1

Reinforcement as "Rat Psychology"

A new vaccine has been developed. Hailed as a miracle, the vaccine protects against ALL sexually transmitted diseases including AIDS and herpes, and prevents the flu, the common cold, and all childhood diseases such as chicken pox. The vaccine is available starting tomorrow. Would you take it? Would you want your child to have a shot?

Sorry, one piece of information concerning the hypothetical vaccine was left out. The vaccine has never been tested on animals and is not based on animal models of the diseases. The pharmaceutical company manufactured the drug by looking at people with the illnesses and put together something that seemed logical to them. Knowing this, would you take the vaccine? Probably not. In reality, before new drugs are even allowed to be tested in a very limited and controlled manner on humans, the drugs must undergo numerous tests on animal models of the disease.

While laws require pharmaceutical companies to test their new drugs on animals before they are allowed to be tested on humans, the opposite is true with many psychological and educational "treatments." The treatments are seldom, if ever, tested on animals and seldom based on animal models of abnormal or inappropriate behavior. Often the "treatments" are not based on any valid research of any sort (Singer & Lalich, 1996; Watters & Ofshe, 1999). Psychologists and educators simply develop the treatments by looking at people with the problem behavior(s) and develop something that somehow relates to what they have seen. This anything goes attitude in psychotherapy has produced, by the estimate of University of Pennsylvania researcher Alan E. Kazdin (1994), over 400 different approaches to psychotherapy! Ed Anderson, trustee of the Cambridge Center for Behavioral Studies lamented on this state of affairs: "Being a

chemist by profession, I often wondered why there is only one chemistry, one biology, one physics, and there are 10,000 psychologies" (from Daniels, 1994, p. xii). While not ethical for physical problems, this "invent a therapy" approach is standard practice when it comes to behavioral and educational problems. The result is that millions of dollars are wasted on such quackery as "past life regression," "facilitated communication," empirically invalidated psychoanalytic "therapy" (e.g., Singer & Lalich, 1996; Watters & Ofshe, 1999; Wolpe, 1981), "whole word" reading instruction, and "new math." Indeed, one child died in a "rebirthing" effort to get her to "bond" to her adopted mother.

The systematic, purposeful use of reinforcement is seen as too elementary, ineffective, irrelevant, or even as unethical for human problems. The science of behavior, called "behavior analysis" that is based on an experimental analysis of behavior (EAB) that often uses rat and pigeon behavior as a source of data to unveil the reinforcement process, is held in disdain by many in psychology, management, and education. Ironically, however, the *most effective* psychological and educational treatments and programs can all be ultimately traced back to animal models or data from animal behavior and behavior's systematic relation to reinforcement. Likewise, *performance management,* developed by Aubrey C. Daniels, directly applies behavior analysis, primarily the effective application of positive reinforcement, to business management. This direct systematic application of reinforcement to management has resulted in improved quality and productivity at such companies as 3M, Kodak, Rubbermaid, and Honeywell, as well as other companies in the United States, Canada, Mexico, Great Britain, France, Italy, and Brazil (Daniels, 1994).

RAT PSYCHOLOGY IN INNER-CITY EDUCATION

In 1975, in one of the poorest, most violent sections of the Houston, Texas, area, Thaddeus Lott took over as principal of Wesley Elementary, a school with a 99% minority population. Only 18% of the third graders were reading at grade level. However, by 1996, 100% of the third graders passed the Texas Assessment of Academic Skills. In 1998, Wesley first graders ranked in the top 13 of 182 Houston schools in reading, out-scoring many upper-class, predominantly white schools. Similar results have occurred with functionally similar programs in other run-down "ghetto" schools, such as Public School 114 in the Bronx (Lemann, 1998).

Despite his truly amazing success, rather than being applauded, Principal Lott is vilified by many in psychology and education. Lott's success is discounted and criticized because his school program is based on rein-

forcement that is contingent on progressive achievement by teachers and students and uses the method of "direct instruction." In direct instruction students are constantly drilled with correct answers reinforced and errors immediately corrected. In other words, the approach Lott uses to run his school is based on principles of learning derived from the study of animal behavior, or derogatorily, his approach is said to be based on "rat psychology." Indeed, according to critics such as Kenneth Goodman, professor of language, reading, and culture at the University of Arizona, not only is Lott's approach called "rat psychology," but it is directed at poor, minority children and is something "that middle-class parents wouldn't stand for" ("Despite Test Scores," 1988).

Despite such unsubstantiated attacks and inaccurate portrayals, progress continues. At Wesley Elementary, the behavior of both the students and the teachers is reinforced according to a strict, purposeful, programmatic, research-based behavior management program centered on reinforcement contingent on successive academic gains. Teaching cannot be said to have occurred if no learning has occurred. Therefore, teaching effectiveness is measured by students' academic progress. Promotions and raises for teachers are contingent upon their students having end-of-year test scores higher than their start-of-year scores. That is, effective teaching behavior is reinforced with raises and promotions. As a result effective teaching behaviors are selected, increasing in frequency, and ineffective teaching repertoires tend to die out or become extinct.

Direct instruction is largely based on the concepts of *shaping* (the method of reinforcing successive approximations) and *fluency*. Behavior that occurs with ease, accuracy, and at a high rate is fluent. Understanding the fundamental nature and the systematic use of both shaping and fluency was derived directly from studies using rat and pigeon subjects in basic experimental analyses of behavior.

Shaping involves the reinforcement of closer and closer responses to a final behavior and the extinction, or nonreinforcement, of previous approximations. To shape a rat to press a lever, first being near the lever is reinforced with a food pellet. Then, touching the lever is reinforced, but just being near the lever is not. Then, pressing the lever is reinforced, but simply touching the lever is not. The rat has been taught to press a lever by reinforcing successive approximations to lever pressing and by not reinforcing, or extinguishing, previous approximations.

A cheetah mother starts to bring meat to her cubs to supplement her milk. Later, she brings small wounded gazelle calves to her cubs so they can kill and eat them. Still later she brings largely uninjured and larger gazelle calves for her cubs. Finally the cheetah mother does not allow her offspring to share in her kills. The cheetah mother, by bringing successively more difficult prey, has shaped the hunting behavior of her offspring.

A child is taught to read the word *was* by first being socially reinforced for making the "waaa" sound in response to the printed stimulus *W*, and by making the "as" sound in response to the printed stimulus word *as*. Next the sound "waaa.....aaaasssa" in response to the stimulus "was" is reinforced. Then the sound "wa...as" is differentially reinforced and the sound "waaa.....aaaasssa" is not reinforced or is corrected. Finally, only the verbal behavior of saying "was" in response to the printed stimulus "was" is reinforced. Learning to read "was" was shaped by reinforcing successive behavioral approximations to the desired response. Learning to read by phonics depends in part upon shaping. While seeming simple, shaping can build complex behavioral repertoires and may require thousands of repetitions. Learning basic math (addition and subtraction) for example, may require over fifty thousand responses (L. K. Miller, 1997, p. 261).

If learning simple math requires thousands of repetitions, then it is easy to see that to learn basic elementary academic skills, hundreds of thousands, if not millions, of repetitions are required. Fluency building is dependent on rapid repetitions, with correct responses reinforced. To have a functional skill, fluency is required (Johnson & Layng, 1992).

Most college graduates and some high school graduates have had a few years study of a foreign language. However, the vast majority of these adults cannot speak, read, or understand the language they studied. They do not have a functional foreign language skill because they never became fluent in the language. Instead, they achieved a minimum level of acquisition necessary to pass the next exam. But the few who did become fluent in a language often enjoy speaking and listening to that language.

Similarly, fluency in math brings appreciation of the power, beauty, and utility of math. In addition to calling a solution "beautiful" mathematicians may call a proof or solution "eloquent." But those with poor, dysfluent math skills are said to have "math phobia." Those who cannot read well do not like to read. But fluent readers enjoy reading. A heart surgeon who has acquired only the basic skills to perform bypass surgery may perform the operation correctly but take many hours. In contrast, a surgeon who is *fluent* in the operation will perform the operation equally well but may take less than two hours. Even though both doctors perform the surgery correctly, the fluent doctor's patients are much more likely to survive. Fluent behavior is needed whether the operant behavior is auto mechanics or heart surgery.

When a behavioral skill is not fluent, it is effortful. According to the law of least effort, effort is aversive (Eisenberger, 1992), and will tend to be avoided. Therefore, teaching basic academic skills to a high degree of fluency increases the probability that more advanced academic skills will be

acquired. Conversely, learning only to a minimum level of acquisition increases the probability of later academic failure.

In colleges across the United States, direct instruction is often belittled as a "drill and kill" teaching method (Cheney, 1999). A more accurate phrase may be "drill and thrill." When a behavior is highly reinforced and built to fluency, as behavior is in direct instruction, it builds "self-esteem" (Cheney, 1999), and the students enjoy learning.

A fluent behavior is one that has been strongly selected and is therefore very likely to occur under the appropriate environmental conditions. The method of fluency building in direction instruction is based on the ("rat") laboratory concept of "free operant responding." In free operant responding, as long as the organism is in the environment, the organism is "free" to perform the operant behavior as frequently or as infrequently as the organism's physiology allows. "Percent correct," the standard educational measurement, captures only part of what is necessary for a behavior to become fluent. Fluency requires a high *rate* of accurate performance.

Lever pressing by a rat may be reinforced when a light above the lever is on but not when it is off. Initially, lever pressing will be equally likely whether the light is on or off. If the training is stopped as soon as seven responses are made when the light is on and only three when the light is off, (70% accuracy, a typical goal required for promotion in education), correct responding is not overly probable for the next training session. Furthermore, training a new behavior that is based on the previous discrimination learning (press when the light is on; don't when the light is off), will be next to impossible because the initial learning, while demonstrated at 70% accuracy, never became fluent.

Conversely, if lever pressing at a high rate while the light was on, one hundred responses per minute, and a low or zero rate when the light was off, was required to end a session or before a new behavior based on the initial discrimination learning was taught, then correct responding during the next session and learning new responses based on the previous learning is highly likely. High-rate, reinforced, free operant responding builds fluency.

If attempts are made to teach a child new math skills based on simple addition and subtraction, *before* the child is fluent, but *after* the child can make 70% correct responses (perhaps the child still uses his fingers to count or it takes one minute per problem), then teaching a new skill such as multiplication, division, or word problems, will be very difficult if not impossible. However, if the child is required to become fluent in simple addition and subtraction, for example, ten correct flash cards for every incorrect flash card, *at the rate of one card per second,* before teaching a new skill, then learning multiplication, division, and word problems will be much easier.

According to educational researchers and reformers Kent R. Johnson and T.V. Joe Layng, requiring fluency in academic behavior is a direct product of "Skinner's (1938) discovery of the importance of response rate as a dependent variable" (Johnson & Layng, 1992, p. 1476). Skinner's classic text *The Behavior of Organisms* (1938), is based entirely on research with rats. Perhaps, the claim that "using reinforcement on humans is 'rat psychology,'" is not a myth after all. The general principles of reinforcement (e.g., how delay, magnitude, frequency of reinforcement, and other variables, e.g., the concurrent availability of alternate responses and sources of reinforcement effect the rate of behavior) have all been systematically established almost exclusively by studying rat and pigeon behavior under various reinforcement contingencies.

Every science-based discipline develops an understanding of general principles in controlled *simplified* laboratory conditions before the general principles are applied to human situations. General principles of a chemical reaction may be established in a test-tube with isolated variables before the principle is applied in a pharmaceutical medication. Electricity, transistors, resistors, and all other components of modern computers were first studied in controlled, simplified, laboratory situations before their systematic application was possible. However, when an experimental analysis of behavior develops general principles in controlled *simplified* laboratory conditions before the general principles are applied to human situations, the general principles are discounted in their applicability to humans. The procedures are discounted, and the promoters are often held in contempt. "People are not rats. Studying rat behavior can't help people."

However, such attacks are inciting but not insightful. To be valid, an attack must be accurate. If what is meant by "rat psychology" is the systematic application of general principles of reinforcement in applied behavior analysis programs, then, in fact, when children are having behavioral difficulties, middle-class parents are increasingly using "rat psychology" themselves, or run to programs based on "rat psychology" for help. Fortunately for these middle-class parents, the data make it clear that they have made the best choice. Furthermore these programs offer the best hope for impoverished minority children to succeed in school.

RAT PSYCHOLOGY IN THE HOME

Upper- and middle-class parents often rely on "timeout" rather than spankings to correct the behavior of their children. For good reason too. Murray A. Straus's research spanning over twenty years consistently shows a direct correlation between the number of spankings a child receives and

increased social, psychological, and behavioral problems, both in childhood and adulthood (e.g., Straus, 1994). Over the course of a person's lifetime, spanking causes many more problems than it ever helps. Spankings frequently occur not because they help the child, but because spankings are often negatively reinforcing *for the parent*.

Parents who use timeout instead of spanking should know that the full term for "timeout" is *timeout from positive reinforcement,* and that, as noted by University of Florida researchers Cynthia J. Pietras and Timothy D. Hackenberg, the general principle of timeout was derived directly from the animal (rat and pigeon) laboratory.

> Timeout from positive reinforcement is one of the most commonly used procedures in educational and therapeutic settings. Like many behavioral procedures used in applied contexts, timeout from positive reinforcement has origins in basic laboratory research. . . . In applied settings, . . . their response-contingent application is typically used to suppress unwanted behavior. (Pietras & Hackenberg, 2000, p. 147)

Every time parents use timeout instead of a spanking to suppress unwanted behavior, they are using "rat psychology" on their children!

In the laboratory, for example, timeout from positive reinforcement may be programmed to teach sequenced lever pressing. During training, if the rat pressed a lever out of sequence the cage would immediately go dark and no lever pressing could produce reinforcement for a brief period of time, usually a few seconds. That is, by pressing a lever out of sequence, a "timeout from positive reinforcement" occurred during which time no responses are reinforced. A timeout from positive reinforcement for an unwanted lever press may be just as, or more, effective than electric shock in producing response suppression. (Is shock a rat's equivalent of a spanking?) Should a rat be shocked or have a timeout from positive reinforcement? Should a child be spanked or have a timeout for "misbehavior"? Timeout from positive reinforcement, "rat psychology," has reduced or eliminated severe, dangerous, and frequent behavioral excesses in children where other methods have failed.

In a classic example of timeout, researchers at the University of Vermont (Knight & McKenzie, 1974) trained parents in the use of timeout from positive reinforcement in a program to eliminate persistent thumb sucking in children six to eight years old who began this habit during infancy. First, each night parents read their child their favorite stories no matter what the child did. The children sucked their thumbs. But when the timeout procedure started the parents simply stopped reading when-

ever the child's thumb touched or went in their mouth. Reading started again as soon as thumb sucking ceased. That is, this habit produced a "timeout from positive reinforcement" (reading). Thumb sucking was eliminated in all children. Three cheers for rat psychology!

RAT PSYCHOLOGY IN PRIVATE SCHOOLS AND COLLEGE

The application of basic operant conditioning principles, or "rat psychology," has produced large rapid academic gains for academically disadvantaged beginning college students. In 1991, 40% of all the students in Malcolm X College in Chicago scored below the eighth-grade reading level; 30% scored below the sixth-grade level. A significant number of these students, virtually all of whom were either Hispanic or African-American, failed to make up this deficiency with remedial education, much less graduate. A summer term, pilot program in 1991 for Malcolm X students, based largely on fluency and general principles of Skinner's "rat psychology," increased reading vocabulary and comprehension 1.1 years in just 20 hours of instruction. Gains in mathematics computation, problem solving, and concepts ranged from 1.9 years to 6.0 years. No homework was required. On the strength of these results, Malcolm X College has established a Precollege Institute modeled after the pilot program (Johnson & Layng, 1992).

With students diagnosed as learning disabled and/or as having "attention deficit disorder," results that are as good or frequently superior to the Malcolm X program are *invariably* obtained at Morningside Academy in Seattle, Washington. In fact, the Malcolm X program is based on the Morningside model (which in turn is based on operant, or "rat" psychology). At Morningside, not only middle-class children, but homeless teenagers having criminal records have made outstanding academic gains. Morningside offers two money-back guarantees. Students will advance at least two grade levels in one year, and those *diagnosed* with attention deficit disorder will increase their average time-on-task behavior from 1 to 3 minutes to 20 minutes or more. *No* parent has asked for their money back (Daniels, 1994; Johnson & Layng, 1992).

Labeling an individual with attention deficit disorder (or with "obsessive compulsive disorder," or with any label for that matter) has as much meaning and does as little good as labeling a program *rat psychology*. The most valid approach for overcoming behavior deficiencies and excesses is to conduct an analysis of the individual's behavior-environment interactions and then to implement an intervention based on that analysis and on

the systematic application of general principles of behavior including reinforcement of appropriate operant responses.

The systematic application of reinforcement principles in the education of disadvantaged children is the most effective, pleasant, and agreeable method of raising the educational achievement of lower-socioeconomic-class minorities to the level of the white middle-class majority. In a success story similar to that of Lott's success in Houston, when Harvest Preparatory Elementary School, a school that serves many children from poor families in Minneapolis, introduced direct instruction, the kindergartners' reading scores went from average to the 89th percentile (Cheney, 1999).

While many of the intellectual elite deny it and cling to romantic notions of human achievement, the elite's children's academic behaviors are richly and frequently reinforced. It is this rich, frequent reinforcement that selects academic, artistic, and intellectual behaviors. Systematic reinforcement programs such as direct instruction can supply the reinforcement needed to select academic, artistic, and intellectual behaviors of disadvantaged children whose environments are otherwise lacking in appropriate and sufficient reinforcers for academic behaviors. It is a human's history of reinforcement for particular operants, whether artistic or anarchist, and not some intrinsic, mystical, inner quality of the human that is responsible for what the individual achieves.

THE RAT PSYCHOLOGY OF READING

Earning by Learning is an example of a reinforcement program for academically at-risk children. Reading behavior is reinforced by paying a child two dollars for each book read. This reinforcement may also be contingent on reading part of the book to an adult volunteer, or writing a report on the book. Alfie Kohn, author of the polemic *Punished by Rewards*, claims that "It would be difficult to come up with a less effective way to help children value reading" (Kelly, 1995). Yet the research is clear, that is, paying academically at risk children to read does indeed teach children to value reading. Research conducted by West Georgia College professors found that the Earning by Learning reinforcement program increases positive attitudes toward both academic reading *and* recreational reading (McNinch et al., 1995). By increasing their reading skills, over ten thousand academically at risk children have benefited from this reinforcement program and learned to value reading.

Earning by Learning generally serves lower-socioeconomic-class children. Middle-class parents, whose children generally go on to college, are

more likely simply to pay their children money themselves in order to increase a child's reading frequency (Flora & Flora, 1999; Flora & Popanak, 2001). Middle-class children are also likely to participate in Pizza Hut's Book It! reading program. During the 1995–1996 school year over twenty-two million children in the United States, Canada, and Australia participated in Book It! and the program is expanding. Book It! reinforces reading with certificates for a free personal pan pizza when reading goals set by the student's teacher are met. Book It! is a plain and simple reinforcement program (Flora & Flora, 1999). A report by the Institute of Human Science and Services of the University of Rhode Island on the "Book It!" program concluded "the basis behind the program was to offer *immediate positive* reinforcement to reward *individual accomplishments*. . . . it was this rewarding of effort and not ability that probably made Book It! so attractive to both parents and students" (Institute, 1986, p. 17, emphasis in original). Furthermore, teachers reported that Book It! increased positive attitudes toward learning (61%), reading level (69%), and enjoyment of reading (80%); the longer the children were in the program the more their reading level rose and their enjoyment of reading increased. Through the Book It! program, over twenty-two million children benefit from "rat psychology" each year.

When middle-class children are facing serious academic difficulties, parents typically will do whatever is necessary and use whatever resources are available to overcome their child's deficiency. Increasingly, to remedy a child's educational deficiencies, middle-class parents are paying out hundreds of millions of dollars, at the rate of $35 to $65 an hour, to private for-profit "learning centers" such as Sylvan Learning Centers. Sylvan operates in the United States and in a hundred seventy countries. Now Sylvan is going into public schools, taking federal Chapter One dollars for remedial education (Hancock, 1994). While Sylvan claims to use customized curricula for each child, the engine that drives the academic success of the children tutored at Sylvan is nothing more than a simple *token reinforcement* program or a *token economy*. Furthermore, at Sylvan, as in direct instruction, correct responses are frequently and immediately reinforced and errors immediately corrected. Like Morningside Academy, Sylvan also guarantees that each child will advance one letter grade in thirty-six hours of instruction or less. Most of what Sylvan does is nothing a parent couldn't do with a little investment of time and a minimal knowledge of reinforcement.

TOKEN ECONOMIES

The modern systematic application of token economies, used at Sylvan Leaning Centers and in other organizations across the globe, is a direct

descendent of general principles of reinforcement established in the rat laboratory as explained by University of Exeter, United Kingdom, researcher S. E. G. Lea:

> "Operant psychology" does not just consist of those still carrying out fundamental research with rats and pigeons in Skinner boxes. Another important influence comes from those who seek to put operant principles into effect, for example in educational or clinical psychology—the behavior modifiers. . . . In an ambitious and original clinical research project, Teodoro Ayllon and Nathan Azrin (1968) sought to apply reinforcement principles to raise the level of behavior in an entire ward of severely regressed schizophrenic patients. . . . Ayllon and Azrin . . . introduced "tokens," which were given to the patients as rewards whenever they performed any desired response, and could be exchanged for any of the range of "backup reinforcers." Ayllon and Azrin's rationale for the token system lay in the well established principle of conditioned reinforcement, which had been studied in detail in animals, and shown to extend to the use of tokens at least in rats and apes. . . . Token economies had considerable success and soon spread widely. (Lea, 1987, p. 97)

In a token economy, *generalized reinforcers,* or tokens, are delivered contingent upon a specified behavior. The tokens have no worth in and of themselves. It is the backup reinforcers that tokens are exchanged for that make the tokens effective reinforcers. Backup reinforcers may be anything that has value for the individual. They could be food or computer time, depending on the individual whose behavior is being reinforced with tokens (see Martin & Pear, 1999, for a review of token economies). As noted by Lea, the systematic use of tokens is derived from the concept of conditioned reinforcement. When lever pressing is reinforced with a pellet of food and a tone immediately precedes the delivery of the pellet, then the tone will become a powerful conditioned reinforcer that a rat will work to produce. When a wife always plays Vivaldi before her husband's sexual advances are reinforced with sex, then Vivaldi will become a powerful conditioned reinforcer and the husband will engage in other behaviors to receive the conditioned reinforcer (buy CDs, request Vivaldi on the radio, etc.). Conditioned reinforcers associated with several backup reinforcers are generalized reinforcers of which tokens are one example. Based on the variety and value of the backup reinforcers, tokens can become very powerful motivators. "Token reinforcement programs have repeatedly proven of value in increasing academic productivity and decreasing inappropriate behavior, and they have proven very effective in large-scale comparative

evaluations in inner-city schools" (O'Leary, 1991, p. 5). Regular classroom teachers have used token reinforcement systems to improve test performance and study hall behaviors (e.g., Karraker, 1971) to name a few. Informal surveys of teachers in my graduate learning classes find that over a third of them employ some kind of token reinforcement system in their classrooms. Furthermore, when teachers are explicitly taught about token economies they are more likely to employ them in their classroom and report good results (Kestner & Flora, 1998).

At Sylvan, appropriate academic behaviors are reinforced with tokens (nothing more than poker chips with "Sylvan Learning Centers" stamped on them). The tokens are then exchanged for CDs, movie tickets, balls, games, or other items of value to the children at the "Sylvan Store." It is the simple application of basic reinforcement principles (e.g. "rat psychology") that makes Sylvan so successful. And it is this success that brings the middle-class parent to Sylvan's door.

"I TRIED REINFORCEMENT. IT DOESN'T WORK IN MY CLASS"

As with other natural phenomenon, when the systematic application of reinforcement principles is attempted, a little knowledge may be a dangerous thing. Occasionally, a teacher may try to increase academic behavior by "rewarding" it with gold stars, or smiley faces next to the student's name. Because the students' behavior doesn't change, or changes only temporarily, the teacher soon finds that they don't really care about the stars or faces. Because the behavior the teacher tried to increase did not increase, she concludes that "reinforcement doesn't work." The teacher is not alone, as we shall see; many psychologists and educators also believe that "reinforcement doesn't work." But that is just like saying that "natural selection doesn't occur."

In this example, the teacher has developed a system of delivering tokens, or conditioned reinforcers, but failed to associate the tokens (the stars), with any backup reinforcer of value. Therefore, the tokens have no reinforcing strength and cannot increase the rate of the behavior on which they are contingent. If the stars or faces were associated with, or had been exchangeable for, backup reinforcers, the teacher would have found that reinforcement does indeed work. It would have been more accurate for the teacher to conclude that "I rewarded academic behavior with gold stars that looked nice. But since I neglected to associate the stars with any backup reinforcers, ultimately the stars had no value for the students, and they were not effective in changing the children's academic behaviors. If I

had made the star have value by associating them with backup reinforcers, like an extra five minutes of recess for each star, then academic behavior likely would have improved."

REINFORCEMENT VERSUS REWARD

Most people use the words *reward* and *reinforcer* interchangeably. In many cases rewards do function as reinforcers. However, the words *reinforcement* and *reinforcer* have functional meaning that is not explicit in the term *reward.* A reward is something given for special behavior. But, a reward is not necessarily a consequence of a behavior, is usually not given repeatedly, and most importantly does not have the explicit meaning of an increased rate of the behavior that the reward was given for. In contrast, a *reinforcer is a contingent*, explicit *consequence* of a behavior, usually occurring repeatedly, which *by definition increases the rate of the preceding behavior.* (Appendix 2 defines and explains several basic terms related to reinforcement.) If a behavior is "rewarded," but the rate of the behavior does not increase, then the behavior was not reinforced and reinforcement did not occur. Rewarding a behavior with a gold star will not necessarily reinforce (i.e., select or increase the rate of) the behavior that was rewarded.

Gold stars *could* become conditioned reinforcers if every time a child showed them to Mom, the child got a hug and kisses. Being kissed, hugged, and praised for bringing home good grades is one way grades become conditioned reinforcers for many people. If grades are not associated with praise and affection or other reinforcers, they are unlikely to become conditioned reinforcers for academic work. The child who is not given affection, praised, or reinforced in some way for academic accomplishment will not care what kinds of grades he brings home.

Reinforcement is a natural phenomenon just as natural selection or gravity are natural phenomena. Claiming that "reinforcement doesn't work" is as logical as claiming that "natural selection doesn't work" or that "gravity doesn't work." A jet flying across the Atlantic or a person's light weight on the moon doesn't mean that "gravity doesn't work." If we fail to understand why the jet flies or why the person is light on the moon, it means that we haven't considered all the other relevant variables operating on the phenomena (e.g., jet propulsion and the differential air pressure created by the wing's shape operate on the jet to allow it to fly) or that we don't understand, or are ignorant of, other relevant factors (perhaps we don't understand or are ignorant of the fact that because the moon has less mass, its gravitational force is less; therefore objects are lighter on the moon). Likewise, a teacher's "reinforcement program" may fail because the

teacher is ignorant of the fact that for tokens, or conditioned reinforcers, to *reinforce*, the tokens *must* be exchangeable for backup reinforcers of value to the child. That is, tokens must be exchangeable for reinforcers that *reinforce* (perhaps each star could be exchangeable for ten minutes of free time, computer time, or an extra snack).

BEHAVIORAL ECONOMICS

All the world's economies are, in fact, token reinforcement programs, or token economies. Tokens, or money, have replaced the barter system. In reinforcement terms, *inflation* means that the same number of tokens are now exchangeable for less backup reinforcement or that more tokens are required for the same amount of backup reinforcement. In the 1980s 2 tokens ($2) were exchangeable for two beers. In the year 2000, one beer often required 4 tokens or more.

Deflation means that the same number of tokens are now exchangeable for more backup reinforcement, or that fewer tokens are required for the same amount of backup reinforcement. In the 1980s, 2,000 tokens ($2,000) or more were required for what now would be considered a shamefully weak, virtually useless, personal computer. At the start of the twenty-first century, 1,000 tokens are exchangeable for a personal computer a thousand times more powerful than the 1980s version.

Because the same amount of behavior produces the same number of tokens, but the same tokens are exchangeable for less, inflation decreases the reinforcing value of money. ("I won't work for $5 an hour anymore.") Because the same amount of behavior produces the same number of tokens, but the same tokens are exchangeable for more, deflation increases the reinforcing value of money. ("During the depression I worked twelve hours a day for $1 and I was glad to get it.") When a country's currency completely collapses, the currency is no longer exchangeable for backup reinforcers and it is worthless. People will no longer work for that country's tokens. The collapsed currency no longer functions as a generalized reinforcer. So too, if a teacher's gold stars are not exchangeable for backup reinforcers, students will no longer work for gold stars.

Of course it would be absurd to argue that the world's economies are nothing more than "rat psychology." However, economic behavior and operant behavior are often synonymous. In economics an employee works (behaves) in order to receive pay, commodities (reinforcers). In operant psychology an organism behaves (works) to receive reinforcers (commodities and money). As first noted by Skinner (1953), the contingency and

resulting response pattern of animals responding on fixed ratio schedules of reinforcement is nearly identical to the contingency and resulting work pattern of employees paid on a piece-rate wage. For example, when a rat's lever pressing is reinforced on a fixed ratio schedule of reinforcement, the schedule produces systematically high steady rates of responding with a break in responding after each reinforcer is delivered. Likewise when an employee is paid on a piece-rate wage, for example $1 for every 25 socks sewed, typically the employee will sew at a fast rate pausing only after 25 socks have been sewed. The behavioral pattern is identical for the human factory worker and the laboratory rat because the reinforcement contingency is identical. The basic experimental model of behavioral economics builds on this observation by arranging various reinforcement schedules, contingencies, and constraints on responding and reinforcement to model economic phenomenon, hypotheses, and problems. The resulting behavior of animals working under such constraints then informs economic theory of the accuracy of economic assumptions and can provide possible solutions to economic problems.

"Laboratory experimentation based on behavioral analysis is the most powerful method for defining, testing, and refining economic theory," argue Steven R. Hursh and Richard A. Bauman from the Walter Reed Army Institute of Research in Washington, D.C. For example, "the most basic concept is the equilibrium of supply and demand. Supply is experimentally controlled by a schedule of reinforcement. Demand is determined by the level of consumption observed across a range of prices. Response rate is determined by the equilibrium point at each price" (Hursch & Bauman, 1987, pp. 154–155).

In response to possible criticism that the nonhuman animal results are not applicable to human economic problems, John H. Kagel, Raymond C. Battalio, and Leonard Green argue that "our results put the burden of proof on those who support a particular position for which our data are incompatible. It is they who must show how our results are not applicable, or are irrelevant, to the human condition" (Kagel et al., 1995, p. 5). Using this approach useful data has been obtained on such economic topics as income-compensated price changes, economic demand theory, the representative consumer hypothesis, labor-supply theory, budget constraints, labor supply curves, alternative jobs with different wage rates, income-compensated wage changes, risk preference, expected utility, cycle-of-poverty, inelastic and elastic demands and substitution, and price consumption curves (e.g., Green & Kagel, 1987; Kagel et al., 1995).

"Animals provide a way of testing *elementary* microeconomic principles" state Kagel, Battalio, and Green in their book *Economic Choice Theory.* They continue:

> For some questions . . . animal models are the only practical means to investigate an issue. They allow us to conduct precise, controlled, and demanding experiments using rewards and punishments of real consequence to test individual choice theory. . . . In applying animal models to the study of economic behavior, we are following the same approach used in biomedicine, where animal models are accepted with few reservations. . . . We use our model to address complicated social issues—such as the "cycle-of-poverty" and the "welfare trap" hypothesis, [that] deal with the effects that wide differences in income and extremely low levels of income have on individual behavior; an experimental treatment cannot adequately approximate these conditions with human volunteer subjects. With rats and pigeons, however, one can impose large differences in income for extended periods of time to address directly the effects on behavior." (Kagel et al., 1995, pp. 3–4).

Economics—back to "rat psychology"!

The basic analysis of economic behavior in reinforcement paradigms using a variety of subjects including rats, chimpanzees, and humans has been instrumental in increasing our understanding of the general principles of drug abuse behavior and has been used to inform drug policy (e.g., Hursh, 1991; 1993). The scientific understanding of the behavioral economics of drug abuse behavior and the implications for an effective humane drug abuse public policy is a product of the basic scientific approach. As exemplified by Hursh's work at Walter Reed, the scientific approach begins with controlled laboratory experiments using the behavior of animal subjects and builds to practical knowledge that can be applied to improve the human condition:

> The concepts of behavioral economics have proven useful for understanding the environmental control of overall levels of responding for a variety of commodities, including reinforcement by drug self-administration (Hurshm 1991, p. 377). . . . An overall strategy . . . would draw on the findings from laboratory research and naturalistic econometric investigations to design model intervention projects. Evaluation and improvement of these projects would then serve as small-scale test-beds for more general public policy initiatives. . . . If future work confirms the utility of this behavioral economic agenda, then we have made the first step toward the development of a more humane society." (p. 392)

BEHAVIORAL PHARMACOLOGY

Like behavioral economics, the foundation of behavioral pharmacology and the effective treatment of substance abuse is also a product of basic research centered on reinforcement using animal models of substance abuse. Indeed, the ubiquitousness and explanatory power of the reinforcement process has been so well established and proven so useful in the field of behavioral pharmacology that it is taken as a given that Newfoundland researcher William A. McKim noted in what may be the most popular introductory textbook on behavioral pharmacology, *Drugs and Behavior*: "The principles of operant conditioning are thought to apply to nearly all behavior of all animals" (McKim, 2000, p. 36). That includes human behavior. Mckim adds that "most human behavior, although very complex, is ultimately controlled by reinforcements, just as the behavior of the animal in a Skinner box is . . . by carefully studying the effects of a drug on operant [reinforced] behavior, we can provide valuable information that will help us understand the effects of the drug on the behavior of humans" (p. 38). That reinforcement is ultimately in control of both rat and human behavior is not presented as an argument or as a hypothesis but as a scientifically established given. If this reality were more widely accepted, then the suffering of both humans and animals could be greatly ameliorated.

Indeed, West Virginia University researchers C. W. Lejuez, David Schaal and Jennifer O'Donnell argue that "the moral implications of drug use and abuse have long since given way to the quest to understand it as a biopsychological phenomenon" (Lejuez et al., 1998, p. 116). The basis of drug use and abuse as a biopsychological phenomenon is the reinforcement process. Understanding the reinforcement process is vital to understanding drug abuse:

> rats and monkeys . . . self-administer most of the drugs commonly administered by humans, including opiates, stimulants, barbiturates and other anxiolytic drugs, phencyclidine, and alcohol [and] physical dependence on the drug is not necessary for drugs to serve as reinforcers. . . . First, self-administration of drugs by animals causes one to question the notion that human drug abuse reflects weak morals or a lack of will; the morality of a rat has little place in understanding a rat's drug self-administration. Second, the conceptual contribution of "reinforcement" to an understanding of drug abuse can hardly be overestimated. Drugs of abuse exploit behavioral processes that have evolved in animals for other reasons; therefore, understanding those behavioral processes *in general* aids in our understanding of drug abuse.

> Third, starting with relatively simple drug-reinforcement procedures, researchers have studied many factors involved in drug abuse, including behavioral, pharmacological, and physiological factors. Such research has often suggested straightforward approaches to treating drug abuse in humans. (Lejuez et al., 1998, pp. 117–118)

In short "the conception and study of drugs as reinforcers has been the most significant contribution of behavioral pharmacology for understanding and treating substance abuse" (Lejuez et al., p. 121). (Reinforcement in drug use, abuse, and treatment is covered in chapter 11 in this book.)

THE REALITY OF RAT PSYCHOLOGY

What direct instruction, fluency, shaping, time-out, the Malcolm X College Precollege Institute, Morningside Academy, Earning by Learning, Book It!, Sylvan Learning centers, token economies, behavioral economics, and behavioral pharmacology all have in common is that they all are directly derived from general principles of operant behavior and reinforcement or are programs based on the general principles of operant behavior and reinforcement. Almost all of these general principles have been established by studying the operant behavior of rats and pigeons in simplified experimental environments. *This is a strength not a weakness.* Almost all of our medical and pharmaceutical advances have come from studying animal models of illness and injury. Establishing general principles in simplified situations and cautiously applying the previous findings to increasingly more complex situations is the inductive approach that has advanced all areas of human understanding. The approach to understanding human behavior and behavioral dysfunction should be no different. The success of this approach is begrudgingly admitted by Jeanne Ellis Ormrod in her *Educational Psychology* textbook: "Students in my own educational psychology classes sometimes resent the fact that . . . their behavior is being compared to the behavior of rats and pigeons. But the fact is that behaviorist theories developed from the study of nonhuman animals often *do* explain human behavior" (Ormrod, 1998, p. 376, emphasis in original).

Animal experimentation and animal models of human behavioral problems, such as depression (see chapter 13 in this book), are the most successful models for studying the factors involved and have produced the most effective treatments for behavioral problems. Indeed, our ignorance of causes and cures of many behavioral problems stem in no small part

from our reluctance to use animal models of human problems. Instead of clinging to the scientifically untenable romantic belief that humans are such unique creatures that knowledge about their behavior can only be learned by studying their behavior, we could gain more practical knowledge of the problems humans face if we put more effort into searching for general principles of behavior in laboratory models using whatever animal model was most pragmatic. Then the scientifically established principle could be more confidently tested with humans. Medicine has long relied on animal models to understand the medical problems humans face. Millions of humans would be dead if it were not for the general principles uncovered and applied to humans from "rat medicine." Millions of humans with behavioral problems will not be effectively helped without application of "rat psychology." But these people could be helped if we relied more on "rat psychology" to understand the general principles of behavior.

A PARTIAL REJOINDER AND CAUTION ON RAT PSYCHOLOGY

While far more has been learned about behavior and about reinforcement from studying the behavior of rats than has been learned by studying the behavior of humans, it would be overly simplistic to assume that any systematic behavior-environment relation established in the animal laboratory would automatically work identically for human behavior outside the laboratory and to cavalierly attempt application to humans. Again, basic laboratory research attempts to isolate and uncover basic principles and relations in controlled environments. But humans (and most other animals) face a "stimulus collage" in life (Baldwin & Baldwin, 2001), a complex environment with a multitude of constantly changing stimuli that occasion, and are discriminative for, a multitude of behavior-consequence relations. For example, a teenage male may usually work diligently on his homework for contingent tokens but not if his girlfriend is present (a competing source of reinforcement); he may work if his tutor is also present (a discriminative stimulus for studying) but not work if his tutor is talking on the phone; he may work if his tutor is on the phone talking to his mother; and so on. The inductive approach requires that laboratory findings are systematically replicated in increasingly complex situations. Each validation of the finding increases the generalizability of the finding, often to human behavior in certain contexts. Therefore, whether or not a finding from the animal laboratory applies to human behavior is not a matter of a priori belief, but an empirical question to be answered by systematic inves-

tigation. In most cases the exploitation of basic behavior-reinforcement relations to human behavior has proven successful. To claim that because a principle was derived from experiments using rats, the principle is therefore automatically inapplicable to humans is untenable and unethical.