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Powers and Petrie at American Education Research Association

Paper prepared by William T. Powers and presented April 20 at the 1995 conference of the American Education Research Association in San Fransisco.

A video of the actual presentation is available from Dag Forssell.

THE NATURE OF PCT

William T. Powers

In the next twenty minutes, I'm going to try to compress 40 years of work into a brief description of perceptual control theory, or PCT for short. PCT is about a phenomenon that you were not taught in school, that none of the mainstream theories of behavior even mention, that is not in most psychology textbooks. I hope that for this brief time you can listen as if you were scientists from some other universe, seeing a new life-form that behaves in ways you've never seen before. And of course I hope that by the time we finish, you may get the feeling that you've never really seen human behavior before, either.

The best way to talk about a theory is to talk about a phenomenon that needs a theoretical explanation. Fortunately, it's not hard to demonstrate the basic phenomenon behind PCT. I can do it with a very simple piece of equipment, a pair of rubber bands fastened together. And just to assure you that there's nothing up my sleeve, I'd like to invite a member of the audience to help me do the demonstration. [Obtain volunteer].

If the volunteer will take one end of this pair of rubber bands in the hand nearest the blackboard, I will take the other end, so we can stretch the rubber band between us, parallel to the blackboard. I hope you can make out the knot in the center where the rubber bands are joined.

We will hold the rubber bands stretched just in front of the blackboard, with the knot over a mark I have already made. Volunteer, your task is very simple. Just keep that knot exactly over the mark while I move my end of the rubber bands around. Let's practice for a moment.

As you can see, this is an easy task if I don't make my movements too fast or extreme. You can see that when I move my end, there's a tendency to move the knot, but the volunteer moves the other end to counteract what I'm doing so the knot remains in one place, right over the mark.

There is obviously some behavior by the volunteer going on here. You can see the volunteer's hand moving around over the blackboard. Let's get a record of that behavior, which the volunteer can make by holding a piece of chalk against the blackboard with the same hand while we do this some more. [I move my end around a large circle several times, and the volunteer's hand traces several times around a large circle].

Now, how would you describe the volunteer's behavior? If someone had just walked into the room, it would seem that the volunteer has just finished drawing a circle. But stop and remember: what was it that I asked the volunteer to do? Did I ask the volunteer to draw a circle? No, I asked that the knot be kept exactly over the mark on the blackboard.

We can see the behavior of the volunteer, but the behavior we see is not what the volunteer is doing. Volunteer, what were you doing? [Keeping the knot over the mark]. Did you mean to draw a circle? [No].

Just to show that this wasn't an accident, let's do it again. Volunteer, please keep the knot as exactly as you can over the mark. [I move my end of the rubber band slowly around a triangle]. Volunteer, were you still doing what I asked you to do? [Yes]. Then why did you draw a triangle this time? [Rhetorical question]. Thank you for your help.

I hope you're all having some seriously new thoughts about this thing we call behavior. We've just seen some obvious behavior by a human being who claims that it was not what that person was doing. How can you claim you weren't drawing a circle, we ask, when everyone here saw you do it? I'm sure everyone here is starting to see the pattern, the form of what was going on, but it's hard to put into words because we haven't spent our lives developing a language for talking about this kind of situation. I hope, too, that everyone here is beginning to have a suspicion that situations analogous to what we have seen here may be rather common. It may be that when we watch people behaving, we are not really seeing what they are doing.

We need some language to use in describing this situation. Let's start with the position of the knot relative to the mark. This position is variable; it depends on where the two ends of the rubber bands are. The volunteer acted to keep the position of the knot the same as the position of the mark. There's a word for that kind of process: the word is CONTROL. The volunteer was controlling the position of the knot relative to a particular position. So we can say that the position of the knot relative to the mark is a CONTROLLED VARIABLE.

The means of control is also clear: the volunteer varied the position of one end of the rubber bands as a way of controlling the position of the knot. Note the verbs: the knot is controlled, but the position of the end of the rubber bands is varied. The ACTION of the volunteer is to vary the position of one end of the rubber bands.

My end of the rubber bands also varied its position. With my end in a given position, there was a certain force being applied to the knot. So the position of my end of the rubber bands relative to the knot is a measure of a DISTURBANCE. We have three terms: the DISTURBANCE, the ACTION, and the CONTROLLED VARIABLE.

Using these three terms, we can describe what was going on. The ACTION was always varied so that when its effects were added to the effects of the DISTURBANCE, the result was that the CONTROLLED VARIABLE stayed near some particular state. When the controlled variable stayed in that state, it must have been true that the effect of the ACTION on the knot was always equal and opposite to the effect of the DISTURBANCE on the knot. That, of course, is why when I moved my end in a circle, the volunteer drew a circle, and when I moved my end in a triangle, the volunteer drew a triangle?both rotated by 180 degrees.

We need one more term: REFERENCE CONDITION. The volunteer was controlling the relationship of the knot to the mark relative to some reference condition, in this case knot-over-mark. But it would have been just as easy to establish some other reference condition, such as knot six inches above the mark, or a foot to the right of it. To say that the volunteer is controlling the relationship of the knot to the mark is to say that this relationship was being maintained close to some particular reference condition.

We can now define control. Control is a process by which a person can maintain some controlled variable near a reference condition by varying actions that oppose the effects of disturbances. That language is now general enough that we can apply it to situations where there are no rubber bands. But there is one more fact we have to establish, which I can do just by asking a question. Do you think the volunteer could have controlled the position of the knot while wearing a blindfold?

All you have to do is imagine trying it yourself. It's impossible. If you can't perceive the variable, you can't control it. Obviously, perception plays an essential role in this process we call controlling. The more you consider that fact, the more you will come to appreciate why we call this theory not just control theory, but perceptual control theory.

When we see other people behaving, we see their actions, and sometimes we see disturbances to which the people seem to be reacting. It looks rather like stimuli causing responses. But when we look at our own behavior, we see something we can't see in other people's behavior: we see what we are controlling by means of our own actions.

So when we think of human behavior, what we notice depends on whose behavior we're thinking of: theirs, or our own. Our own behavior is seen in terms of perceived outcomes, what our actions accomplish. But other people's behavior is seen in terms of their actions and we know little of what perceptions those actions are supposed to be controlling. PCT gives us a way of understanding behavior that works both for ourselves and for other people, and it shows us that we need to understand something about other people that is not obvious. We need to understand that their behavior is not what they are doing. That simple understanding, and the questions it raises and the answers it leads us to seek, can greatly change the way we understand human nature.

My time is almost up, and I've just skimmed the surface of this subject. I haven't yet got to PCT. PCT is a theory of behavior, a model of how a human being must be internally organized to accomplish this process called controlling. It is a technical theory that involves neurology and physiology and mathematical theories of control systems developed some 60 years ago by engineers. I won't get into that here. What I hope has been accomplished in this short introduction is to bring to your attention a neglected phenomenon, the phenomenon of control. Once you have an orderly way to think about it, in terms of actions, disturbances, controlled variables, and reference conditions, you can start seeing it in every aspect of human behavior.

It isn't necessary to understand the technical side, the theory itself, to appreciate that there is a phenomenon here and that it needs an explanation. Nor is it hard to see that the mainstream theories going around today are inadequate to the job; they don't even recognize that this phenomenon exists. So even if you're hearing about this for the first time, and feeling overwhelmed by the implications and by your own ignorance of how to tackle this huge new scientific problem, you can at least be gratified to know you understand something about a new direction in psychology of which most psychologists know nothing at all.

More to the point, you will be happy to know that we up here at the podium don't really know a great deal more about this new subject than you do. We are very much feeling our way into new territory and wondering where it will lead. We haven't yet reached the time when the vast resources of mainstream science are brought to bear on this new approach; only the youngest of you here will see that day. All we can do is show you what we have found, and describe some applications that look very promising, and hope that you will join the effort by pondering the phenomenon of control as it shows up in your own work. We haven't yet reached the point in the maturation of a science where we are jealous of others who beat us at our own game. We will be grateful for your company.

Durango, CO April, 1995

PERCEPTUAL CONTROL THEORY: A POST-COGNITIVE THEORY OF BEHAVIOR

A Demonstration and Workshop/Discussion Strand

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The Perspective of Perceptual Control Theory:

In the past several decades, an interdisciplinary group of researchers (Powers, 1973, 1989, 1992; Marken, 1992; Petrie, 1981; Cziko, 1992a; Ford, 1989, 1994; Forssell, 1993; McPhail, 1990; Robertson & Powers, 1990) has emerged. They are propounding and applying a new perspective ? perceptual control theory (PCT) ? to our basic understanding of human behavior. PCT is the product of a long period of exploration and development that follows a line of thought suggested early in the history of cybernetics but leads into quite different territory. At its core is a belated recognition that what people learn to do is not to respond to stimuli or to plan actions and then execute them, but to act on their environments to control what happens to themselves. Human beings, even young ones within their capacities, are active agents, purposive systems with goals and hierarchies of goals. Their actions are not simply push-button responses to stimuli, nor emitted blindly according to precalculated formulae. Instead each action has a purpose, a goal, which is defined in and by the actor and in terms of the actor's perceptions of the world. PCT shows how to recognize control and lack of control in an individual's behavior, how to put oneself in the position of a person trying to learn to control new aspects of the environment, and how to avoid the clashes that always threaten when independent, actively controlling organisms, both adults and children, share the same environment.

Two main conceptions of human behavior, stimulus-response theory and cognitive theory, have traditionally guided educational research and practice. The S-R approach has focused on eliciting the production of appropriate responses through drill, reward, and sometimes punishment. The cognitive approach has focused on teaching the logical organization of ideas and facts so that they can be comprehended at various stages of learning and will generate the appropriate responses. Perceptual Control Theory goes beyond both behaviorist and cognitive theories in accounting for the fact that people can accomplish the same end in an indefinite number of varying circumstances and contexts. PCT theorists have elaborated an underlying generative model of such purposeful behavior that has resulted in predictions which correlate 0.95 and above with actual human behavior in the tasks studied thus far (e.g., Marken, 1990).

Despite its elegance and simplicity, the PCT model is initially difficult to grasp precisely because it turns on its head our common sense and common research wisdom about how to understand behavior. William T. Powers, the major figure in perceptual control theory, captures this new way of looking at behavior in the title of his seminal work, Behavior: the Control of Perception (1973). Instead of viewing behavior as the outcome of stimuli or perceptions (as modified by cognition, emotions, or planning), PCT views behavior as the means by which a perceived state of affairs is brought to and maintained at a (frequently varying) reference or goal state. Traditional theories require the modeling of behavior as planned and computed output, an approach that requires levels of precise calculation that are unrealistic in a physical system and impossible in a real environment that is changing from one moment to the next. PCT, however, provides a physically plausible explanation both for the consistency of outcomes and the variability of means human beings actually employ to reach those outcomes in a constantly changing environment.

The exchange in Educational Researcher between Cziko (1992a, 1992b) and Amundson, Serlin, & Lehrer (1992) illustrates the difficulty of understanding PCT in its own terms. The medium of language allows for significant misinterpretation and talking past one another. Clearly, the Educational Researcher exchange never engages perceptual control theory on its merits. Fortunately, however, researchers in PCT have developed over the years

striking demonstrations of the phenomenon of perceptual control and simulations of control systems that are able to keep a sensed variable at a (possibly changing) reference state despite a wide range of external variations and disturbances. These demonstrations, most of them interactive, provide dramatic examples of behavioral phenomena that are extremely difficult or impossible to explain using traditional theories. They are, in the theory of paradigm shifts, truly anomalies (Kuhn, 1970) for behaviorist and cognitive theories but are explicable as a matter of course in perceptual control theory.

Objectives: We will explain and demonstrate a new theory of human behavior in which theory and practice merge, where the principles of the theory are seen at work and used every day in the classroom. The theory is based on universals of human nature that apply across cultural, class, and age boundaries, applying to the challenged and the ordinary as well as to the gifted, and which can be tested and refined even as they are being used to guide events in the classroom, in families, in social service agencies, and in health care organizations.

The objectives of this two-session strand are, first, to present a wide variety of vivid illustrations of PCT; second, to allow the audience to interact with these demonstrations for themselves so that they can get a real feel of the phenomenon of control and how PCT approaches its explanation; and, third, to begin relating these demonstrations to traditional educational research issues such as learning, instruction, motivation, assessment, management and organization, and school change.

Educational Importance: As with any truly revolutionary theory, a wide range of common phenomena are seen in a new light and a deeper understanding and a range of new phenomena are uncovered.

Perceptual control theory is about human nature and its basic organization. It provides an understanding of principles rather than lists of actions to take under specific circumstances. Teachers who have learned to use these principles find that they are finally true professionals because they know what to do without having to be told, because they understand what is happening. Students experience less conflict among themselves and with their teachers. They are less distracted from learning. Teaching itself, done with an understanding of the learning process as it is experienced and demonstrated, becomes less stressful because conflicts are recognized and dealt with before they escalate.

Teachers come to see that what is learned is neither a set of mechanical responses to stimuli nor a collection of abstract reasoning processes isolated from the real world. Students, and teachers too, learn how human beings perceive, compare, and act, all at the same time, and all in order to increase their control over their own lives. Perceptual control theory deals with the classroom at the level at which we ask ourselves "What on earth are these students up to? Why am I always in conflict with them? What are they learning when they fail to learn what I am trying to teach? How can I find out whether a student is learning or not, and, if not, how can I find out what is wrong?"

The graduates of an educational system organized around the principles of PCT will be neither animals capable of doing clever tricks when systematically rewarded, and otherwise devoid of initiative, nor disembodied intelligences stuffed with facts and incapable of acting without a complete prediction of the future. They will be real human beings with skills and understandings that work together with the world as it is, and with respect for other human beings as equally autonomous agents.

For example, in perceptual control theory an explicit model is available to account for much of the currently metaphorical language on the "construction of meaning." New ways of looking at motivation as essentially intrinsic are suggested. The roles of students, teachers, administrators, and parents as autonomous actors in the educational system are revealed. The near impossibility of "making" people learn or teach or administer or parent in

certain pre-specified ways becomes apparent. Strategies for helping the most difficult of students to learn can be derived, at least in broad outline. Common current critiques of standardized forms of assessment are given a deeper underpinning. The centrality of perceptual and experiential learning, along with the necessity for risk-taking and experimentation in the educational process, are straight-forward results of a PCT perspective.

Moreover, PCT provides insights into a wide variety of historical and social phenomena. In particular, events, such as the civil rights movement, which involved individuals who strove against great odds and many obstacles to accomplish important personal goals and make valuable contributions to society are seen as straightforward outcomes of autonomous agents controlling their higher level perceptions. PCT may also serve as a potential antidote to the environmental fatalism that seems so rampant in many of our inner-city schools. A PCT perspective opens up new ways of thinking about how people can find ways of taking control of their lives. New light is shed on issues of diversity and tolerance, both providing a basis for understanding how diversity arises and demonstrating the absolute centrality of tolerance if we are to avoid destructive conflicts.

SESSION STRUCTURES:

There will be two sessions in the strand--a demonstration session and a workshop/discussion session, each of two hour's duration.

The demonstration session will consist of a variety of demonstrations of PCT phenomena and theory using everything from rubber band experiments to computer simulations of different individual human behaviors and social phenomena. Some of the demonstrations will be interactive with the audience, although the major "hands-on" phase of the strand for the audience will occur during the second, workshop/discussion session (see below). In the demonstration session, the presentations will illuminate such key educational concepts as learning, instruction, motivation, assessment, school reform, organization, and leadership. However, the major forum for the discussion of PCT and education will occur during the discussion phase of the second session.

The second, workshop/discussion session will engage the audience hands-on activities and discussion of the relationship of PCT to educational issues. The audience will experience the phenomenon of control for themselves, explore hierarchies of control, have their own performance predicted (with 0.95 accuracy) by the model, and experience cooperation and conflict with other control systems. The presenters will be available to answer questions and to explore with the audience further, more complex, issues and research topics suggested by the demonstrations and hands-on activities.

Hugh G. Petrie (Chair), Dean, Graduate School of Education, University at Buffalo, "PCT, Standards, and Assessments"