The Generic Concept of Stimulus and Response

The central finding of the chapter is that reinforcers select environment-behavior relations. Here, we consider more closely the characteristics of the environmental and behavioral events that are selected. The key insight into the nature of these events is that they are inherently variable. They are inherently variable because the contingencies of reinforcement rarely specify precisely the constituents of the environmental and behavioral events that precede the reinforcer. Consider the simple laboratory case of a rat pressing a lever with food as a reinforcer. The contingency—lever press followed by food—only partially constrains the environmental and behavioral events that precede the food. The animal could have just sensed any of a number of stimuli—the sight of the lever, the ambient light level, the appearance of the wall of the test chamber, the sound of the lever being pressed, the smell of a previous occupant of the chamber, and so on. Similarly, the just-executed behavior could include any of a number of responses—depressing the lever with the right or left forelimbs, with the nose as it sniffs the bar, with both limbs as it attempts to climb out of the chamber, with the flank as it turns around in the chamber, and so on. In general, selection processes, including selection by reinforcement, only partially constrain the events that are present when selection takes place. Because the selected environmental and behavior events are variable, it is incorrect—strictly speaking—to describe the outcome of selection as *one* stimulus guiding *one* response. Instead, a variable set of stimuli acquires control over a variable set of responses. As Skinner (1935) uniquely appreciated, the concepts of stimulus and response are *generic* concepts. That is, they refer to *classes* of events not single events. (See **Figure 1**.)

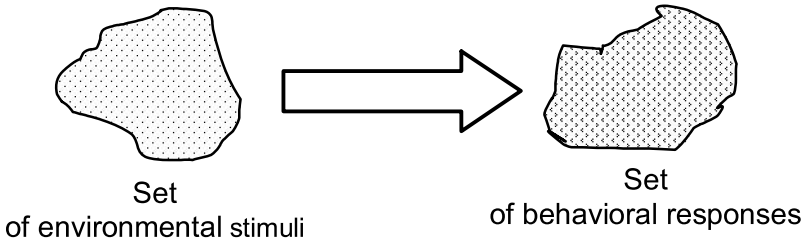

Figure 1. *Schematic diagram illustrating the generic concepts of stimulus and response*
The guiding environment consists of a set of stimuli and the guided behavior consists of a set of responses. The elements within each set represent the variable stimuli and responses that are potentially able to enter into the environment-behavior relation. Some members of each set may be more important than others, but a varying subset of elements of both sets must be present at a given moment if the environment-behavior relation is to occur. Skinner's generic concept of the stimulus informed the development of stimulus-sampling theory by William Estes (1950), Skinner's former student. Skinner's generic concept of the response had its counterpart in Edwin Guthrie's (1935) idea that actions were composed of individual movements.

Over successive reinforcers, some stimulus and response components are more likely than others to be present immediately before the reinforcer occurs. Returning to the simple lever-press example, the lever is more apt to be pressed when the animal is facing the lever than when it is looking elsewhere. Thus, at the moment of reinforcement the environment more likely includes sensing the lever than sensing the back of the chamber. Likewise, the behavior of lever pressing more likely occurs when the forelimbs are in contact the lever than when the animal is using them to turn in the chamber. Contact with the paws is more often followed by lever pressing with a shorter delay of reinforcement than turning responses. In spite of the winnowing of stimulus

and response components by the reinforcer, the components remain somewhat variable and differ from one moment to the next even when the contingencies of reinforcement are constant.

A consequence of the generic nature of environment-behavior relations is illustrated by superstitious behavior (***LCB***, p. 46). The following indicates the breadth of responses that can form an operant class: A faculty colleague believed that it was "improper" to train lever pressing by intruding the experimenter into the "natural contingencies" encountered when an animal is simply exposed to a lever after the click of a feeder has become a signal for food. Guided (or, perhaps, misguided) by this advice, a student of this colleague came into our laboratory to announce that something "funny" was going on: A rat had been placed in the chamber, but now a "thumping" noise was coming from the chamber. A look inside the chamber led to the discovery that the rat was jumping up to the ceiling and bumping its head—hence the "thump." Then, as the rat fell, it extended its legs to break the fall and—in so doing—occasionally pressed the lever. For this animal, the operant class of responses sufficient to press the lever had included leg extension after bashing its head on the ceiling! If the components of the selected environment-behavior relation are variable when rats are lever pressing in the controlled conditions of the laboratory, then how much more variable are the components when experienced learners are behaving in the natural environment.

Generic Responses on the Physiological Level of Analysis

On the neural level, the responses that are selected by reinforcement are generic as well. Consider the following experiment: Arm movements in monkeys were reinforced with food when they were directed toward lights placed at various locations on a horizontal board. During this differential conditioning procedure, recordings were made from individual cells in the motor cortex (Georgopoulos, Schwartz, & Kettner, 1986). These recordings indicated that a given cell fired maximally for a movement in a particular direction, with different cells firing maximally for different directions. **Figure 2** shows the behavioral and neural results for one such reinforced arm movement.

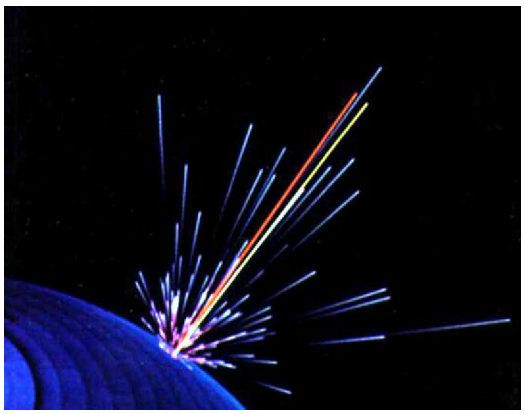

Figure 2. *Behavioral and neural responses during a reinforced arm movement in a monkey*
The YELLOW LINE indicates the direction and extent of a particular arm movement. The LIGHT BLUE LINES INDICATE the directions in which the rates of firing of different single cells were maximal. Their lengths indicate their rates of firing during this particular movement. The ORANGE LINE indicates the average direction and rate of firing when the responses of single cells were averaged (i.e., the resultant of the summation of the vectors for individual cells). (*Adapted from Georgopoulos, Schwartz, & Kettner, 1986*)

The critical finding, for present purposes, is that arm movements are selected via the conditioning of a *class* of neurons. From one moment to the next, the individual neurons that mediate the movement might differ, but the concerted effect of their action reliably produces the reinforced behavior.

The products of selection processes are always generic whether at the behavioral level—where operant behavior is selected from among variable response components—or at the physiological level—where neural activity is selected from among variable cellular components. The environment incompletely specifies the selecting conditions and acts upon a substrate of variable environmental and behavioral events. Selection does not produce a unitary "thing," but a statistical array of variable components.

References

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