Control Theory: A New Direction for Psychology

A reply to Todd Nelson

Mary A. Powers

This unpublished paper from 1994 was discovered following Mary's passing in October 2004.
Mary was a tireless supporter and advocate of Perceptual Control Theory.

Over the last dozen years or so, beginning with Carver & Scheier (1) a number of psychologists have adopted the control theory model of William T. Powers (2)(3)(4) as a taking-off point from which to address the topics of self-regulation and goal pursuit. The recent article by Todd Nelson (5) is the latest example. These well-intentioned efforts to bring control theory into mainstream psychology have unfortunately come at a price: the distortion of some of the key concepts of control theory, and the addition of elements which are inconsistent with the main theory.

I think that such authors (and their reviewers) believe that they understand control theory, and that their interpretations and embellishments are in the service of bringing an obscure but interesting behavioral model into view. Control theory from this perspective is an extension of existing thought on goals and purposes which merely requires an adjustment here and there to be compatible with the body of work that already exists.

But control theory is a model unlike any other yet seen in psychology. It is not an input-output, independent-dependent variable model, nor is it a self-regulatory model in the planned-action sense. To both environmentalists and cognitivists it says "you are both partly right, and therefore you are both wrong." This, of course, is not a welcome message to anyone who has spent a lifetime of honest work trying to cope with the elusive variability of behavior, to find order and predictability in this "softest" of the sciences.

The problem of variability has been approached by severely controlling the environment in which subjects are immersed, or by trying to eliminate it through the use of increasingly sophisticated statistics, or by speaking of distal behavioral consequences rather than the immense variety of proximal acts that achieve those consequences. Control theory takes a different path. It views variability as the essence of behavior: the phenomenon to be explained, not explained away. The heart of control theory is that organisms control, and that what they control is not behavior at all, but perception.

This shift in viewpoint resolves the problem. Organisms achieve consistent ends in a variable world. The consistent ends that are achieved are the perceived consequences of their actions in combination with any environmental disturbances; not the actions alone, or the environmental disturbances alone. Organisms do not, cannot, program a series of actions that will have a consistent result. The simplest movement is immediately affected by the infinite variety of positions from which it begins, and by the state of fatigue of the muscles depending on previous actions. These are environmental disturbances, as much as the uneven ground one walks on in the country, traffic on the highway, and so forth, on up to one's social milieu and the requests and demands—and cooperation—of other people.

The only known organization that can maintain itself in a variable world is a control system. A control system receives input—perceptions—from its environment. This input is a combined function of environmental effects plus the perception of its own actions. The input is compared to a reference state, and the difference drives the output, which is immediately and continuously perceived, along with its effect or lack of effect on the environment. The output varies to reduce the difference between input and reference states.

The reference state is not a fixed quantity: if one thinks of an organism as a hierarchical arrangement of control systems, the lower levels, such as those which actuate muscles, receive continually varying

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reference signals from higher levels, which receive their reference signals from higher levels yet. Each level embodies an order of complexity derived from the levels below: on the perceptual side, the lowest level is a perception only of intensity, which at the next level is perceived as a sensation of a specific kind, while at levels above that such constructs as configuration, motion, and sequence are developed, with the highest levels hypothesized as controlling perceptions of programs, principles, and systems concepts (such as personality). This suggests that the highest level, once developed, is relatively fixed, but that all the lower ones vary as required to maintain the integrity of the highest. It suggests a way of understanding human intellectual growth, as the development of levels, and relates the various forms of life to one another as a matter of number and degree of complexity of levels.

A crucial aspect of this model is that it is a generative model—a model in the physical science sense, not vague, conceptual boxes and arrows on a blackboard. The functions and signals of a control system model are actual and quantitative. Assembled correctly, they generate the phenomenon of control, and conversely, given control phenomena, the model itself can be constructed. Control systems are designed and built all the time in the engineering world, and computer simulations of the organic, living version can be simulated on small computers. These simulations (specifically a three-level model of an arm tracking a randomly moving object) show that a control system does not require elaborate calculations of actions in order to track, and tracks, in a rapid, graceful, and entirely life-like manner, an object subject to continuous random disturbances.

Again with a computer, a person can track a randomly disturbed object, and a control model of that person's characteristic mode of control derived, such that in tracking another target, disturbed in a different random way, the model matches the person's behavior to a degree unheard of in the life sciences, even though the two tracking performances take place one or more years apart (6). Unfortunately, in the behavioral sciences, correlations of .997 are thought to be indicative of triviality or tautology, and these demonstrations have not found acceptance in the literature.

While these experiments and demonstrations are focused on the lower levels of the multi-level hierarchy, the rigorous modeling they represent is intended to be applied to higher levels as well, addressing such topics as personality and the conduct of psychotherapy, the phenomena of social interaction and of organizations. But the value of the control-theoretic approach is diluted by the gratuitous use of concepts which are contradictory or irrelevant to control theory, or by the use of the control theory model as simply a metaphor.

What we find in much of the literature about control theory, then, are assertions about it which are inaccurate and fanciful. They may succeed in making control theory more like other psychological theories, but do so at the cost of making the model unworkable. And the unique feature of control models is that they work: in electronics, in computer simulations, and, given what is known about nervous and chemical systems (with relabeling of signals and functions) in living systems as well.

Drawing on Nelson's recent article, a variety of misapprehensions about control systems can be identified and confuted.

1. Self-regulation keeps an individual on track towards attaining a goal. (Self-regulation is the process of maintaining a perception, including the perception of moving toward a goal.)
2. The brain sends a signal to the appropriate muscles to take action. (This is a plan-execute model; in control theory the brain specifies perceptions, which makes it unnecessary to calculate "appropriateness".)
3. Standards for behavior can be imposed by external sources. (An external standard is a property of the perceived social environment. One can align one's own reference standard with a perceived one—or not—depending on whether or not such a standard is identical with or compatible with one's own standards or goals.)
4. The comparator function is used occasionally to determine whether one's perceptions match a reference value. When perceptions do match, the negative feedback loop is disengaged after the comparator function. (Comparison is an ongoing, continuous process, and the loop remains closed; a condition of no error, however, requires no action.)

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5. It is behavior that is regulated rather than perception. (This is the fundamental difference between control theory and other theories. From inside the organism, where we all live, however objective we try to be, what we know of our actions, the actions of others, and the world around us, are perceptual constructs. There is no extra-sensory means of knowing. Objectivity in science means fairness, lack of bias, and the ability to reproduce, communicate and agree upon those perceptions which we construe as originating externally.)
6. That such evaluation is always conscious, that homeostasis has nothing to do with self-regulation, that goals and standards can be imposed from outside, that feedback is too slow, etc., etc. (These myths conform to present concepts of how behavior works. In the multi-dimensional space of concepts, control theory is off on a new axis entirely, and cannot be appreciated unless one is willing to suspend previous beliefs and start again from scratch. Most of these myths are present in Nelson's article.)

This is not the place to get into a detailed exposition of the control model. The primary literature (2)(3)(4) is available to anyone who wishes to pursue it. The textbook by Robertson (7) is helpful and the concepts are extended by Marken (8) in a series of experiments. Computer demonstrations of the phenomenon of control and a detailed development of the model, and the three-level arm experiment have been developed by Powers. The 10th annual conference of the CSG will be held in Durango, Colorado, July 27-31, 1994, and, like previous conferences, will draw its participants from such diverse fields as experimental psychology, sociology, education, counseling, organizational development, linguistics, economics, etc. The fundamental and productive nature of the model is reflected in the broad scope of phenomena to which it can be applied.

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