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Signs and Learning Theories

We begin with the most primitive level of signs, and then proceed in the next four chapters to progressively more advanced levels, ending with the forms of discourse used within institutionalized specializations. We shall see how each advancement of level makes possible increased specialization of pragmatic function and extension of reference. Signs at the most primitive level we shall term *natsigns*. Natsigns are contrasted with what Morris called *comsigns*, signs produced with a communicative intent recognized by interpreters. Within comsigns we can distinguish the differing levels of unstructured signals of animal communication, subject-predicate sentences formulated within a language, and forms of discourse as combinations of sentences about a common topic.

Our primary source of information about natsigns comes from the learning theories of experimental psychology as applied to animal behavior. These theories apply to both conditioned reflex learning, where a response is transferred from one stimulus to another, and to instrumental learning, where responses are shaped by positive and negative reinforcements. The theories themselves can be formulated in a purely descriptive language describing behavior and functional relations. But to apply these theories to sign interpretation and extend them to language use requires introducing the quasi-external psychological and logical terminology characteristic of the third grade of involvement. The implications of this introduction and the difficulties raised by it are the principal topics of this chapter. We begin in the next section with a brief review of the two principal models used by psychologists to investigate associative learning.

3.1. Conditioned Reflex and Instrumental Learning

The Conditioned Reflex Model. The conditioned reflex model developed by Pavlov is the simplest to relate to sign interpretation. Investigators first identify types of stimuli that evoke reflex responses, such as an application of food particles to a dog's mouth evoking a response of salivation, or an electric shock applied to a paw evoking a reflex withdrawal response. This stimulus is the *unconditioned stimulus* S^*. The causal relation between it and the reflex response *R* is an invariable or deterministic one, one that allows of no exceptions in normal animals under normal conditions. It is also one that can be explained by innate physiological mechanisms, and cannot itself be modified by later learning. This unconditioned stimulus is then paired with another stimulus called the *conditioned stimulus S*, as the tone of a bell might be paired with the presentation of food or a flash of light paired with an electric shock. After a number of such pairings the response *R* may observed to be transferred from the unconditioned stimulus *S** to the conditioned stimulus *S*. Such transference occurs when *S* alone evokes *R*, or at least a response similar to *R*. After a number of pairings of light flashes and shocks, when the animal is presented with a flash of light without an accompanying shock it will respond by lifting its paw. *R* has then been transferred from *S** to *S*.

This process of transference can be described by means of behavioral laws relating *S*, *S**, and *R*. In general, unlike the invariant, deterministic relation between *S** and *R*, the causal relation between *S* and *R* changes over time and is probabilistic. The probability of *S* being followed by *R* increases with the number of past pairings between *S* and *S** and decreases as these pairings are later reduced or eliminated. Also, this probability will vary with the temporal and spatial interval between *S* and *S**. For temporal and spatial intervals beyond a very restricted minimum (about two minutes for mice) no response *R* will be observed to occur. We can formulate this as the *contiguity condition* for the *S*-*S** pairings of conditioned reflex learning. An exception to this condition will be presently discussed.

Let's suppose that our unconditioned stimulus is an electric shock evoking a dog's paw-raising response *R* and that an experimenter pairs with this stimulus the conditioned stimulus of a flashing light that can be colored either red, green, or blue. We suppose further that the experimenter administers the shock only when the red flash occurs, never after the green or blue. During early trials the dog will tend to generalize the red flash to the other colors; a red flash is simply a flash of light. At this stage the response *R* will be evoked by both green and blue, as well as by red. After a certain number of trials the animal will learn to discriminate red from green and blue, and *R* will be evoked only by the red colored light. This initial generalization of red to the other colors is known as *stimulus generalization*. It and *stimulus discrimination*, the acquired differential response to red and not the other colors, are basic features of conditioned reflex learning. Stimulus discrimination has been shown to be quicker within a given qualitative dimension than between different dimensions. Thus, an animal can discriminate red from blue within the color dimension as followed by a shock more readily than between red and the presentation of a square object within the shape dimension or between red and a certain sound.[1] Stimulus discrimination thus seems to be most effective as a kind of locating of different positions within a given qualitative dimension.

Acquiring the capacity for conditioned reflex transference from an unconditioned stimulus S^* to a conditioned S and for discriminating S from similar stimuli not followed by S^* surely bestowed on primitive organisms an evolutionary advantage, and we can conjecture this capacity evolved through the same forces of genetic drift and natural selection that have caused the development of other features of organisms.[2] Even a very brief temporal interval between a S and a later S^* may prevent the ingestion of a toxic substance, as for the amoeba learning to eject a piece of glass after pairings between stimulations (cf. 2.1). The importance of a capacity to correlate taste with toxicity for survival seems indicated by an exception to the contiguity condition noticed by investigators studying the behavior of rats presented with a saccharin solution followed by X-ray radiation inducing illness. Even though the illness may have followed six hours after the drinking of the solution, the rats learn after a single trial to avoid drinking the solution. For no other types of pairings does such an extension beyond the contiguous seem possible.[3] Evolution has thus bestowed on organisms those capacities essential for survival. Toxic effects occur after long temporal intervals, and more than one occurrence would usually be fatal. For short-term correlations between sights and touches or sounds and sights, on the other hand, nature can be more flexible and forgiving.

Instrumental Learning. When we turn to the models of instrumental learning developed by B. F. Skinner, we find different elements being distinguished and different relations existing between them. The type of behavior most relevant for our purposes is one where investigators identify a *controlling stimulus* S, a response R to this stimulus, and positive and negative reinforcements $R^+$and R^- to this response. To use one of Skinner's standard examples, the controlling stimulus may be a flash of light, the response a bar-pressing response by a rat, the positive reinforcement R^+ the release of a food pellet following a given press of the bar, and the negative reinforcement R^- the absence of any reward or an electric shock. If the flash of light occurs at the same time or shortly before bar-pressing is followed by pellets, while no light when the bar is pressed is followed by no reward, the animal learns to press the bar only in the presence of the light. In Skinner's terminology, the flash of light becomes the "occasion" for the response to be reinforced.[4] The response is not a reflex response, but a learned response, an effect whose cause is both the controlling stimulus and the results of prior conditioning.

The basic features of conditioned reflex learning are present in instrumental learning. As before, there is a contiguity condition: learning occurs only if there is a relatively restricted time interval between occurrences of the controlling stimulus, the response R, and the positive and nega-