9

Theories of Reinforcement

Did you know that

- reinforcers need not reduce a biological drive or need?
- responses, as well as stimuli, can serve as reinforcers?
- instrumental conditioning procedures not only increase the rate of the instrumental response, they also decrease the rate of the reinforcing response?
- instrumental conditioning procedures restrict how an organism distributes its behavior among its response alternatives?
- reinforcement effects are a by-product of the new response choices an organism makes when its activities are constrained by an instrumental conditioning procedure?
- the effect of an instrumental conditioning procedure depends on all the activities of a participant and how these activities are organized? An important factor is the availability of substitutes for the reinforcer activity.
- behavioral economics developed from efforts to use economic concepts to gain a better understanding of how instrumental conditioning procedures cause a redistribution of behavior among possible response options?

In Chapter 8, we discussed various types of instrumental conditioning procedures and their behavioral outcomes. There is no doubt that reinforcement

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procedures can produce dramatic changes in behavior and that these changes are much more complex than just an increase in the probability of a response. Different schedules of reinforcement produce different patterns of response runs and pauses and also determine choices among response alternatives. The issue we turn to next is how reinforcement causes these effects. That question is addressed by theories of reinforcement.

All good theories must be consistent with the findings they are intended to explain. In addition, good theories should stimulate new research that serves to evaluate and increase the precision of the theory. Good theories also provide new insights and new ways of thinking about familiar phenomena.

The story of the development of theories of reinforcement is a marvelous example of creativity in science. The story is peppered with examples of small refinements in thinking that brought a particular theory in line with new data. The story also includes dramatic new departures and new ways of thinking about reinforcement. And there are interesting cases in which incremental changes in thinking culminated in major new perspectives on the problem.

A theory of reinforcement must answer two questions about instrumental conditioning. First, it has to tell us what makes something a reinforcer or how we can predict whether something will be an effective reinforcer. Second, a good theory has to reveal how a reinforcer produces its effects. It has to tell us what mechanisms are responsible for an increase in the probability of the reinforced response.

THORNDIKE AND SKINNER

The first systematic theory of reinforcement was provided by Thorndike, soon after his discovery of instrumental conditioning (Bower & Hilgard, 1981). According to Thorndike, a positive reinforcer is a stimulus that produces a "satisfying state of affairs." However, Thorndike did not go on to tell us what makes something "satisfying." Therefore, his answer to the question "What makes something effective as a reinforcer?" was not very illuminating.

One can determine whether a stimulus, such as a pat on the head for a dog, is a "satisfier" by seeing whether the dog increases a response that results in getting petted. However, such evidence does not reveal why a pat on the head is a reinforcer. By calling reinforcers "satisfiers," Thorndike provided a label, but he did not give us an explanation for what makes something effective as a reinforcer independent of its effect in increasing behavior. This approach does not allow one to determine ahead of time which events will be effective reinforcers, and that is key for our understanding of the concept of reinforcement.

Thorndike was somewhat more forthcoming on the second question: "How does a reinforcer produce an increase in the probability of the reinforced response?" His answer was provided in the law of effect. As we noted in Chapter 7, according to the law of effect, a reinforcer establishes an association or connection between the stimuli S, in the presence of which the response is performed, and the instrumental response R. The reinforcer produces an S–R association. Because of this association, when the participant returns to the training situation S, it performs the response R.

Thorndike did not say much about how a reinforcer can act retroactively to strengthen the S–R association, only that it did. However, modern neuroscience has come to the rescue and filled this gap in our knowledge. Evidence indicates that a dopamine signal triggered by the delivery of an unexpected reinforcer directly strengthens neuroplasticity in sensory-motor synapses, especially those that are active in dorsal striatum (e.g., Petter et al., 2018; Schultz, 1998). This dopamine mediated neuroplasticity is the basis for reinforcement learning, which is widely used in computer simulations of learning (Sutton & Barto, 2018).

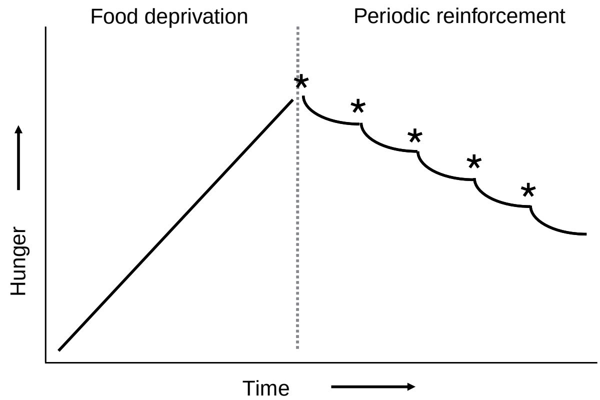
Skinner was primarily interested in the prediction and control of behavior (e.g., Skinner, 1953). Like Thorndike, he recognized that certain consequences that follow a response will increase the probability of that response. He referred to this as reinforcing or strengthening the response. Skinner acknowledged that various response consequences can act as reinforcers, but he did not identify what effective reinforcers had in common. He also did not speculate about the mechanisms that were responsible for increases in the probability of a reinforced response and thought that associative explanations of operant behavior (such as those highlighted by Thorndike's law of effect) would be counterproductive for a science of behavior. Instead, Skinner focused on the prediction and control of behavior. He was fascinated with identifying the functional relationships that exist between observable environmental variables and measures of behavior, but he was extremely skeptical about the usefulness of theoretical analyses.

HULL AND DRIVE REDUCTION THEORY

While Skinner worked on developing the technology of operant conditioning, Clark Hull, another giant in the history of learning, focused on theories of learning (for a review of Hullian theory, see Amsel & Rashotte, 1984). Hull accepted the S–R mechanism of the law of effect and concentrated on the question that Thorndike had pretty much ignored—namely, "What makes something effective as a reinforcer?" To answer this question, Hull made use of the concept of homeostasis, which had been developed to explain the operation of physiological systems.

Homeostasis is the tendency of organisms to defend a stable state with respect to critical biological functions, such as body temperature, salt–water balance, and blood sugar level. When a system is not at its homeostatic level, the organism experiences a **drive state**, which creates motivation to return to homeostasis. Consider, for example, food intake (see Figure 9.1). To survive, organisms must maintain a stable or optimal supply of nutrients. Food deprivation challenges the nutritional state of the organism and creates a need for food. The psychological consequence of this is the drive state of hunger, which can be

FIGURE 9.1. Illustration of the Mechanisms of Drive Reduction Reinforcement Using Hunger as an Example



Note. Deliveries of the food reinforcer are indicated by asterisks.

reduced by the ingestion of food. According to Hull, food is an effective reinforcer because it reduces the hunger drive. More generally, Hull proposed that what makes a stimulus reinforcing is its effectiveness in reducing a drive state. Hence, his theory is called the **drive reduction theory** of reinforcement.

Primary Reinforcers

Common laboratory examples of instrumental reinforcement are consistent with Hull's drive reduction theory. Mild food deprivation is routinely used to make food an effective reinforcer for laboratory animals in experimental situations. Similarly, mild water deprivation makes water an effective reinforcer. Rats will press a response lever to obtain heat when they are in a cold environment. Conversely, they will lever-press to obtain cold air in a hot environment. Deprivation procedures and other circumstances that challenge a biological homeostatic system create drive states, and stimuli that reduce these drive states are effective reinforcers for instrumental behavior.

Hull's drive reduction theory provides a successful account of reinforcers such as food and water. Stimuli that are effective in reducing a biological need without prior training are called **primary reinforcers**. However, if Hull's theory could only characterize reinforcers that reduce primary biological drives, it would be rather limited. Many effective reinforcers do not satisfy a biological drive or need. You may find the smell of Italian food reinforcing, but the smell of food does not reduce hunger. Likewise, a $20 bill does not itself reduce a biological drive or need, but it is a highly effective reinforcer.

Secondary Reinforcers and Acquired Drives

Hull's theory has been successfully extended to stimuli such as the smell of food by adding the principle of Pavlovian conditioning. As one repeatedly eats a savory food, the smell of that food becomes associated with the reduction of hunger through Pavlovian conditioning. This makes the food's aroma a **conditioned reinforcer**, or **secondary reinforcer**. The concept of conditioned reinforcement increases the scope of Hull's theory to stimuli that do not reduce a drive state directly but gain their reinforcing properties through association with a primary reinforcer.

Another extension of Hull's theory beyond primary biological drives involved the concept of a conditioned or acquired drive state. Stimuli that become associated with a primary drive state are assumed to elicit a **conditioned drive**, or **acquired drive**. For example, sometimes encountering a stimulus previously paired with food can increase your hunger level even though you may have eaten recently (e.g., Cornell et al., 1989). Reduction of a conditioned or acquired drive is assumed to be reinforcing in the same manner as the reduction of a primary or biological drive state.

The concept of conditioned or acquired drive has been used extensively in the analysis of aversively motivated behavior. You can lose your balance and fall on a moving escalator. If the fall is severe enough, you may become afraid of escalators. Such conditioned fear is an example of a conditioned or acquired drive. According to Hull's drive reduction theory, a reduction in the intensity of the acquired drive will be reinforcing. Therefore, any response that enables you to escape from the conditioned fear of escalators will be reinforced. Walking away from the escalator and using an elevator instead will be reinforced by reduction of the conditioned fear elicited by the escalator. (We have more to say about these mechanisms when we discuss avoidance behavior in Chapter 12.)

The concept of conditioned or acquired drive is also critical in the analysis of drug addiction. Drug-associated cues elicit incentive motivation to engage in behaviors involved in the procurement and consumption of drugs such as alcohol or opioids (Anselme & Robinson, 2016; Bechara et al., 2019; T. W. Robbins, 2019). We previously discussed such incentive motivation in Chapter 7. Incentive motivation elicited by drug-associated cues has its roots in Hull's concept of acquired drives.

Sensory Reinforcement

Although Hull's theory was successfully extended to some situations that do not involve primary biological drives, the theory could not explain all instances of reinforcement. For example, investigators have found that rats kept in the dark will press a response lever to turn on a light, and rats kept in an illuminated chamber will press a response lever to produce periods of darkness. Chimpanzees will perform instrumental responses that are reinforced by nothing more than the opportunity to watch an electric toy train move around a track. These are all examples of **sensory reinforcement**, reinforcement provided by presentation of a stimulus unrelated to a biological need or drive. In many situations, sensory stimulation with no apparent relation to a biological need or drive state can serve as an effective reinforcer (see Berlyne, 1969). Listening to music, watching a football game, or riding a rollercoaster are examples of sensory reinforcers that people enjoy.

The growing weight of evidence for sensory reinforcement, along with the success of alternative conceptualizations of reinforcement, has led to the abandonment of Hull's drive reduction theory. As we shall see, the alternative theories that have emerged are highly creative and involve radical new ways of thinking about the issues of instrumental reinforcement.

THE PREMACK PRINCIPLE

The modern era in reinforcement theory was ushered in by the work of David Premack, who approached reinforcement from an entirely different perspective. Like Hull, Premack considered basic questions such as why food is an effective reinforcer for rats pressing a response lever. However, instead of thinking of the reinforcer as a pellet of food, he thought of the reinforcer as the act of eating the food. For Premack, the question was not what makes food a reinforcing stimulus, but what makes eating a reinforcing activity. Premack (1965) framed the issues of reinforcement in terms of responses, not in terms of stimuli or nutritional substances.

What makes eating different from pressing a response lever in a standard Skinner box? Many answers are possible. The rat must learn to press the lever, but it does not have to learn to eat. Eating can occur not just in the Skinner box but anywhere the rat finds food. Eating involves a special set of muscles and activates digestive processes. Another difference between eating and pressing a lever is that a food-deprived rat in a Skinner box is much more likely to eat than to press the lever if it is given free access to both activities. Premack focused on this last difference and elevated it to a general principle.

According to Premack, the critical precondition for reinforcement is not a drive state or incentive motivation. Rather, it is the existence of two responses that differ in their likelihood when the organism is given free access to both activities. Given two such responses, Premack proposed that *the opportunity to perform the higher probability response will serve as a reinforcer for the lower probability response.* This general claim became known as the **Premack principle**.

According to the Premack principle, the specific nature of the instrumental and reinforcer responses does not matter. Neither of them has to involve eating or drinking, and the individual need not be hungry or thirsty or have its "drive" reduced. The only requirement is that one response be more likely than the other. Given such differential response probability, the more likely response can serve as a reinforcer for the less likely response. For this reason, the Premack principle is also known as the **differential probability principle**.

The Premack principle took the scientific community by storm. For the first time, scientists started thinking seriously about reinforcers as responses rather than as special stimuli. The Premack principle liberated psychologists from the grip of stimulus views of reinforcement and views of reinforcement rooted in biological needs and drives. Moreover, the Premack principle provided a convenient tool for the application of instrumental conditioning procedures in a variety of educational settings, including homes, classrooms, psychiatric hospitals, institutions that serve individuals with developmental disabilities, and correctional institutions (Danaher, 1974; Herrod et al., 2023).

Applications of the Premack Principle

In all educational settings, students are encouraged to learn and perform new responses. The goal is to get students to do things that they did not do before and things they would not do without special encouragement or training. In other words, the goal is to increase the likelihood of low-probability responses. Instrumental conditioning procedures are ideally suited to accomplish this. But the teacher first must find an effective reinforcer. Withholding a student's lunch so that food may be used as a reinforcer is not socially acceptable and would create a great deal of resentment. Candy and other edible treats are effective reinforcers for young children without food deprivation but are not good for them nutritionally.

The Premack principle provides a way out of this dilemma. According to Premack (1965), a reinforcer is any activity the participant is more likely to engage in than the instrumental response. Some students may like playing a video game; others may enjoy spending time on the playground; still others may enjoy helping the teacher. Whatever the high-probability response may be, the Premack principle suggests that one can take advantage of it in encouraging the student to engage in a less likely activity. All one needs to do is provide access to the high-probability response only if the student first performs the lower probability behavior. In other words, the opportunity to engage in the high-probability behavior is provided contingent on the lower probability response.

Consider, for example, a child with autistic spectrum disorder who shows some form of perseverative behavior (repeatedly manipulating the same object, for example). Studies have shown that the opportunity to perform such perseverative responses can be used as a reinforcer in efforts to teach more desirable behaviors such as simple arithmetic and language skills (Charlop et al., 1990; Hanley et al., 2000).

Theoretical Problems

The Premack principle has been highly influential, but it is not without complications. One major problem involves the measurement or calculation of response probabilities before imposing the operant contingency. We all have an intuitive sense of what it means to say that one response is more likely than another, but assigning a numerical value to the probability of a response can be problematic. Furthermore, the likelihood of a given response may change unexpectedly. A youngster may enjoy swimming in the afternoon but not first thing in the morning.

The problems associated with using response probabilities to identify reinforcers can be avoided in applied settings with the use of a token economy (Hackenberg, 2018; Matson & Boisjoli, 2009). In such a system, students are given tokens or points for performing certain target instrumental responses. The students can then exchange their points for various response opportunities (playing a video game, watching a movie, reading a comic book, going out to the playground, and so forth), depending on what they want to do at the moment and how many points they have accumulated. If a wide-enough range of reinforcer activities are available in exchange for tokens, one need not obtain precise measurements of the probability of each reinforcer response or worry about fluctuations in reinforcer preferences.

Token economies avoid problems associated with measuring response probabilities, but they do not solve a major conceptual problem with the Premack principle—namely, that the Premack principle is merely a prescription or rule for identifying reinforcers. It does not tell us how reinforcers work. It answers the question "What makes something effective as a reinforcer?" but it does not answer the question "How does a reinforcer produce an increase in the probability of the reinforced response?"

THE RESPONSE DEPRIVATION HYPOTHESIS

The next major development in behavior theories of reinforcement was the **response deprivation hypothesis**, proposed by Timberlake and Allison (1974), which states that restricting access to a particular response is sufficient to make the opportunity to perform that response an effective positive reinforcer. Timberlake and Allison followed in Premack's footsteps in thinking about reinforcers as responses rather than as stimuli. Their starting point, like Premack's, was to figure out what makes an instrumental response different from a reinforcer response. However, their consideration of this question led them down a different path. Timberlake and Allison suggested that the critical difference between instrumental and reinforcer responses is that the participant has free access to the instrumental response but is restricted from performing the reinforcer response.

In a typical Skinner box, for example, the rat can press the response lever at any time, but it is not at liberty to eat pellets of food at any time. Eating can occur only after the rat has pressed the lever, and even then the rat can only eat the single food pellet that is provided. Timberlake and Allison (1974) suggested that these restrictions on the reinforcer response make eating an effective reinforcer. In their view, instrumental conditioning situations deprive the participant of free access to the reinforcer response. This is why the Timberlake–Allison proposal is called the response deprivation hypothesis.

Response Deprivation and the Law of Effect

The response deprivation hypothesis highlights an important idea. The idea is obvious if one considers what would happen if there were no restrictions on eating for a rat in a Skinner box. Imagine a situation in which the rat receives a week's supply of food each time it presses the response lever. According to Thorndike's law of effect, a week's worth of food should be a highly satisfying state of affairs and therefore should result in a strong S–R bond and a large increase in lever pressing. But this hardly makes sense from the rat's point of view. A more sensible prediction is that if the rat receives a week's supply of food for each lever press, it will press the response lever about once a week, when its food supply becomes depleted.

According to the response deprivation hypothesis, what makes food an effective reinforcer is not that food satisfies hunger or that eating is a high-probability response. Rather, the critical factor is that an instrumental conditioning procedure places a restriction on eating. If the response deprivation is removed, instrumental responding will not increase; the instrumental response will not be reinforced.

Response Deprivation and Response Probability

Notice that the response deprivation hypothesis does not require the computation of response probabilities. Thus, the response deprivation hypothesis avoids the first shortcoming of the Premack principle. To apply response deprivation, one merely has to determine the rate of a response during a baseline period in the absence of any restrictions and then limit access to the reinforcer response to below that baseline level. This makes the response deprivation hypothesis useful in creating effective reinforcers in various clinical and applied situations (K. W. Jacobs et al., 2017; McFall et al., 2019).

Response Deprivation and the Locus of Reinforcement Effects

In addition to avoiding the problems involved in computing response probabilities, the response deprivation hypothesis shifted the locus of the explanation of reinforcement. In earlier theories, reinforcement was explained in terms of factors that were outside the instrumental conditioning procedure itself. With drive-reduction theory, the external factor involved procedures that established a drive state. With the Premack principle, the external factor involved the differential baseline probabilities of the reinforcer and instrumental responses. In contrast, with the response deprivation hypothesis, the locus of reinforcement rests with how the instrumental conditioning procedure constrains the organism's activities. This was a new idea. Never before had someone suggested that reinforcement effects are determined by the response restrictions that are an inherent feature of all instrumental conditioning procedures.

The response deprivation hypothesis moved our understanding of reinforcement forward in that it avoided some of the problems of the Premack principle. However, just like the Premack principle, the response deprivation hypothesis only provided an answer to the question "What makes something effective as a reinforcer?" The answer to the other major question, "How does a reinforcer produce an increase in the probability of the reinforced response?," had to await examination of how instrumental conditioning changes how individuals distribute their behavior among various response options.

RESPONSE ALLOCATION AND BEHAVIORAL ECONOMICS

The response deprivation hypothesis helped to redefine the basic problem in instrumental conditioning as a problem of **response allocation**, the distribution of responses among various options available in a situation. Decreasing access to the reinforcer response creates a redistribution of behaviors such that the reinforcer response occurs less often and the instrumental response occurs more often. If instrumental conditioning involves a change in response allocation, what causes the change and what are the rules that govern these changes? Efforts to answer such questions encouraged scientists to import concepts from the study of microeconomics into the analysis of instrumental behavior (Allison, 1983; Kagel et al., 1995) and helped to establish the field of behavioral economics.

Economics basically deals with the allocation of resources among various options. One major resource for people is money, which is allocated among various goods and services that money can buy. In an instrumental conditioning situation, the resource is behavior, which can be allocated among various response options. A central economic concept in analyses of how people elect to spend their money is the concept of a bliss point. In economics, the bliss point refers to an individual's ideal or preferred distribution of monetary resources among the goods and services the person might wish to purchase.

Translated to behavioral choices, the **behavioral bliss point** is how an individual elects to distribute their behavior among various options when there are no limitations and the person can do whatever they want. Consider, for example, a teenager named Kim. Left to her own devices, during the course of a 24-hour day Kim might spend 4 hours talking to or texting friends, 1.5 hours eating, 2 hours driving, 10 hours sleeping, 3 hours playing video games, 3 hours listening to music, and half an hour doing schoolwork. This distribution of activities would constitute the behavioral bliss point for Kim. Notice that at the bliss point, Kim devotes only half an hour each day to doing schoolwork.

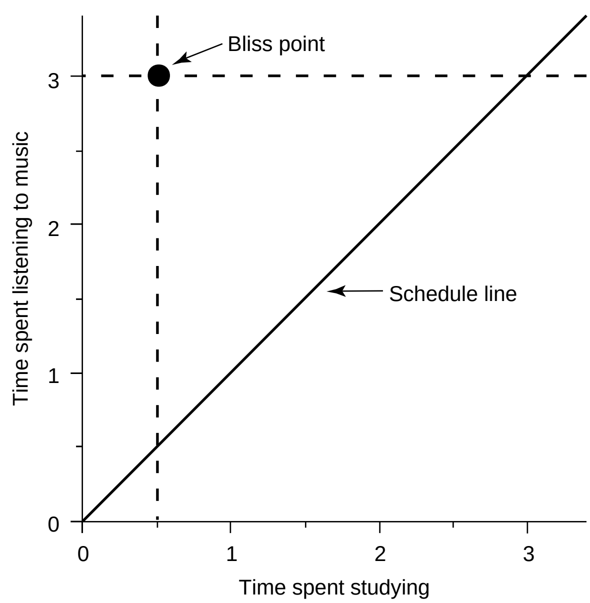
A simple instrumental conditioning situation includes two obvious response options, the instrumental response and the reinforcer response. The behavioral bliss point may be defined as the ideal or preferred distribution of behaviors between these two response options when there are no limitations or constraints on either activity. The behavioral bliss point is also referred to as the **equilibrium point** because there is no reason to change choices if they already reflect the individual's preferences. The behavioral bliss point is the individual's preferred response choices before an instrumental conditioning procedure is imposed.

Imposing an Instrumental Contingency

Kim's parents may want to introduce an instrumental conditioning procedure to increase the amount of time Kim devotes to schoolwork. They could do this by restricting her access to music. They could, for example, require that Kim spend a minute doing schoolwork for every minute that she gets to listen to music. Before this instrumental contingency, listening to music and doing homework were independent activities. How much time Kim spent on one activity had little to do with how much time she spent on the other. Once the instrumental conditioning procedure is introduced, this independence is lost.

Kim's behavioral bliss point for listening to music and studying is illustrated in the upper left quadrant of Figure 9.2. Before the instrumental contingency, Kim spent much more time on music than on studying. Requiring her to do a minute of homework for every minute of music listening ties the two activities together in a special way. Now time spent on homework must equal time spent on music. On a graph of rates of instrumental and reinforcer responses, the **schedule line** indicates how much access to the reinforcer activity is provided for various rates of instrumental responding on a particular schedule of reinforcement. In Figure 9.2, the schedule line is the 45° line. With the instrumental conditioning procedure in effect, Kim can no longer distribute her responses as she did at the behavioral bliss point. Notice that

FIGURE 9.2. Illustration of the Behavioral Regulation Approach to Instrumental Conditioning



Note. The bliss point represents how much time a person spends studying and listening to music in the absence of an instrumental conditioning procedure or schedule constraint. The schedule line represents how much time the person can devote to each activity when she is required to spend 1 minute studying for each minute spent listening to music.

the schedule line does not go through the behavioral bliss point. Therefore, the instrumental conditioning procedure creates a **disequilibrium** and forces response choices that can no longer satisfy the bliss point.

How will Kim respond to the challenge to her bliss point or the disequilibrium that is created by the schedule of reinforcement that has been imposed? Behavioral economics assumes that challenges to the bliss point will cause adjustment that move response choices back toward the bliss point. Interestingly, however, every possible strategy for returning to the behavioral bliss point involves some cost or disadvantage. If Kim elects to listen to music for as long as she would like (ideally, 3 hours a day), she would have to do much more schoolwork than she likes. On the other hand, if she spent as little time doing schoolwork as she prefers (half an hour per day), she would have to settle for much less music than she likes.

Instrumental conditioning procedures constrain response options. They disrupt the free flow of behavior and interfere with how an organism selects among its available response alternatives. Furthermore, most cases are like Kim's in that the instrumental conditioning procedure does not allow the participant to return all the way to the behavioral bliss point. The best that can be achieved is to move toward the bliss point without ever reaching it.

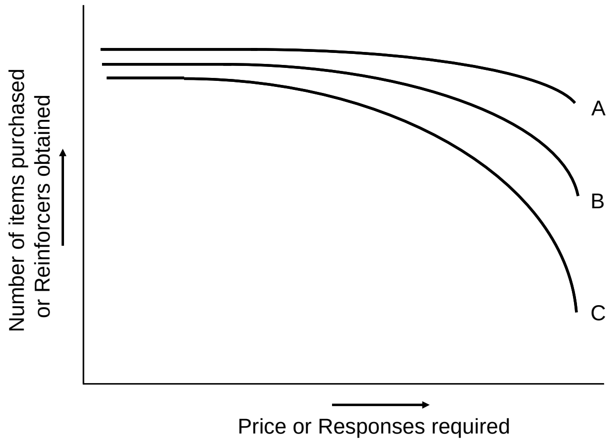
Responding to Schedule Constraints

How an individual goes about moving back toward its behavioral bliss point after an instrumental contingency has been imposed depends on the costs and benefits of various options. Much of behavioral economics is devoted to the analysis of such cost–benefit trade-offs (Hursh et al., 2013). How one navigates this problem depends on which activity one is willing to give up to defend the other. If listening to music is so important to Kim that she is willing to pay any price to maintain her access to music, then she will increase her time doing schoolwork to get her preferred access to music. In contrast if studying just 30 minutes a day is very important for Kim, she may be willing to defend that by giving up her access to music once the instrumental contingency is introduced.

As the preceding discussion suggests, navigating the costs and benefits of different ways of getting back to the bliss point depends on the **elasticity of demand**, or the degree of flexibility associated with one activity or the other. In economics, elasticity of demand reflects how easily purchasing decisions are influenced by increases in the price of an item. Psychologists have introduced the concept of **essential value** to capture the same general idea (Hursh & Silberberg, 2008). The greater the essential value of a reinforcer, the less flexibility there is in how much of that reinforcer you will seek to obtain.

For people who operate cars powered by gasoline, there is relatively little flexibility in how much gasoline they purchase. Higher prices do not result in much of a drop in gas purchases, indicating that gas purchases show little elasticity of demand. This is illustrated by curve A in Figure 9.3. In contrast, an increase in the price of candy will cause a sharp drop in purchases, showing

FIGURE 9.3. Demand Curves Showing the Number of Items Purchased (or Reinforcers Obtained) as a Function of the Price of the Item (or the Number of Responses Required)



Note. Elasticity of demand is lowest for item A and greatest for item C.

that the purchase or consumption of candy is much more elastic, as illustrated in curve C in Figure 9.3. This shows that candy has less essential value than does gasoline.

In instrumental conditioning, the reinforcer is the item being "purchased," and the "money" that is used to purchase the reinforcer is the instrumental response. Price is set by the schedule of reinforcement. In ratio schedules, for example, the price of obtaining a reinforcer can be increased by increasing the ratio requirement (requiring more responses for each reinforcer). Elasticity of demand is studied by seeing how the number of reinforcers obtained changes as the ratio requirement is increased. If the number of reinforcers obtained drops precipitously as the ratio requirement is increased, the reinforcer is said to show high elasticity of demand. (e.g., Hursh, 2014; Schwartz et al., 2021).

If Kim insists on listening to music for 3 hours a day no matter what, she is showing little elasticity of demand for music listening and will have to substantially increase studying to defend her preferred access to music. A major factor that determines elasticity of demand is the availability of substitutes. A **substitute** is a commodity or activity that provides some of the same benefits or satisfaction as the original item. There is little elasticity of demand for gasoline because we cannot use anything else to operate a car with a gasoline engine. In contrast, many substitutes are available for candy. If the price of candy goes up, one can switch to eating other things that are sweet, such as cookies or ice cream.

A particularly important factor determining how an individual responds to schedule constraints is the availability of substitutes for the reinforcer activity (Green & Freed, 1993; Murphy et al., 2007). Instrumental conditioning procedures are powerful only if no substitutes are available for the reinforcer activity. If Kim loves music and cannot derive the same satisfaction from any other type of activity, then music will be a powerful reinforcer for her, and she will adjust to the instrumental conditioning procedure imposed by her parents with a large increase in time spent on schoolwork. However, if playing video games is a good substitute for listening to music for Kim, then the instrumental contingency will have little effect on how much schoolwork she does. Instead, she will respond to the schedule constraint imposed by her parents by substituting video games for listening to music, without having to increase how much time she spends on schoolwork.

Behavioral economics suggests that one must be careful to assess the availability of substitutes in designing a practical application of instrumental conditioning principles. Unfortunately, these substitutes may not be clearly evident before an instrumental contingency is imposed. Kim's parents, for example, may not be aware that Kim considers video games a satisfactory substitute for listening to music. In fact, Kim may not be aware of this herself before the instrumental contingency links studying with listening to music. For this reason, it is important to monitor an individual's full range of activities when an instrumental conditioning procedure is introduced to produce the desired change in behavior.

Contributions of Response Allocation and Behavioral Economics

Thinking about instrumental conditioning as a problem of response allocation guided by economic concepts has advanced our understanding by encouraging thinking about instrumental conditioning and reinforcement within the context of the participant's entire behavioral repertoire. Response allocation and behavioral economics focus attention on the fact that instrumental conditioning procedures do not operate in a behavioral vacuum. Rather, instrumental conditioning procedures disrupt the free flow of behavior; they interfere with how individuals allocate their behavior among available response options. Behavioral economic concepts also tell us that the effects of instrumental conditioning are not limited to changes in the rate of the instrumental response. Schedule constraints also produce changes in the rate of the reinforcer response as well as substitutes for the reinforcer activity.

Behavioral economics challenges us to think about instrumental behavior from a broader perspective than previous conceptualizations. It shows us the importance of considering all the activities of an individual—how these activities are organized and how that organization determines the choices the person makes in response to a schedule constraint. This approach is a far cry from the limited stimulus–response perspective that dominated earlier theories of reinforcement. However, it brings along its own challenges. It is difficult to predict whether an instrumental conditioning procedure will produce an increase in the target response if we don't know what might serve as a substitute for the reinforcer or how rigid or flexible the individual is in defending various aspects of their behavioral bliss point.

SUMMARY

A theory of reinforcement has to tell us (a) what makes something a reinforcer and (b) how the reinforcer produces its effects. Early theories assumed that reinforcers were special types of stimuli. According to the most influential of these theories, a stimulus will be reinforcing if it is effective in reducing a drive state. Drive reduction theory was dominant for several decades but ran into some difficulties (e.g., it could not explain sensory reinforcement) and was supplanted by response theories of reinforcement. Among the most prominent of these was the Premack principle, according to which a reinforcer is not a drive-reducing stimulus but rather the opportunity to make a response whose baseline probability is higher than the baseline probability of the instrumental response.

The Premack principle continues to form the basis of numerous applications of reinforcement in clinical and educational settings. However, shortcomings of the principle stimulated the next theoretical development, the response deprivation hypothesis. According to this hypothesis, the opportunity to perform a response will be an effective reinforcer if the instrumental conditioning procedure restricts access to that activity below its baseline rate. The response deprivation hypothesis shifted the focus of attention from reinforcers as special stimuli or responses to how an instrumental conditioning procedure constrains the organism's activities and creates a new allocation of responses among the individual's behavioral options. Analyzing the processes that are important in the reallocation of behavior was facilitated by the use of concepts from economics, and this led to the establishment of the field of behavioral economics.

Behavioral economics suggests that organisms have a preferred or optimal distribution of activities in any given situation. The introduction of an instrumental conditioning procedure disrupts this optimal response distribution, or behavioral bliss point. The disruption activates changes in response allocation to defend the bliss point. Typically, the response reallocation involves an increase in the instrumental response and a decrease in the rate of the reinforcer response. The magnitude of these changes is determined by the elasticity or essential value of each response and the availability of substitutes for the reinforcer response.

SUGGESTED READINGS

Cory, M., Loiacono, B., Withington, M. C., Herman, A., Jagpal, A., & Buscemi, J. (2021). Behavioral economic approaches to childhood obesity prevention nutrition policies: A social ecological perspective. *Perspectives on Behavior Science*, *44*(2–3), 317–332. https://doi.org/10.1007/s40614-021-00294-y

Herrod, J. L., Snyder, S. K., Hart, J. B., Frantz, S. J., & Ayres, K. M. (2023). Applications of the Premack principle: A review of the literature. *Behavior Modification*, *47*(1), 219–246. https://doi.org/10.1177/01454455221085249

Hursh, S. R., Madden, G. J., Spiga, R., DeLeon, I., & Francisco, M. T. (2013). The translational utility of behavioral economics: The experimental analysis of consumption and choice. In G. J. Madden (Ed.), *APA handbook of behavior analysis: Vol. 2. Translating principles into practice* (pp. 191–224). American Psychological Association.

Jacobs, K. W., Morford, Z. H., King, J. E., & Hayes, L. J. (2017). Predicting the effects of interventions: A tutorial on the disequilibrium model. *Behavior Analysis in Practice*, *10*(2), 195–208. https://doi.org/10.1007/s40617-017-0176-x

TECHNICAL TERMS

homeostasis, page 141
drive state, page 141
drive reduction theory, page 142
primary reinforcer, page 142
conditioned reinforcer, page 143
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conditioned drive, page 143
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For chapter summaries and practice quizzes, visit https://www.apa.org/pubs/books/essentials-conditioning-learning-fifth-edition (see the Student Resources tab).