Living Control Systems III
The Fact of Control

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By William T. Powers

Seeing is behaving

Living Control Systems III: The Fact of Control
by William T. Powers
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The field of behavioural science, combining psychology, sociology and neuroscience, has diversified over the past century such that there is a desperate need for an integrative theory. William T. Powers, medical physicist and engineer, proposes that 'control' is the unifying process. *Living Control Systems III* is the latest in an influential but contentious series of works in which Powers presents his theory of perceptual control and illustrates its explanatory power.

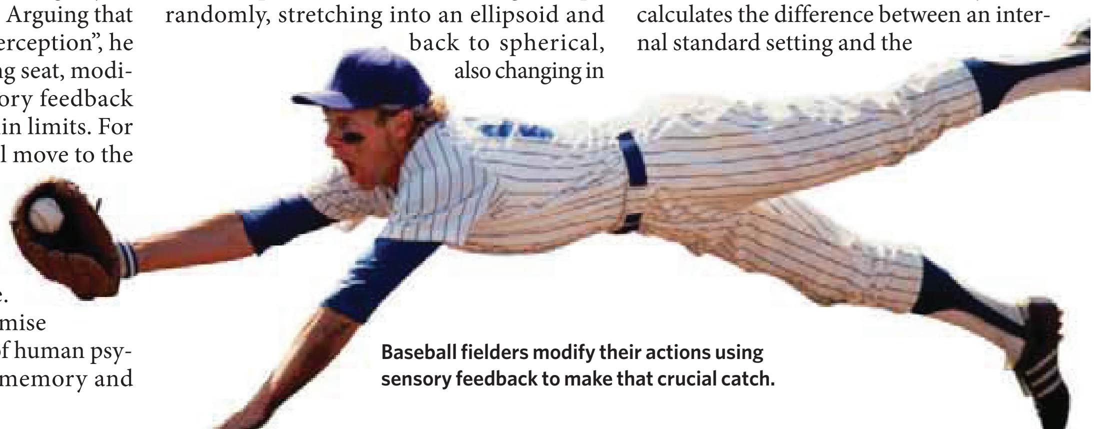
Powers innovatively applies the principles of 'control engineering' — as used in devices such as amplifiers and cruise-control systems — to the management of perceptual variables, such as our ability to track a moving object or maintain a sense of comfort. Arguing that "behaviour is the control of perception", he puts the organism in the driving seat, modifying its action through sensory feedback to control its experiences within limits. For example, a baseball fielder will move to the optimum position to catch a ball by maintaining an image of the ball moving at a constant velocity, relative to the playing field, on the retina of his eye. Powers builds on his basic premise to account for the complexity of human psychology, including learning, memory and skill acquisition, through the operation of multilevel hierarchies of control systems.

Recent developments within computing allow Powers to bring his theory to life. The book is organized around an accompanying compact disc containing 13 computer simulations of perceptual control. They span from the tracking of moving targets and the simulation of balance, to three-dimensional models of arm coordination and the emergence of crowd behaviour. Powers uses a combination of common sense reasoning, philosophical argument and mathematical models to make his case. Throughout, the style is engaging yet authoritative.

> **"Behaviour is the control of perception and not a learned response."**

After setting the historical context, Powers turns to the interactive computer demonstrations. A sphere on the screen changes shape randomly, stretching into an ellipsoid and back to spherical, also changing in placement and projected angle. The viewer is asked to control the shape, location or the orientation of the figure by moving the computer mouse, the movement of which is recorded and plotted. The graph makes it clear that the user's behaviour exactly opposes the random changes in the sphere's perceived properties. The more that the computer tries to squash its shape, the more the user moves the mouse to return it to a spherical form. According to Powers, this shows that behaviour is controlling perception and is not a learned response to the environment. By contrast, most traditional theories explain behaviour as the result of a learned association between a stimulus and a response; for example, as a rat might be conditioned to press a lever for a food reward. Such theories, Powers proposes, do not provide an adequate explanation of behaviour.

The basic unit of control is the negative feedback loop. This is a mathematical system that calculates the difference between an internal standard setting and the



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Baseball fielders modify their actions using sensory feedback to make that crucial catch.

perception of that same quantity, and uses this difference to drive the behaviour that reduces the discrepancy. A newly hatched duckling, for instance, would have a setting for how near it needs to be to its parent. When the parent is further away, the difference drives the duckling's behaviour, perhaps making it run, to restore the error to zero. According to Powers, this continuous process of perception, comparison and action goes on in many systems simultaneously within any living animal.

Because these adjustments involve many systems, conflict between them is common. An animal might need to regulate its proximity to safety and an optimum level of novelty or stimulation in its environment, for instance. But going closer to novel environments can take the animal further from the safety of its lair. Powers proposes that two systems in conflict have their set points determined by a higher level system. In order for the conflict to cease, these settings need to change. He suggests that a random, trial-and-error change in these settings takes place until they no longer cause conflict — a process known as reorganization. An example is the mechanism by which the bacterium *Escherichia coli* heads towards increasing levels of certain chemicals in a surrounding fluid, known as chemotaxis.

Living Control Systems III is an interactive tutorial rather than a coffee-table introduction, and occasionally, but not crucially, demands mathematical knowledge. Increasingly, academic textbooks are becoming more electronic and interactive. But this book's dual format is inconvenient: it would be easier to absorb the material if it was fully electronic. The computer demonstrations are powerful, and the novice reader may get a good grasp of the theory simply by skipping to the penultimate chapter to experiment with a range of novel displays of perceptual control.

Perceptual control theory has spawned a diverse range of applications within psychotherapy, education and artificial intelligence over the past 50 years. It has been lauded by Carl Rogers, the creator of person-centred counselling; Thomas Kuhn, the philosopher of science; and self-regulation theorists such as Charles Carver. Yet it has still to be accepted within psychology, perhaps because it requires psychologists to accept the same level of precision as in physics, biology and engineering. Whether this animated third volume will prompt that leap is an open question, but it succeeds in being a sophisticated yet colourful demonstration of a contentious theory. ■

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