MIND AT PLAY

THE PSYCHOLOGY OF VIDEO GAMES

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CHAPTER 2

WHY VIDEO GAMES ARE FUN

Syndicated columnist Ellen Goodman has described her own initiation into video games. One cloudy day she was waiting for an airplane in the Detroit airport. She had time on her hands and thought she would try a quick game of Pac-Man. Before she knew it, she was hooked; Pac-Man took her for every last quarter she had. It began innocently enough. She put in her first quarter but, not yet having a feel for the game, she shoved Pac-Man into the arms of the nearest monster. Undiscouraged by defeat, she tried again. She did a little better this time. Something about the game made her think she could win. So she kept at it. Fortunately for Goodman, she was able to break the habit before it broke her. Once she gained some distance —away from the clutches of Pac-Man—she thought about it

clearly. "Pac-Man hooks only those people who confuse victory with slow defeat."[1]

Why do people find the games so compelling? In this chapter we will illustrate how the psychological concepts of reinforcement, cognitive dissonance, and regret help explain the process of video game addiction. Although very few psychological studies deal directly with the issue of why video games are fun, we found one that does. At the end of this chapter, we'll describe it.

Pac-Man, by Way of Example

In describing how experimental psychologists might view and explain video game behavior, it's useful to have one example to rely on throughout. Because it has been one of the most popular games, we've chosen Ellen Goodman's nemesis, Pac-Man. For the benefit of any readers who have been living somewhere besides Earth for the past few years, we'll provide a brief description of Pac-Man here.

The game Pac-Man gets its name from the Japanese term *paku paku,* which means "gobble gobble." The character Pac-Man is a little yellow creature who looks like he's smiling. He is set in a somewhat complex maze that's initially filled with yellow dots. The player controls Pac-Man's movements with a four-directional joystick or control knob, thereby allowing him to move left, right, up, or down. His jaw faces the direction in which he's moving.

As he glides around through the maze, Pac-Man gobbles up

[1]E. Goodman, "I Should Have Known He Was . . . Temptation," *Seattle Times,* 18 May 1982.

the dots. Simultaneously, however, he's vigorously pursued by four monsters (each a different color) named Inky, Blinky, Pinky, and Clyde. If one of the monsters catches him, Pac-Man slowly folds up and wilts away while the machine provides sympathetic noises. Pac-Man can be eaten only three times before the game ends, the score reverts to zero, and another quarter is required for further play.

Pac-Man has a variety of ways of combatting and outwitting the monsters. First, by adept maneuvering, he can keep away from them. Second, at each of the four corners of the board is a glowing, extra-strength dot called an energizer. Whenever Pac-Man eats an energizer, some, or all, of the monsters turn blue. When a monster is blue, contact between it and Pac-Man results in the monster's demise rather than in Pac-Man's. However, monsters remain blue only for brief periods following Pac-Man's consumption of an energizer; moreover, a monster destroyed by Pac-Man doesn't stay destroyed, but instead returns to action following a short interlude in the penalty box.

If Pac-Man eats all the dots in the maze, the player has completed a "board" and a new maze with fresh dots appears. This provision of new boards can continue indefinitely; however, with each successive board, things become more difficult. The monsters move faster and are blue for shorter periods of time; Pac-Man moves slower; and so on. In between each board, a short, amusing skit occurs on the screen.

When playing Pac-Man, the player is rewarded in many ways. For example, points are awarded for gobbling up the dots and for destroying monsters. Additionally, there is some symbol in the center of the board. What the symbol is depends on how many boards the player has managed to get through. For instance, a cherry appears on the first board, a strawberry on the second, until finally, a key appears on the twelfth board and all subsequent boards. Naturally, Pac-Man aficionados have

memorized the sequence of symbols, and the symbols that signify that many boards have been accomplished are the most prestigious. The symbols themselves can be eaten by Pac-Man for progressively increasing numbers of points. And finally, additional sources of reinforcement are the amusing skits that occur between boards.

The first time you drop a quarter into a Pac-Man game, you might get a score of 1,000, if you're lucky. Less than a minute will pass, and your Pac-Man will be eaten three times in disconcertingly rapid succession. But chances are you'll play again. And again. And again. You might get through a couple of boards, and your score might get up to 5,000 or so. But what will puzzle you most is this: the top score for the day will be posted on the machine. It might be 56,000. Or 102,000. It could be over 500,000.

How could anyone get such a score? In the next chapter we'll focus on the mental and physical skills that go into video game facility. For the moment, however, let's concern ourselves with the question of how people become so motivated that they'll play video games hour after hour, day after day. To do so, we'll consider the phenomenon of reinforcement.

Mechanics of Reinforcement

On a clear Vermont night, a young boy sits methodically scanning the sky in search of shooting stars. In a sleazy Las Vegas casino, a glassy-eyed old woman mechanically deposits nickel after nickel in a slot machine. And in a posh Chicago suburb, a teenager spends hours playing Gallaxian at the video parlor every afternoon when school lets out.

These three situations have a common element: in each one, behavior is dictated by what psychologists refer to as the partial reinforcement effect. To understand this effect—which is a critical psychological ingredient of video game addiction—it will be useful to provide a thumbnail sketch of reinforcement itself and the role it plays in shaping behavior. Video games are designed to take your money, and they have an uncanny way of doing so. They play on the ordinary person's weaknesses for reinforcement.

BASIC CONCEPTS

Reinforcement is the provision for you of something that you like. In each of the three preceding examples, reinforcement of some sort is involved. For the aspiring astronomer, seeing a shooting star is a reinforcement. For the Vegas gambler, the slot machine's payoff is a reinforcement. And for the video game player, beating a previous high score or winning a free game or shooting down enemy spaceships is a reinforcement. There are a variety of psychological theories designed to explain the role of reinforcement in behavior. Central to all of them, however, is the idea that any behavior that is followed by reinforcement will increase in frequency. In short, video games that do something to make a player feel good will be played again and again.

Certain elementary kinds of human behavior can be analyzed nicely by referring to well-studied principles of reinforcement. To get the complete picture, of course, we will need to go beyond reinforcement and examine other important topics such as motivation and social pressure. For the moment, though, we consider only the subject of rewards.

From observations made with rats, pigeons, monkeys, and other organisms—and some studies with humans—we have come to know a great deal about how reinforcement hooks people and gets them to behave in certain predictable ways.

Experiments with rats are the easiest to do, and certain laws of reinforcement emerge in their simplest form in a rat study.

A typical experiment to investigate reinforcement involves a white laboratory rat placed in what is called a "Skinner box," named after Harvard psychologist B. F. Skinner, who invented it. A Skinner box is a cage containing a protruding lever that the rat can push and a small container into which food can be dispensed by the experimenter. When a novice rat is initially placed into the box, it wanders around, performing the sorts of behaviors that rats typically perform: exploring, sniffing, grooming. Eventually—probably out of sheer boredom—it presses the lever, whereupon a rat pellet appears in the container. This is a reinforcing event, which undoubtedly makes the rat very happy. The event, like any reinforcement, leads to an increase in the behavior that just preceded it—in this case, lever-pressing. Eventually the rat will be pressing the lever at a rapid clip and eating rat pellets to its heart's content. Already you may be sensing a correspondence between the rat in the Skinner box and the human in front of the "video parlor box." Both are continually performing actions that lead to reinforcement. The rat gets crunchy food, while the video game player gets higher scores and free games. While food would be reinforcing for the video gamer, there are undoubtedly times when given the choice between (1) a slice of pizza and (2) a chance to play Space Invaders and perhaps achieve the high score for the day, the game would be a more powerful reinforcer.

SCHEDULES OF REINFORCEMENT

Game designers confront many decisions when trying to create a game that people will like. One question is: How often should a player be reinforced? Is it a good idea to make sure that players never leave their first game without some form of reinforcement? Or should the games be created so that they are sufficiently difficult and several plays are necessary before a single rewarding event occurs? As we shall see, game designers have apparently stumbled on the optimal strategy for reinforcing people so they (like the rat that keeps pressing) will continue dropping quarters at a rapid clip.

To see this, let's return to the rat. In the scenario we have just sketched, the rat was reinforced after each lever press. This is called continuous reinforcement—the rat gets a reward each time it presses the lever. This schedule is usually necessary to get the rat started.

However, continuous reinforcement is just one of many possible schedules of reinforcement. Suppose that after the rat starts pressing away, we stop providing food pellets after each press and instead provide them only now and then. What will the rat do? It will continue pressing, at least for a while. At some point, however, the rat will again be reinforced, since eventually another pellet will follow a lever press. This schedule of reinforcement is called partial reinforcement—reinforcement is intermittent rather than continuous. Partial reinforcement is a powerful way of hooking both rats and people. They keep responding in the absence of reinforcement because they are hoping that another reward is just around the corner. The gambler keeps pulling the slot machine lever even though he has lost ten times in a row because he hopes that the next time around he'll win big. This would never happen if reinforcement had been continuous. If it were, then as soon as the money stopped, the gambler would quickly decide that the machine was no good anymore and turn his attention elsewhere.

EXTINCTION

We knew a woman we'll call Ruth who went to Las Vegas at least twice a month. Each time she stayed for three days and

spent most of her waking hours diligently pumping nickels into a slot machine. If you happened to wake up as the sun was rising, you'd find Ruth glued to the machines. Her case was classic. When she was in her early twenties, Ruth went to Las Vegas for the first time to celebrate her best friend's twenty-first birthday. While there, she experienced a "big win" of $850, which was more than her monthly salary. This experience made a lasting impression on her and from then on she was hooked.

What if reinforcement were cut off altogether? As you might expect, Ruth and the other players would not stop playing immediately. Rather, they would doggedly continue to play for some time before giving up in exasperation. This decline and eventual cessation of behavior (lever pumping) in the absence of reinforcement (money) is referred to as extinction, and the length of time it takes for the behavior to cease, or extinguish, is referred to as the extinction period.

How long will it take Ruth to stop playing these machines? This depends heavily on the schedule of reinforcement that she had been exposed to earlier. If Ruth was used to winning each time she dropped a coin, then she would extinguish very quickly. However, this continuous schedule of reinforcement would have been very unlikely in Vegas. It is far more likely that she had been reinforced intermittently—that she had been on a partial reinforcement schedule—and in this case the extinction period is considerably longer.

But which partial reinforcement schedule leads to the longest extinction periods? It turns out that the "variable" schedules (either variable ratio—say, one in five turns, on the average—or variable interval—say, every minute, on the average) are the most powerful ones because they lead to the longest extinction periods. More precisely, a variable schedule with moderately long intervals between reinforcements is a good idea for game designers since it leads people to continue to play the longest in the face of nonreward. However, if the variable schedule is *too* long, a person might actually extinguish when the game designer had not meant this to happen. With a very long interval between reinforcements, the person has no way of being sure that the reinforcement drought is ever going to end. He or she may actually give up playing rather than drop the next quarter that would lead to a reward.

In sum, we know a great deal about reinforcement and how it affects people. A partial reinforcement schedule leads to behavior that (1) occurs more rapidly and (2) is more resilient to extinction than does a continuous reinforcement schedule. The dependence of extinction on the prior schedule of reinforcement has been dubbed the partial reinforcement effect. Taken together, these two effects of partial reinforcement produce what looks very much like "addictive behavior."

The question of why the partial reinforcement effect occurs has long been of interest to psychologists, and a variety of experiments have been carried out to test various theories. For our purposes, however, the important thing is that the phenomenon happens at all. Knowing how rates of responding and resilience to extinction are affected by reinforcement schedules should—in principle, anyway—allow us to account for the seemingly addictive behavior engendered by video games. Furthermore, we can explain why some video games are more addictive than others.

With these concepts in hand, it is easy to see the underlying principle that governs behavior not only in the case of Ruth, the compulsive gambler, but also in the case of the young, aspiring astronomer and the teenager in the video parlor. In all cases, the person is under a partial reinforcement schedule: slot-machine payoffs occur only infrequently, as do shooting stars and video game wins. Moreover, the schedules are of the

variable sort (slot-machine payoffs, shooting stars, and video game wins do not occur in a fixed, systematic way) and therefore produce the most powerful resistance to extinction. According to the principles of partial reinforcement, therefore, the behaviors involved should be highly resistant to extinction, which indeed they are. In all cases, the person is willing to pursue the behavior for lengthy periods of time, even in the absence of reinforcement.

REINFORCEMENT AND VIDEO GAME DESIGN

Given an understanding of these principles, the task of a person who designs and manufactures video games is more focused. The designer's goal, of course, is to make money on the game. This goal is achieved by ensuring that the eventual players will insert quarters into the game as rapidly as possible. It's to the designer's advantage to design a game that reinforces the player on the most addictive schedule possible. And this usually turns out to be a variable-ratio or a variable-interval schedule.

What this means in the world of video games is that reinforcement will be somewhat unpredictable. A reward might come on the average of once every ten times a player plays. For example, the player might achieve three complete boards in Pac-Man only once every ten times, or so, that he or she plays. This is an example of a variable-ratio schedule. If a reinforcement came on average once every ten minutes, with the actual times ranging randomly from once every ten seconds to once every half hour, our player would be on a variable-interval schedule. So, for example, if the Space Invader's mother ship appeared and was destroyed on this sort of schedule, we would say that the player was on a variable-interval schedule. These irregular schedules of reinforcement are, in part, what cause video games to be so compelling and irresistible.

In trying to implement these reinforcement schedules, an interesting problem arises for the video game designer. To understand the nature of this problem, it is useful to consider not a video game but, rather, pinball. As you probably know, pinball is played with a steel ball, initially ejected via a spring mechanism, into the playing area. While in the playing area, the ball can strike various knobs, springs, and other assorted paraphernalia, all of which cause the score to increase. If, however, the ball rolls down to where it originated, that ball is eliminated and a new ball must be ejected. The player has three kinds of control over what is going on. First, the initial ejection of the ball can range from soft to powerful, depending on how far back the player draws the spring-loaded plunger. Second, near the player is a small gate, partially guarded by flippers that the player can manipulate. These flippers, if used properly, eject the ball back into the field before it can roll out of play. And finally, the player, by using his or her whole body, can tilt the entire machine ever so slightly, in order to influence the path of the ball. The tilt can't be too much, however, or "tilt" will register on the scoreboard and the game will end.

Any game—pinball included—can't be too easy, or it will provide continuous reinforcement for practiced players, which, as we've seen, doesn't really lead to much of an addiction to the game. On the other hand, the game can't be too difficult —that is, reinforcement can't be too intermittent—because then most novice players will never get enough reinforcement to become addicted to the game in the first place. Just as the rat in the Skinner box never really begins pressing the lever unless initial reinforcement is more or less continuous, so the would-be game addict needs some early reinforcement in order to get interested in the game. This means the pinball game designer is forced to an intermediate stance—the game is made moderately difficult. This solution has two difficulties. First, and probably most serious, many potential players won't ever start playing pinball, because they don't get reinforced enough when they first start playing and can't play very well. Second, a really expert player will be reinforced continuously, which, as we've seen, doesn't produce much addiction. A colleague of ours named Graham, who teaches at the University of Aberdeen, tried a game one evening and got a score of zero. He said he never wanted to play again. A half hour later, another player —fifteen-year-old Dennis—tried the same game and, much to Graham's dismay, gave up after ten minutes because it was "much too easy."

Enter video games. The feature that sets them apart from all other games is the extremely flexible nature of the digital computer that controls them. We'll talk more about computers in chapter 6. For now, it's sufficient to realize that the computer can be programmed to make the games easy to begin with and progressively more difficult. A good example of this is seen in Pac-Man. The major determinants of difficulty in that game are such things as the speed of Pac-Man himself, the speed of the monsters, the period of time that the monsters remain edible by Pac-Man, and so on. These factors change from board to board such that the game becomes progressively more difficult as play continues. A novice player is usually able to get through one complete board after only a few trys. However, only a very few experts—who have played literally thousands of games—are able to make it up to the highest level of difficulty. The same sort of strategy is seen in the design of other popular games such as Space Invaders, where the invaders move faster, shelters disappear, and the player's life becomes generally more difficult and harrowing as the game progresses.

There is another advantage of having the computer control the reinforcement schedules. Suppose we turn into a nation of Pac-Man experts. Suppose, that is, virtually everyone practiced

Pac-Man enough to be able to play it perfectly. Wouldn't reinforcement then become continuous, with the resultant lack of addiction? No problem. Another salient feature of a computer program is that it is very easy to modify. It would be a trivial job to make the monsters go even faster or make Pac-Man go even slower. Less trivial, but still not especially difficult, would be the insertion of features that are altogether new—for example, a new monster could be created that is even more adept at devouring Pac-Man and generally creating havoc than are the current ones. In contrast, the capability of easily changing the rules of the game is not present with a precomputer game such as pinball, where all such changes would involve difficult-to-modify mechanical devices rather than simple-to-modify computer programs.

Other Aspects of Reinforcement

Knowing about the partial reinforcement effect gives any video game designer an edge in designing a particularly appealing game. But there is more that the designer needs to know. For example, Pac-Man gobbles yellow dots that are worth 10 points each. Why 10 points? Is this the best number of points to award a player for each dot devoured? These questions raise the important issue of how big the reward ought to be. Another principle of reinforcement is necessary for understanding behavior, and that concerns the size, or magnitude, of reinforcement.

MAGNITUDE OF REINFORCEMENT

There is no question that behavior is related to the size of the reinforcing event. Rats, for example, will run faster and

more frequently if they are rewarded with more food rather than less food. People will work harder and play longer on a slot machine if they have a chance of winning $1,000 than if they have a chance of winning only $100. Intuitively, of course, this doesn't seem surprising.

When it comes to video games, however, the issue of reinforcement magnitude becomes a bit more interesting. You may have noticed that the number of points one accumulates in video games always seems to be very large, even if the player is just a novice. For example, in Pac-Man, a player acquires 10 points for devouring each dot, 200 to 1,600 points for devouring the monsters, and so on. Thus even on a very first Pac-Man effort, a player can generally score in excess of a few hundred points.

Why is this? Why not, for example, just one point per dot and 20 to 160 points for the monsters? At the very least, there'd be less space needed on the screen to display the score. When we look at things in terms of reinforcement principles, the reason is clear: large rewards lead to faster responding and greater resistance to extinction—in short, to more addiction—than do smaller rewards. From the point of view of the video game manufacturer, of course, points are free—the cost of manufacturing and programming the game is the same whether small or large numbers of points are awarded to the game's eventual players.

Given these considerations, you might ask why the game designers stopped where they did in terms of point magnitudes. Why only 10 points per dot in Pac-Man? Why not 100 or 1,000? The answer is twofold. First, the point magnitudes, after all, have to be something, and whatever they're made to be they could always be higher. So the actual values chosen by the designer are somewhat arbitrary. Second, however, at some point people stop having an intuitive grasp of what some magnitude means—that is, above some magnitude, any amount is psychologically pretty much equal to any other similarly high amount. To get a feeling for this phenomenon, imagine that you are a participant in a TV game show and you are given the following choice: (1) you can either have $1 for sure, or (2) a coin will be tossed, and you will receive $10 if the coin comes up heads but nothing if the coin comes up tails. Almost invariably people choose the latter alternative, figuring that $10 is worth so much more than $1 that the chance of winning the $10 is worth the risk of losing the coin toss and forsaking everything. But now imagine a new version of the choice: either you get a sure $1 million or a coin is tossed and you get $10 million if the coin comes up heads but nothing if the coin comes up tails. Now we find that people almost invariably choose the first alternative. For most people, $1 million and $10 million are psychologically pretty much the same thing—they're both "very large amounts of money." Thus it makes perfect sense, psychologically, to opt for the sure thing—the million dollars—rather than the choice that involves a 50 percent chance of getting nothing.

Bearing this example in mind, we see why video game scores —despite principles of reinforcement—can't be too large. In Pac-Man, for example, the designer wants the accomplishment of eating a monster to be psychologically much greater than the accomplishment of eating a dot. This is done by awarding differential numbers of points, but, as in the money example, the absolute value of the points can't be too large. A million points for eating a dot would, psychologically, be not very dissimilar from 20 million points for eating a monster; they are both just "huge numbers of points."

DELAY OF REINFORCEMENT

We have pointed out that any behavior will increase in frequency if that behavior is followed by reinforcement. It

turns out that the delay between the behavior and the reinforcement is, in most cases, very important: the shorter the delay, the quicker will the behavior increase in frequency. In other words, short delays lead to more powerful reinforcement effects.

In many real-life situations, delay of reinforcement is very long. For example, if we save money in a savings account, it's a long time before we begin to see the interest accumulate or are able to withdraw the saved money in order to make some large purchase. Because of this delay of reinforcement, the behavior of saving money isn't as frequent as it otherwise would be—in everyday language, we say that saving money is difficult. So, many people don't save money; instead they spend it as soon as they get it, and reinforcement is immediate.

In the case of video games, however, at least some sort of reinforcement is always provided immediately. In most cases, a score of some sort is prominently posted somewhere in the display, and the score changes the instant we shoot down an enemy ship or eat a monster. It is, in part, this instant reinforcement that makes the behavior of playing video games so satisfying and therefore so prevalent.

MULTIPLE REINFORCEMENTS

One aspect of video games that sets them apart from most other games is that they can be, and usually are, much more complicated than arcade-type games have traditionally been. Pac-Man, for example, has many different ways to reinforce you. You can eat dots; you can eat monsters; you can avoid monsters; you can eat the symbols; you can get through boards; you can see between-board skits; hear music; and so on. Other games, invented more recently than Pac-Man, are even more complicated.

From the standpoint of what makes games fun, these multiple reinforcements are important because different people enjoy different things. By using a "kitchen-sink" approach—that is, by inserting into a game a wide variety of things that might be reinforcing—the designer winds up with a game that appeals to a wide variety of people and will, accordingly, be widely played. This flexibility of video games can be contrasted with that of pinball. Pinball, for all its bells and whistles, really provides only limited types of reinforcement—you see the ball move, you hear the sound effects, you see your score increasing, and that's about it. The reason for this contrast, once again, is that the computer program that underlies a video game is itself infinitely flexible, whereas pinball, being mechanical, has to be kept relatively simple or else it will become prohibitively costly.

If video games are reinforcing in a variety of ways, at least some of the reinforcement is no doubt extrinsic, taking the form of praise and admiration from peers and other onlookers. But it's perfectly possible to play a video game by yourself and feel gratified when you do well or when you improve your performance. This kind of reinforcement is called intrinsic reinforcement. Video games can provide very powerful intrinsic reinforcement, which is probably a very important reason for their success. The fundamental source of intrinsic reinforcement—the very person receiving the reinforcement—is perpetually present.

Cognitive Dissonance

As we have seen, video games have a variety of ways of reinforcing players. But, at least for the games played in video arcades, there is another side of the picture: you have to pay

for them. You might expect that the reinforcement obtained from the games themselves might in some sense be countered by the punishment that stems from having to insert quarter after quarter. Interestingly enough, however, a large body of social psychological research suggests that the opposite may be true: games may be *more* reinforcing, not less, if you have to pay for them.

During the 1950s and 60s, a group of psychologists (led by Leon Festinger and his colleagues) developed a theory called cognitive dissonance to account for some seemingly paradoxical types of behavior. The paradox is that people sometimes seem to enjoy things that are less reinforcing over other things that are more reinforcing. Consider, for example, an experiment reported by Festinger and Carlsmith.[2] In this experiment, a group of people performed a repetitious, tedious, and thoroughly boring task. After completing the task, the group was asked by the experimenter to lie to a new group of people—to tell them that the task was more fun than it actually was. One group was offered $20 to lie, whereas the other group was offered only $1. Finally, after the lies had been told, the people were asked to rate how much they enjoyed the original task. It turned out that, contrary to what you might expect on the basis of reinforcement effects, the $1 group claimed to like the task much better than did the $20 group.

Why did this happen? Cognitive dissonance theory assumes that when a person performs acts or holds beliefs that are in conflict with one another, the person will act so as to reduce the conflict. In the $1/$20 experiment, the conflict was between the people's knowledge that they were performing a boring task and their knowledge that they had told someone else that the task was fun. Why did they lie? People who were

[2] L. Festinger and J. M. Carlsmith, "Cognitive Consequences of Forced Compliance," *Journal of Abnormal and Social Psychology* 58 (1959): 203–10.

paid $20 had adequate justification—they were hired guns, *paid* to lie. The $1 group didn't have this handy justification, and their only recourse was to change their attitude about the task. By believing that the task was more interesting, they created a justification for the positive report that they made about it.

We can recast this sort of finding into a statement about extrinsic versus intrinsic reinforcement. Given that a person was performing some act to begin with, it's necessary to have *some* kind of reinforcement to account for it. If there's extrinsic reinforcement, as there was for the $20 group, that's fine. But if there's insufficient extrinsic reinforcement, as was true for the $1 group, then intrinsic reinforcement had to be generated—the subjects had to decide that the task was more intrinsically fulfulling. This sort of effect can be seen more directly in an experiment by Lepper, Greene, and Nisbett.[3] Here, nursery school children were given the choice of playing or not playing with marking pens. One group of children was given a reward for playing with the pens, whereas another group was given no reward. It turned out that the reward group played with the pens *less* than did the no-reward group. Again, this appears to be the opposite of what you would expect from reinforcement theory; and again, it can be explained if you assume that, in the absence of external reward, the pens developed a powerful, intrinsically reinforcing quality of their own. As an aside, it's interesting to note that this experiment has close analogues in real life, since parents will often pay their children for academic success. This practice is probably unwise, since such extrinsic reward may remove the intrinsic

[3] M. R. Lepper, D. Greene, and R. E. Nisbett, "Undermining Children's Intrinsic Interest with Extrinsic Rewards: A Test of the Overjustification Hypothesis," *Journal of Personality and Social Psychology* 28 (1973): 129–37.

motivation that produces optimal and most satisfying academic performance.

WHAT IF VIDEO GAMES WERE FREE?

Video games have the interesting quality that they take your money but provide you with no tangible, extrinsic rewards that you can put in your pocket and take home. By anyone's definition, having your money taken away from you is not reinforcing—on the contrary, it's punishing. This means that video games must develop qualities that provide powerful intrinsic reward. Since people are standing there having their money taken away, they must develop the attitude that whatever they're doing is a lot of fun. In other words, if games were free, people would probably like them less. To our knowledge, no research has ever been done that has appropriately compared free games with money-devouring ones in terms of how enjoyable the games are perceived to be. But a large body of psychological research indicates that games requiring at least some minimal amount of money (like a quarter) would be perceived as more enjoyable than free games.

Does this mean that arcade operators should be advised to make the games more expensive? Not necessarily. It's important to keep track of the distinction between how much a person enjoys the game on the one hand and how much the person plays the game on the other. A game that costs a dollar might be perceived as more enjoyable than a game that costs a quarter. But there comes a point at which, enjoyable or not, cost would be prohibitive and the game wouldn't be played. Thus there's a tradeoff between enjoyment and cost, which implies that some intermediate game cost is the optimal one. Any scientist would shriek in agony at this unjustifiable conclusion.

Regret and Alternative Worlds

So far we've talked about reinforcement in terms of being rewarded for things that you have done—like getting high scores. There's another side of this motivational coin, however, which is regret over things that you haven't managed to accomplish. In most situations regret is something that you just have to live with. But that's not true with video games. Often when playing a video game, the game ends because you've made a mistake, and you immediately know exactly what you've done wrong. "If only I hadn't eaten the energizer in this game before trying to grab that cherry," you say to yourself. "I *knew* it was the wrong thing to do, and I did it anyway." But now you don't have to just sit there being annoyed and frustrated. Instead you can play the game again and correct that mistake. So in goes another quarter. But in the process of playing again, you make another mistake. And spend another quarter to correct *it.* And so it goes.

Two psychologists, Daniel Kahneman and Amos Tversky,[4] have recently been studying the phenomenon of regret. To give you a flavor for the kind of things they've discovered, consider the following question:

> Mr. Smith and Mr. Jones both have to catch planes. They're on different flights, but since both flights leave at 9:00 A.M., they decide to take a cab together. Owing to a combination of unfortunate circumstances, the cab is late and doesn't arrive at the airport until 9:30. On consulting with the airline agent, the two men discover that, whereas Mr. Smith's flight left on time at 9:00, Mr. Jones's flight was delayed and left at 9:28, only two minutes ago. Who is more upset, Mr. Smith or Mr. Jones?

[4]D. Kahneman and A. Tversky, "The Psychology of Preferences," *Scientific American*, January 1982: 160–73.

Given this question, people invariably and immediately report that Mr. Jones was more upset. Why is this? After all, both men missed their flights and, objectively, they're both in equal difficulty. Kahneman and Tversky offer an explanation in terms of alternative worlds that can be constructed in the mind. They propose that, when some unfortunate event occurs, the victim constructs an alternate reality in which the unfortunate event didn't occur. The less this alternative world differs from reality, the worse the victim then feels. In the example at hand, it's very easy for Mr. Jones to construct an alternative world in which he caught his flight. "If we had just gone through that yellow light instead of stopping for it," he might say to himself, "then I would have made my flight." Mr. Smith, on the other hand, would have a much more difficult time constructing an appropriate alternative world. In order for *him* to have made his flight, they would have had to have gone through the yellow light *and* have not gotten stuck behind that trailor truck, *and* have not had to wait so long for the cab to pick them up in the first place. Since Mr. Smith's alternative world would differ so substantially from the real world, he would wind up with a lot less regret than would Mr. Jones.

Regret in video game play fits quite nicely into this framework. The mistake that (in general) ends the game is the last thing, or close to the last thing, you did prior to the game ending (eating the energizer before trying to get to the other side of the maze in the example we gave before). Therefore, the alternate world in which the mistake *was* not made is extremely close to the real world in which the mistake *was* made—and that's just the situation that produces maximal regret. Naturally, given the opportunity to make that alternate world a reality and eliminate all your regret, you'll avail yourself of the opportunity. You play again.

An even more striking example of the alternative world phenomenon as it operates in computer games is seen in Adventure. Adventure games are very similar to the precomputer game of Dungeons and Dragons. In them, the player is placed into some kind of hypothetical mazelike environment, where both danger and excitement abound. In one of them, for example, you (the player) are in a nuclear power plant and your mission is to find and defuse a time bomb that has been placed somewhere in the plant by a wicked saboteur. Carrying out this mission requires a complex series of actions, not the easiest of which is figuring out your way around the plant to begin with: learning not only where various rooms, nooks, and crannies are relative to one another, but also which actions—complying with the automatic security locks and so on—are necessary in order to cross from one place to another.

You actually play this game by issuing a sequence of instructions to the computer. In return, the instructions are carried out to the best of the program's ability; and, also, brief descriptions are provided of objects that can be seen and of actions that occur.

A couple of key features heighten the game's interest. First, there are lots of ways that you can go wrong and kill yourself. For instance, you can accidentally blow up the bomb, you can fall off a ledge, you can die of radiation poisoning, and so on. But fortunately, you can save the game at any stage, so if you do make a mistake, you can go back to the point at which the game had been saved—that is, prior to when the mistake had been made. Again we see a classic case of an alternative world. "If only I had put on the radiation suit," you say to yourself, "I wouldn't have died that horrible death in the radiation chamber." And since the alternative world in which you put on the radiation suit is very close to the "actual" world in which you didn't, regret is very high. But since you saved the game, you can go back and create that alternative world, thereby

eliminating the regret. So you do. Computer games provide the ultimate chance to eliminate regret; all alternative worlds are available.

Research on Video Games

Since video games are a relatively new phenomenon, psychologists have, thus far anyway, performed relatively little research on the games themselves. One piece of research that has been done, however, is a Stanford University Ph.D. dissertation by Thomas Malone.[5] Malone was primarily concerned with educational techniques, and his dissertation was aimed at finding ways of making classroom learning more fun. Noting the mass appeal of video games and the intrinsic reinforcement that they provide, he ventured to suggest that these games may prove to be superb teaching devices. This educational theme recurs throughout Malone's dissertation; however, the research that he reports was concerned primarily with the features of certain games that made them fun to play.

Malone studied school children (kindergarten kids through eighth graders). All the children had been playing with computer games in a weekly class when the study began in 1979. The survey involved relatively nonstandard games, but it is still highly suggestive.

Malone asked the children to rank a variety of computer games they had played on a simple four-point scale. He then analyzed the features of the games and concluded that incorporation of a specific goal was the single most important feature in making a game enjoyable. Other popular features were score-

[5]T. W. Malone, *What Makes Things Fun to Learn? A Study of Intrinsically Motivating Computer Games* (Palo Alto, CA: Xerox, 1980).

keeping; audio and visual effects; the degree to which players had to react quickly; and randomness (unpredictable games are preferred). The games ranked highest incorporate these features; those ranked lowest don't.

Malone also asked children what they liked about the games. Almost 40 percent of the reasons the students gave dealt with fantasy. For example: "I like it because it's just like Star Wars." "I like it because it has bombs." "I like blasting holes in the other snake." Of course, children also provided other reasons. Some liked a game for its challenge, others because it was easy to do well. One student liked Petball because "you can get a high score very fast. . . . It's easy to get bonuses. I like to win; I'm a sore loser." Interestingly, while the children *talked* a lot about fantasy, the games they rated most favorably were notably low in fantasy: perhaps children are no better than adults at reporting their own motivations.

The results of Malone's survey provide interesting but inconclusive suggestions about what makes the games fun to play. His next step was to create new versions of particular games in which some of the hypothesized important features were missing. He investigated two different games, Breakout and Darts. Breakout requires primarily muscle skills, whereas Darts requires primarily thinking, or intellectual, skills.

Breakout is a derivative of Pong, the first video game, which was a simulation of table tennis. Figure 2.1 shows a typical screen display in Breakout. In this game, the player manipulates a knob that controls the vertical motion of the paddle, shown on the left side of the screen. The paddle is used to hit a ball that bounces against the wall on the right-hand side of the screen. The wall is made up of multiple layers of bricks, and each time the ball strikes the wall, it knocks out one brick. The ultimate goal is to knock out all the bricks from the wall. In addition, however, points are awarded for each brick that is

knocked out, and the score is continuously displayed on the screen. The player is allowed a total of three balls and uses up one ball each time he misses the ball with the paddle.

Based on the results of his survey, Malone generated a list of features that, he hypothesized, contributed to Breakout's popularity. There are clear goals: increasing the score by knocking out bricks and ultimately tearing down the whole wall. The game keeps score. It has audio effects—tones sound when the ball bounces off a wall—and visual effects—the ball moves, the bricks break from the wall. It has fantasy—the player destroys the wall, perhaps imagining himself escaping from prison or rescuing a hostage.

Malone then proceeded to create several versions of Breakout and to compare them with the original. To see how important was the challenge of getting a higher score, he created some variations in which the computer did not keep track of the score. To see how important was the visual stimulation of watching the bricks break out, he created some variations in which the bricks did not actually break away—the ball just bounced back and forth against the wall, with a point being awarded for each bounce. To answer other questions, he created other variations. Malone's subjects—who, by the way, were Stanford students this time, rather than the younger children used in his initial survey—played the various games and indicated which ones they liked and did not like.

The results were clear. The most important feature in determining how much the game was liked was the breaking out of a brick when the brick was hit by the ball. The versions in which the wall remained intact when struck by the ball were not liked nearly as well (even though the score increased just as it had before). Two other features—the computer's keeping score and the ball's bouncing off the paddle (as opposed to being simply ejected from the paddle)—were also important,

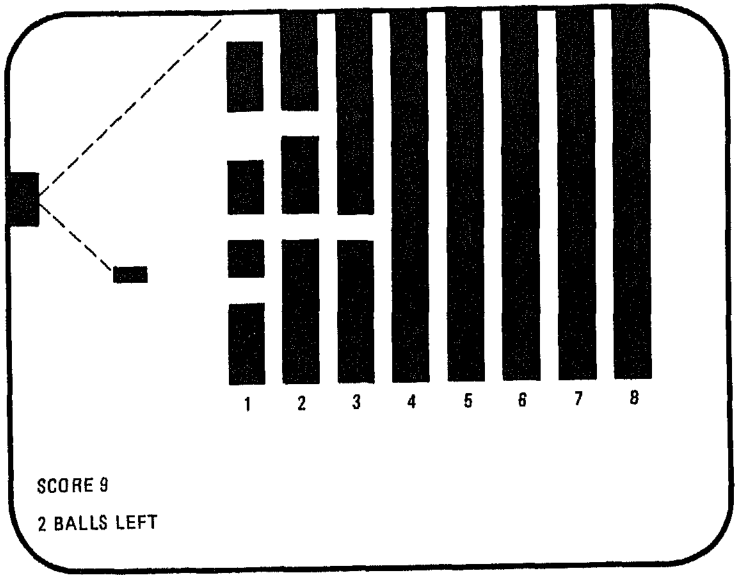

FIGURE 2.1

Breakout display. A player manipulates a knob that controls the vertical motion of the paddle shown on the very left of the screen. The paddle is used to hit a ball, which bounces against the wall on the right-hand side of the screen—a wall made up of eight layers of bricks. The score refers to the number of bricks in the wall that the player has successfully knocked out. A ball is used up whenever the player misses the ball with the paddle, and the number of balls left before the game ends is shown underneath the score.

From T. W. Malone, *What Makes Things Fun to Learn? A Study of Intrinsically Motivating Computer Games* (Palo Alto, CA: Xerox, 1980), p. 24. Used by permission of the author and the publisher. Subsequently reproduced in T. W. Malone, "Toward a Theory of Intrinsically Motivating Instruction," *Cognitive Science* 4 (Ablex, 1981): 345, and used also with permission of Ablex Publishing Co.

but less so than the gradually deteriorating wall. Why is the breaking out of the bricks so appealing? Although the experiment doesn't permit a definite answer, there are various possibilities. Watching a deteriorating wall of bricks provides visually compelling entertainment, it provides a cumulative scorekeeping device, and it shows you how far you are from reaching the ultimate goal of destroying the wall. Any one or a combination of these effects could be responsible.

Malone showed clearly that when both the score and the brick destruction were removed from the game, people didn't like it at all. Without these features, the game had very little purpose. In this degenerate version of Breakout, the players might try to keep the ball moving as long as possible but they have no easy way of knowing how well they are doing. Without the goal the game is no fun.

In Breakout, people learn a sensorimotor skill—they learn how to move the paddle in such a way as to successfully maneuver the ball. But playing Breakout doesn't require any higher-level skills such as thinking, remembering, or problem solving. For this reason, Malone next turned his attention to a new game—Darts—that did teach a bona fide academic skill, that of estimating magnitudes on a number line and expressing them as mixed numbers. (A mixed number is an integer plus a fraction, such as 1 3/8.) This experiment (in which fifth graders were used as subjects) revealed, among other things, some intriguing differences between the types of games preferred by boys and girls.

In the game of Darts, a number line is presented with specified numbers defining the ends of the line, as shown in figure 2.2. There are three "balloons" protruding from the line, and the player's job is to decide which numbers correspond to the positions of the balloons. The player types a guess, and a dart (shown on the right) is moved to the position indicated by the player and fired. If the number corresponds to a balloon's position on the line, the balloon is burst. In the example shown in figure 2.2, if the player were to type 3 3/16, the lowest balloon would burst. If the number doesn't correspond to a balloon's position, the dart remains stuck in the line and the incorrect number that had been typed in is indicated, as shown in figure 2.2. Here the player incorrectly typed 3 7/8. A total of three darts is provided; thus a perfect player can burst all three balloons.

In addition to the obvious visual effects, there are abundant auditory effects in this game. For example, circus music begins the game, and to reward the player who pops all three balloons a short song is played.

Malone again tried to find out what it was about the game that made it fun and whether any new variations would make it more enjoyable. He created a version in which, after each incorrect try, the player was told in which direction and by how much the answer was wrong. In other words, the player was given "constructive feedback" such as being told "A little too high" or "Way too low." In other variations, the balloons were broken, but not by the darts; rather, when the correct position was typed in, a balloon over on the right side of the display burst. Thus the visual display of bursting balloons was more or less the same in the two versions; however, in one the player could fantasize that the dart itself was bursting the balloon, whereas this fantasy wasn't possible in the other version. Finally, some versions of the game had the original music, whereas other versions had no music. Different players played the different versions of the game and then indicated how much they liked it.

The most intriguing result to emerge from the experiment was that boys and girls differed substantially in terms of which features determined their preferences. For every feature that

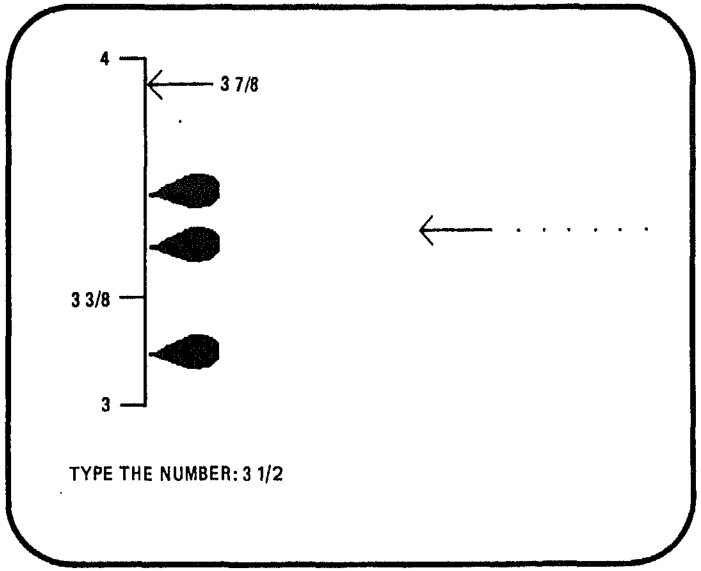

FIGURE 2.2

Darts display. Thomas Malone describes the set-up this way: "Three balloons appear at random places on a number line on the screen, and players try to guess the positions of the balloons. They guess by typing in mixed numbers (whole numbers and/or fractions), and after each guess an arrow shoots across the screen to the position specified. If the guess is right, the arrow pops the balloon. If wrong, the arrow remains on the screen, and the player gets to keep shooting until all the balloons are popped" (p. 31). In this example, the player has previously made an incorrect guess that 3 ⅞ is the position of a balloon. But he's right this time by typing in 3 ½, and the dart will move across the screen to that position, bursting the middle balloon.

From T. W. Malone, *What Makes Things Fun to Learn? A Study of Intrinsically Motivating Computer Games* (Palo Alto, CA: Xerox, 1980), p. 32. Used by permission of the author and the publisher. Subsequently reproduced in T. W. Malone, "Toward a Theory of Intrinsically Motivating Instruction," *Cognitive Science* 4 (Ablex, 1981): 349, and used also with permission of Ablex Publishing Co.

was examined, girls and boys reacted in the opposite direction —if boys liked a particular feature, girls disliked it, and vice versa. Some of the most striking differences were the following: Girls liked music, whereas boys disliked it. Girls liked (and boys disliked) being *told* (verbally) how they were doing, whereas boys liked (and girls were relatively indifferent to) having a visual, or graphic, representation of how they were doing. Finally, boys liked having bursting balloons and especially liked the version in which the balloons appeared to be burst directly by the darts. Girls disliked both of these balloon representations, and especially the latter.

In addition to these game characteristics, Malone also found that certain characteristics of the group he studied influenced how well the students liked the game. For example, those students who considered themselves to be good in math liked the game better than those who considered themselves to be poor in math. Students who thought they did well in the game liked it better than those who thought they did poorly in the game—although preference was unrelated to how well students *actually* did, providing further evidence for a distinction between what students think and what they do.

Malone worried that in reporting his results he risked perpetuating stereotypes of human beings based upon their gender. There is ample reason to believe, he urged, that the game preferences primarily reflect differences in the ways boys and girls are socialized in our culture. But whatever the basis for these preferences, it is important to understand them. For example, if a mathematical game like Darts happens to be designed in a way that appeals more to boys than to girls, then a sex difference toward mathematics may be unwittingly created.

The boys in this study liked the arrows and balloons fantasy,

while the girls did not. Why? One possibility is that destroying balloons with arrows is aggressive, and the aggressiveness underlies the difference in preference.

A major reason given for why video games are fun is that they are responsive. In a world in which people are often too wrapped up in themselves to give you the time of day, the games are just the opposite. As a player, you get feedback all the time. The experiment with Darts showed that fantasy was more important than feedback, but as Malone has pointed out, the fantasy in these games is a unique form of responsive fantasy. The fantasy is feedback.

When we watch a movie or read a book, we passively observe the fantasies. When we play a computer game, we actively participate in the fantasy world created by the game. For this reason alone, the computer game might an ideal vehicle for learning. We'll return to this educational theme in chapter 5, but for the moment, it's worth noting that Malone felt he had the beginnings of a learning theory that was "intrinsically motivating." By this, he meant a kind of learning in which reinforcement comes from within the person rather than from the outside world. For Malone, there are three major ingredients inherent in the student-computer game experience that make the games such ideal vehicles for learning. These three ingredients are: challenge, fantasy, and curiosity.

Challenge comes into play because the games provide a goal to be reached and an uncertain outcome. The ideal game, if it is to provide the challenge necessary for true intrinsic motivation, undoubtedly includes an element of chance—or at least something that seems like chance to the learner. In card games, the cards are typically dealt randomly to players, and uncertainty is thereby introduced. Similarly, in a game like Darts the particular problem to be solved at any moment, whether it is the location of 3 1/2 or 2 5/8, is more or less randomly determined. Challenge is also achieved by having a "variable difficulty level": as the player gets better at the game, the game gets harder. The effort, skill, or knowledge required to reach some subgoal may increase. This keeps the player from getting bored, providing the requisite challenge.

Fantasies are the second ingredient for making a learning environment more interesting and more educational. For Malone, fantasy-inducing environments are those that evoke mental images—images of physical objects such as balloons or images of social situations such as being the ruler of a kingdom. Long before Malone's work, theorists such as child psychologist Jean Piaget assigned a central role to make-believe play in the development of skills in children. So Malone's idea about the importance of fantasy is not completely new; his contribution, rather, is to identify the important role it plays in making video games an ideal vehicle for learning.

The final ingredient for making a learning environment more interesting is the evocation of the learner's curiosity. For this, one needs to provide an optimal level of informational complexity. By optimal level, Malone means that the environment should be neither too complicated nor too simple with respect to how much the learner already knows. The world of learning should be novel and surprising; at the same time, it cannot be incomprehensible. Finding the optimally complex environment constitutes the fundamental challenge for the designers of the educational video games of tomorrow.

CHAPTER 3

GAMES AND THE COGNITIVE SYSTEM

Ability is the focus of this chapter. What aspects of mind figure in the performance of an act requiring complex skills, such as playing video games? Psychologists refer to the mind as the "cognitive system" because the "mind" isn't really a unitary entity. Rather it is an elegant system of delicately intertwined and finely tuned components. The means by which these components are combined into an ability—such as the ability to play a video game—is called a strategy. In the pages to come, we'll describe both the components themselves and the ways in which they can be combined into strategies.

A major theme of the chapter is that quite different strategies can be used for accomplishing the same mental goal—the goal, for example, of being good at a particular video game. Which strategy is appropriate for a particular person depends on which of his or her mental components are good. Some