, but by comparing the various patterns of movement in the model to patterns that had been observed and documented in several actual crowds. They did not show that actions taken by actual individuals to counter disturbances were mimicked by the simulated actions of the computer model to counter the simulated disturbances. Instead, they showed that the patterns of action resulting from the interaction of the internal motivations and the external obstacles had some very similar features in the records of actual crowd movements and in the model.

Furthermore, those authors showed how certain realistic variations of motivation in the individuals brought about particular patterns of movement in the model that had been observed also in actual crowds. In that same way, behavior such as mine when I encounter a friend on the way to the library could be simulated by programming the computer to insert a friend at some point along my path. Perhaps my comparative motivations to talk with my friend and to continue to the library could be simulated by parameters such as the "destination proximity reference level" and "seek proximity reference level" described on page 25 of the paper by McPhail, Powers, and Tucker. Perhaps a parameter like "destination proximity gain percentage" (also on p. 25) could be programmed to increase slowly during the time I talk with my friend. It seems to me that a path and its distractions could be complicated a good deal before it would exceed the capacity of a small computer or the patience of a programmer.

Still, for strictly scientific purposes, verisimilitude in social complexity is not urgent. More needed at this point, I think, is the second thing we can do: model the parts or episodes or situations of social life. My welcome-and-unwelcome encounter with my friend is an example. Does one actually oscillate? Is the variation in error signals actually continuous—that is, does zero act merely as a point on the continuum, or are there conditions in which "zero" provides a time when the variable itself changes its nature? If I decide I can talk with my friend now and go to the library tomorrow, does that conception change the nature of my goal at the library—perhaps, for example, opening the possibility of looking for several articles instead of only one? I think myself that our conceptions or visualizations of possibilities and goals and supragoals are in repeated or even constant revision, and I would surely like to see some investigation of those metamorphoses. Perhaps we can make some models of resolving conflicting goals, of modifications of goals, of changing attractions of delayed goals, and other aspects of continuing control in social life. Am I talking here about models of reorganization?

Some examples of good beginnings are the investigations of social processes by Bourbon (1989, 1990), Chong and Bourbon (1991), and Lazare (1992). And would it be possible to apply The Test to everyday life?

Practical Action

The problem I am discussing here is a problem for those who ponder the springs of action, but it is not one for those who spring into action. Buying an apple brings none of the perplexity of trying to explain how one finds one's way into doing so. One stumbles far less in following the urge to buy an apple than in following the urge to understand the desire. The disturbances in the path to the apple are usually much easier to counteract than those in the path to understanding. One can easily maintain one's balance while riding a bicycle, but not if one thinks about how to do it while doing it.

The task of keeping a perceived variable close to the value required by one's own internal standard is not plagued by the difficulties we encounter in hunting for someone else's internal standard—difficulties such as uncertainty about the person's purpose. When observers or experimenters are puzzled about a person's actions or motivations, or you are, or I am, that is no sign that the person observed is puzzled or should be.

Observers sometimes say something like, "How can he let himself do a thing like that?" The observer seems to think the observed person has the same goals (reference conditions) and perceptions of possible controlling actions as the astonished observer and must therefore feel the same conflict or puzzlement the observer is feeling. Some observers go so far as to conclude that the observed person is failing to feel the observer's puzzlement because the person is defective in some way. A good many "diagnoses" of "mental illness" make use of that kind of reasoning.

Complications

Complications, subtleties, and surprises are bound to occur. We can, however, anticipate a few things from work already done. For example, while control of a variable is temporarily set aside, held in abeyance, the value of that variable, when again perceived, may have fallen farther away from the value called for by a person's internal standard than it had been before the control was set aside. For example, I may be out for a walk with my wife, and I want to maintain a position beside her as we walk along. But my eye may be caught by a beautiful set of chessmen in a store window, and I may postpone maintaining my position beside my wife so that I can enjoy for a moment the beauty of the chessmen. But then the distance from my wife becomes too great to be

longer suffered, and I run to catch up. Perhaps my run carries me even a step or two beyond her before I match my pace to hers. Or let's say I have been on a reduced-calorie diet for two weeks. On the day I go off the diet, I eat two pieces of pie and a scoop of ice cream, and then on subsequent days fall back to a proper caloric intake. Or perhaps I am a member of a steering committee, and we are discussing some possible ways of organizing a conference. I want to be sure I keep hearing the ideas of other people, but I find I have been spending a good deal of time arguing the merits of my own ideas. So I hold my tongue for a long time except to ask others for their opinions when they do not volunteer them. After a while, however, I think the discussion is veering too far from the matters I think are important, and I demand the floor to give my own opinions. I oscillate between quiet and speech-making. This sort of catching up, or overcompensation, or oscillation seems to me common in intermittent control. It might be modeled in a manner similar to that conceived by Marken and Powers's 1989 study, though those investigators were not, in their study, modeling exactly the phenomenon I have just been describing.

Modeling a Stroll

Suppose we want to model a walk through a park. In such a stroll, spatial relationships are important; we do not want our protagonist to blunder into a tree. But other effective dimensions may not be readily visible to the onlooker. The stroller might want, for example, to go to where the music is loudest—or softest. Or to where the air contains the least—or the most—cigarette smoke. Or the person might want to get somewhere by a certain time. Or the person might want to stroll slowly enough to be able to look for a friend among the crowd or to watch the habits of the pigeons.

Let's say our protagonist wants to eat lunch in a restaurant across the park. What can happen in this small world of a walk through a park? Let's not complicate the walk with too many obstacles such as fences, brooks, thickets, and the like. Let's limit such obstacles to a few trees with trunks small enough not to hide a person on the other side. Let's not put up any signs reading "Keep off the grass" or "Stay off the flower beds." We must write the model to keep the protagonist from bumping into trees and people, but otherwise we can allow P to move freely.

Let's have P encounter a friend or two with whom P wants to talk. Perhaps, too, P might encounter a flower he wants to admire. And perhaps a friend might come along while P is admiring the flower.

What happens to the motivation to eat when P encounters a friend? If P's hunger is not too strong, P can stop and talk for a short time. Presumably P will experience some degree of conflict during the conversation with the friend: P will want to walk on to the food and at the same time want to pause and talk. The model must specify a hierarchy of goals such that the person will not faint from hunger before breaking off the conversation. Questions arise about further possible specifications. Does P satisfy the desire to talk by spending so many minutes doing it, or does P have some content of the communication as a goal, such as finding out at what time the friend will be near a telephone tomorrow? At what rate does P's hunger rise as P stands talking?

Presumably P can be distracted during the walk if P is not too hungry. Perhaps he can be distracted by the beauty of a flower only for a few seconds, but by a friend for several minutes. When P pauses to gaze or talk, should the model say that the urge to gaze or talk becomes controlling over the urge to eat? Or should the model be built, instead, to let the hunger continue to increase, but let P encounter opportunities to pursue other goals (gazing at beauty, conversing with friend) that conflict with the pursuit of eating? Maybe at a certain level of hunger, P might perceive the appearance of the friend as an opportunity to get some needed information, but at a higher level of hunger, P might not perceive an opportunity; if queried, P might in the latter situation say, "I don't want to take the time right now; I'm hungry." In the extreme case, if P has not eaten for three days, P might not even recognize the friend.

My intent here is to wonder about modeling the situation in which goals get postponed because of the changing opportunities for pursuing them in the environment. My intent, too, is to include conflicts among goals—to include instances in which the person pushes aside one goal in favor of another, at least temporarily. Some of the goals, listed here in no particular order, are to get to the restaurant; to stay a certain minimum distance from obstacles such as trees, fences, and strange persons; and to spend some time conversing with certain persons encountered—or perhaps to get certain information from them. Numerous other goals could be included, such as the desire to perceive oneself as a person who _____, but I dare say we will want to make this kind of modeling very simple in our first efforts.

The instructions to our living protagonist would be something like: "How about meeting me at the Red Dragon Restaurant about 12:15 for lunch?" For verisimilitude, one might arrange for a confederate or two to intercept the protagonist at certain places or times. Or one might choose a park at which acquaintances of the person would be likely to appear, and leave to chance the times and places of the encounters. I suppose one would have several observers recording the times and places of actions that seemed to be counteracting disturbances that would alter the protagonist's course. But here I am getting beyond my depth.

Tracking

Let me draw a parallel to the studies that people of the Control Systems persuasion have done with tracking tasks on computers. In those experiments, the person was presented with an environment (a restricted environment) in which she could maintain a preferred perception (a goal) for a period long enough to suit the convenience of the experimenter. The environment contained a series of disturbances to the goal-state. To collect the necessary data, the quantities defining the goal-state for the person were recorded at regular intervals. The quantities were typically (a) the position of the target on the screen, (b) the position of a pursuing cursor as it would be if its position were completely controlled by the hand of the person (this is equivalent to the position of the handle or key), and (c) a vector of disturbance to the action by the person. Data must be taken on some such set of variables that spans the space (the mathematical space) of the action. When the screen of a computer is the space or environment experienced, data can be taken several times per second. Presumably the experiments could be done about as adequately with a much slower rate of data-collection if nothing atypical were to happen between points of data-collection.

I am supposing there are corresponding quantities in the experiment of walking across the park. The first quantity would be (a) the position of the target: the restaurant. The person's output is action that reduces the distance (or minimizes delays) from self to the restaurant. The second quantity (b) is the position of the person. The third quantity (c) is the disturbance to the position of the person that comes from the various obstacles, moving and unmoving, that the person encounters on the way to the restaurant.

Sometimes, in the tracking experiments, the experimenter could not identify the internal standard the person was matching until after the data were collected and analyzed. That will be the case in the walk across the park. For convenience, I'll list here the tracking studies of which I am aware in which the internal standard had to be deduced.

Tom Bourbon has carried out several studies in which the participant has a choice of variable to control: Bourbon (1993), Bourbon and Powers (1993), and Bourbon's paper in the volume from Wales. I think maybe the title of the last is "Program-level control of a sequence of perceived relationships."

Marken (1982) asked the participant to choose either an upper or lower line to move back and forth across the computer screen. The experimenter does not know before analyzing the data which line the person chose. This report appears on pages 35–39 of *Mind Readings;* I have described the study, too, on pages 123–127 of *Casting Nets*.

Marken (1985) asked the person to choose one of three target squares and to keep a dot near it. In a study reported in 1989, Marken asked the participant to choose one of five squares on the screen and to move it. I have a feeling that pages 200–202 of Marken's (1991) study are also relevant here, but I can't quite put my finger on how.

Modeling a Stroll, Continued

In the experiment with the walk across the park, it is necessary to collect data about the three quantities I mentioned earlier so that the movement of the protagonist can be compared to the movement of the simulated protagonist. I do not know any way to collect data several times per second without adding unwanted disturbances to the person's peregrination. Perhaps it will suffice for observers to collect data every few seconds or even every few minutes. But perhaps the protagonist could be provided with the equivalent of a radio-navigation device, and the park could be bracketed by three radio-receiving stations, so that the position of the protagonist could be ascertained many times per second. Perhaps carrying a small radio device would be no more distracting that being set down in front of a computer screen. I don't know.

The rate of data collection will, I suppose, have an effect on the correlation between the path taken by the person and the path taken by the simulated person. Effects of disturbances on the person cannot be modeled unless data on the disturbance vectors are collected. There will always be small disturbances at work whose effects can cumulate, and if data collections are too far apart, the model will let a

counteraction continue unchanged, while the actual person would be altering counteractions to accomplish a more continuous readjustment. In the case of stationary obstacles such as walls, hedges, trees, and the like this is no great difficulty. In the case of moving obstacles such as other strollers, complexities arise—especially when the strollers want to stop and talk. If the protagonist copes with a disturbance by deviating from the otherwise shortest route, but we do not collect data on the strength and direction of the disturbance, then the path of the person and the path of the simulated person will differ more than it would had we collected the data, and the correlation between the two will be less. But it may be profitable to accept the lower correlation, if only to see whether such "naturalistic" modeling can be done at all.

Ascertaining the direction of effect of a disturbance in the experiment on a computer screen is simple when the person's task is to maintain a cursor at a given distance from a target. But ascertaining the direction of effect of a disturbance to a walk across a park is more difficult, since the disturbance is not a preplanned random quantity, but is instead a series of encounters and interruptions, the timing and direction of which will often depend on the person's reactions to earlier encounters and interruptions. And of course we will have variables both of space and of time. I am hoping that some adaptation can be made of the methods used in the study by McPhail, Powers, and Tucker (1992).

The modeling of the walk through the park must be a model of a single person walking through the park, with all other persons considered as sources of disturbances. That is not to say that the *experiment* must contain only one person, nor is it to say that the experiment must produce only one model. It is possible to collect data on two or more persons and construct a model for each of them; an experiment with two persons and two models has been done by Bourbon (1990). I am saying only that we will be trying to model neither a park nor a collectivity.

This project is one of constructing a model of the controlling of consequences by a person whose intention (or at least his or her intention at the outset) is to walk through the park so as to achieve the goal of getting to the Red Dragon and eating lunch. Note that we do not presume to construct a model of *social* (collective) behavior of the protagonist and his friends as a group. We do not presume to construct a model of any "thing" except an individual person. We cannot model the functioning of pairs, groups, families, crowds, organizations, political parties, or nations. We can *describe* the behavior of collectivities, but we cannot build a machine or a computer program that will function like a collectivity. The reason that we cannot is that an individual is a system with tight (that is, positive) links among its components. Its boundaries are reasonably easy to specify (you can see what I mean by boundaries on pages 22–23 of *Casting Nets*). When a person wills an arm to reach out, the action follows every time (unless the neurons or muscles are damaged). The action does not occur sometimes or probabilistically. It happens regardless of the day of the week, of the position of the rest of the body, of amount of experience in reaching out, and of what other people are doing. Similar specifications do not hold, for example, in an organization. When, for example, a boss wills a subordinate (S) to perform a certain action or task, S will do something like what the boss has in mind—unless (S) fails to understand sufficiently well what the boss wants, unless S doesn't want to do it, unless S has conflicting instructions from a higher boss, unless S gets distracted by interesting conversations with co-workers, unless S is called home suddenly to take the spouse to the hospital, and so on.

Summary

Sociologists have contributed much useful knowledge to society by using the method of relative frequencies. I hope we shall continue to see that kind of work. Some sociologists, however, aspire to discover natural laws of social action. Sociologists who have striven mightily toward that scientific goal are among those most admired by their academic confreres. But that goal will not be reached by the method of relative frequencies. I gave reasons in *Casting Nets*.

I tried in this paper to propose some ways that methods used by researchers in PCT might be applied in research settings less restrictive than the computer screen. I proposed that a small world such as a stroll through a park might be constructed with very frequent data being collected as the protagonist copes with disturbances. I proposed, too, that clues to internal standards in the less restricted environment might be obtained through the use of multidimensional scaling. I also proposed several lines of current research that will surely be abandoned by sociologists knowledgeable about PCT.

That is a meager harvest of ideas. I hope something I have said will stir some more productive idea in some reader's mind.

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