Chapter 4

challenge

We measure ourselves by the challenges we face. In the universe of possibilities that encompasses what we could be, it is the challenges we face up to that delineate who we actually are. We therefore go through life seeking new challenges that permit us to expand our identities. Once a challenge has been overcome, it is no longer a challenge, and we move on to a new challenge. We seek our challenges in all spheres of our lives: social, work, romantic, and artistic. Sometimes we fail and adjust our challenges accordingly. Sometimes we succeed and raise the notch a level. But no matter the outcome, we continue our quest for challenges that expand our identities.

Challenge Necessitates Rules

All challenges take place in some sort of defined context, setting the conditions under which the challenge is presented. Sometimes that context is financial, in which case a contract specifies the conditions. Sometimes the challenge takes the form of a job; a great variety of factors specify what is and is not permitted, expected, and required. Some challenges are physical in nature, in which case the laws of physics define the nature of the challenge.

Most challenges are at heart voluntary efforts on our part. We don't sign a contract unless we believe ourselves able to meet its conditions. We don't accept a job offer unless we accept the challenges it offers us. And of course, all sports, in which we accept a physical challenge, are voluntary.

The conditions under which a challenge is presented are its rules. Some rules are imposed upon the player by forces outside his control. The water skier cannot change the nature of water, nor can the rock climber defy gravity. Other rules are administrative in nature, such as the rules that organize the pyramid of games in a tournament. But the important rules are those that define the nature of the challenge and that make it a truly interesting challenge.

For example, mountain climbing would be so much easier with a helicopter—but that would remove all the challenge. Plenty of other technological aids could assist the mountain climber, but most climbers have a set of self-imposed rules that limit their utilization of such aids. After all, the point of mountain climbing is not to get to the top of the mountain, but rather to challenge oneself.

The Point Is the Challenge, Not the Goal

I once designed a little exercise game for myself. I hung a motorcycle tire from a rope tied to the ceiling of a high garage. Halfway up the rope I also attached a heavy weight. This created a *compound pendulum*, whose mechanical properties are quite complicated. When the tire is placed in motion, the intermediate weight is dragged along with it, and starts oscillating in its own fashion, dragging the tire in its turn. From ground level, the tire appears to gyrate in wild and unpredictable ways. Then I drew a circle one meter in diameter on the floor directly underneath the pivot point of the rope. This was the field of play.

The goal of the game was to hit the tire with my sword as many times as possible, without stepping outside the circle or being touched by the tire. This required me to weave, duck, twist, and turn to evade the tire when I couldn't hit it. Of course, hitting the tire sent it off in new and more complicated gyrations. It was an excellent game and provided me with much all-body exercise.

Quite proud of my design, I showed it off to another designer. I explained the rules to him and handed him the sword. He stepped inside the circle and began lightly tapping the tire with the sword. When I asked him what he was doing, he replied, "Winning the game."

My game designer friend's clever trick demonstrates a crucial factor in the enjoyment of challenge: It's easy to ruin a good challenge by exploiting loopholes in the rules. No matter how carefully you set up the challenge, somebody will think of a way to subvert your system. One solution to this problem is to write reams of rules to prevent every imaginable form of cheating. For example, I wonder if baseball has a rule that makes it illegal for a runner to shoot opposing players to prevent them from tagging him out. Probably not. But in what we call "friendly games," players rely on simple rules and reject clever tricks that subvert the challenge of the game. "No fair!" is a cry that makes up for a lot of complicated rule-mongering.

A variation on this problem is called the "lock on victory." This is a strategy or technique that guarantees success. For example, in the classic game **MazeWar**, one of the earliest multiplayer games, the players move around through a maze shooting at each other. Sometimes a player would back up into a dead end, facing the only entrance. The moment somebody passed by, the dirty rat would shoot them. Since nobody could ever get into position to shoot the rat quickly enough, he was guaranteed never to lose. This behavior was perfectly legal within the framework of the rules, but everybody knew that it was "no fair."

This is a key element of challenge that is often misunderstood. The player's formal goal is to beat the system enclosing the challenge, but the player's ultimate goal is to overcome the challenge. Thus, even the cheater who finds a way to beat the rules without beating the challenge feels unsatisfied with the result. Of course, with computers, it's much easier to enforce rules— you simply make undesired behavior impossible to execute. Nevertheless, you should always be aware of this potential problem.

I well remember a big wargame that I played many years ago with a friend. There was an unfortunate ambiguity in the rules; we both perceived the problem and, after some discussion, agreed on a patch to the rules that fixed the problem. Unfortunately, the patch itself had an unintended ambiguity, and the two of us interpreted that ambiguity in opposite fashions. We played the game for many hours and then, as the game came to its climax, my opponent pounced with a move that I thought was illegal. Only then did we discover our misunderstanding. All our hours of careful play had been a complete waste of time; the game was ruined. We abandoned the game and parted in foul moods; each of us felt that the other had somehow been stupid to misunderstand our agreement.

Eliminate loopholes that allow the player to evade the challenge of the game.

The primary purpose of rules is to prevent strategies that subvert the challenge. In most sports games, there is some sort of boundary and any play that goes "out of bounds" is forbidden by the rules. That's because, if players could run around outside the boundary, then they'd come up with all sorts of creative ways to circumvent the real challenge of the game.

There are a myriad ways to play a game, but a good design ensures that only the challenging ways are possible. This raises an interesting design problem: What constitutes a challenging strategy? There is no objective answer to that question. Tic-tac-toe is challenging for some people and devoid of challenge for others. Your job as a designer is to define the challenge in the game and then make that challenge as clear and precise as possible.

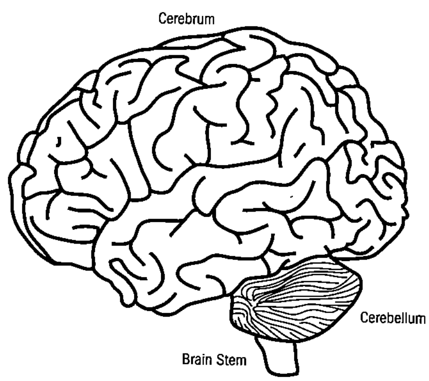
Dimensions of Challenge

Every challenge forces us to bring to bear some combination of skills. In many recreational challenges, that combination tends to zero in on particular skills. The primary challenge for a competitor in a ski race is a matter of physical strength and coordination, but other skills such as reading snow, judging distances, and gauging speeds are also vital.

Most recreational challenges are centered on particular mental skills. It is true that physical sports require superb musculature, but in very few sports—running and weightlifting, for example—is musculature the primary factor in success. In most sports, the precise control of that musculature is more important to success. Thus, we can characterize most challenges by the nature of the mental challenge they offer us. Here are some categories.

Cerebellar Challenges

The cerebellum sits at the base of the brain; the spinal cord enters it. In engineering terms, you could call the cerebellum the control module for motor functions. High-level brain decisions are passed to the cerebellum, which breaks each command down into smaller, precisely timed commands to trigger particular muscle bundles. These commands go down the brain stem to the spinal cord and thence to the muscles in the body (see Figure 4.1).



4.1 *The brain.*

There are only a few sports that are exclusively cerebellar in nature; the discus, shot-put, and javelin are three. Such sports don't involve much sensory input; they don't require accuracy of aim. The goal is to throw the projectile as far as possible. The thrower can do the job almost with his eyes closed; it's a pure motor-control challenge.

Sensorimotor Challenges

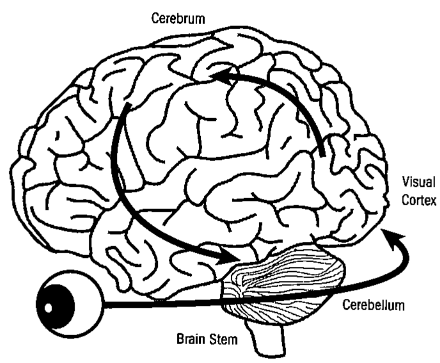
Most cerebellar challenges include a sensory element. You don't just trigger muscles in some predetermined sequence; you must use your senses (most often vision) to direct and control the muscular activity. A simple example of this is throwing a projectile to hit a target. As it happens, the task of accurately throwing an object is not easily handled by neurons. Consider, for example, the mechanics of throwing a balled-up sheet of paper into a wastebasket. The timing of muscle activity, and especially the release of the ball, must be accurate to within about a millisecond. Unfortunately, a single neuron takes a few milliseconds to fire. It's like timing an eyeblink with a stopwatch—the event being timed is faster than the timer. So how do we do it? The trick is achieved by applying large numbers of neurons and using their average value. Statistically, the average time of firing of a hundred neurons is ten times more precise than the timing of a single neuron. Throw enough neurons at the problem, and you can get as much precision as you desire.

And that's what the human brain does. It applies huge numbers of neurons to the task and thereby attains high precision in throwing. In fact, the ability to accurately throw a projectile is the one area of physical action in which human capability bests any other creature on the planet. So the next time somebody tries to humble you with tales of a hawk's visual acuity, a cat's reflexes, a bat's echolocation, or a cheetah's speed, retort by asking, "Yeah, but can they shoot baskets?"

I can't think of any sensorimotor challenges that are explicitly aural; as far as I can recall, all sensorimotor challenges require the integration of visual information with motor response. At its simplest form, we can call this "hand-eye coordination," but in many such challenges, it's not just the hands that are responding. Indeed, here we arrive at one of the most striking distinctions between sports and videogames. In all sensorimotor-challenging sports, even those relying primarily on manual activity, the entire body is involved in the task. Even the trivial task of tossing the paper ball into the wastebasket requires the player to rotate his chair, lean his body, twist his neck, and position his arms. Yet the videogame player seems to work best with most of his body immobile; even the upper arms move but little. It's all in the thumbs.

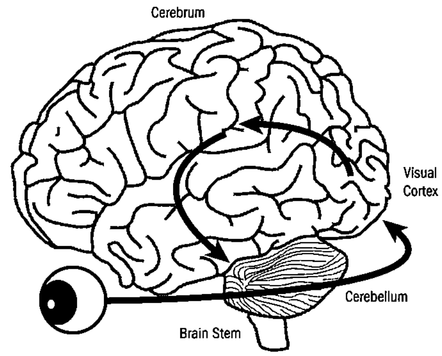
Pushing the Pathways Down

The neural pathways utilized in such sensorimotor challenges are complex. Preprocessed visual data passes from the retina to the visual cortex at the back of the brain, where it is further processed into visually meaningful components such as walls, floor, targets, and so forth. From there it travels to the cerebral cortex, where it undergoes high-level processing. In other words, the cerebral cortex recalls the rules of the game and its goals, integrates the information from the visual cortex, decides what to do about the situation, and passes those decisions down to the cerebellum, which translates them into muscle action (see Figure 4.2).



4.2 *Information flow in the brain when first learning a videogame.*

As you might imagine, all this processing is quite time-consuming and so the beginning player can be slow and clumsy. The difference between a beginner and a skilled player is that the skilled player has learned to build shorter, faster neural pathways from the visual cortex to the cerebellum (see Figure 4.3).

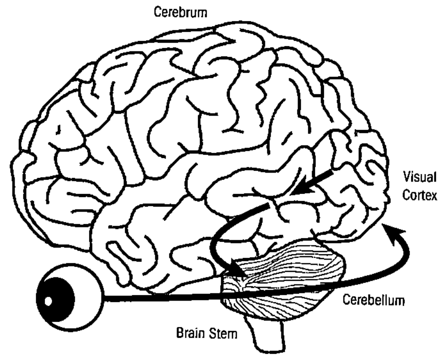


4.3 *Shortened pathways for information flow yield faster responses and more successful play.*

By moving the pathways lower into the brain, the player reduces the amount of processing required to react to events in the game or sport. Decision-making is no longer conscious or deliberate. It is often described as "instinctive." The player sees, and the player acts without conscious thought. There's still plenty of mental processing going on, but it's faster because it is no longer part of the elaborate (shall I say bureaucratic?) structure of conscious thought.

It is one of the wonders of the human brain that we can learn so readily. Any process that we concentrate on repetitively can develop its own custom neural pathways that render its operation faster and smoother, requiring less mental effort. In effect, whenever we learn a task, we reduce the amount of conscious effort required to carry it out. When I first began to use a keyboard, I had to concentrate on the locations of the keys. After literally millions of keystrokes, my brain has burned that information into its neural pathways. I think of a word, my fingers move, and the word appears on the screen. All the mental computations go on in a deeper, lower level of mental processing beneath my conscious awareness.

Even more striking is the ability of the brain to learn different tasks with different degrees of facility. Typing on a keyboard is now a subconscious process for me, while the particulars of my word processor are a little less familiar; some of the commands take a fraction of a second of thought to recall. Commands that I use rarely demand my full attention to recall. My brain's organization of its knowledge is an elegantly proportioned and optimized system; the more often I perform a task, the more deeply it is driven into my subconscious and the faster my execution of the task is.



4.4 *Information flow in the brain of an expert player.*

This ability to drive task execution deeper and deeper can be taken to dramatic extremes. There's no reason why a player cannot learn a task this well (see Figure 4.4).

In such a case, the player is able to attain extremely high levels of performance because the neural pathways are much shorter and lower in the processing hierarchy of the brain. This extreme degree of proficiency is most difficult to attain in sports, because the exercise of these pathways necessarily entails lots of exhausting muscle activity. You can only practice your sport so many hours a day before your aching muscles put a stop to your exercise.

But what if we could invent a sport that didn't involve so much exhausting muscular activity? What if all that mental activity could still be going on, but it used only muscles that didn't require lots of strength, muscles that are used for lots and lots of low-power activity? These muscles wouldn't tire, and so the player could go for hours and hours, attaining previously unheard-of levels of proficiency. This, it would seem, would be the ultimate exercise of this learning capability, and it would surely be an exciting sport, wouldn't it?

Technology has in fact provided us with just such a sport: the videogame. A kid can sit in front of a videogame for hours, working his fingers frantically but never tiring. In the process, he can push those neural pathways down so deep in his brain that his game-reflexes become inhumanly quick. The parent watching a kid playing such a videogame has difficulty keeping up with the action on the screen, so fast are the kid's reflexes. It's truly mind-boggling.

Of course, no videogame is ever mastered; no matter how good the kid is, there's always something new to learn, some reflex that can be made sharper and quicker. So the kid never relaxes.

Oftentimes when I am engaged in a friendly telephone conversation, I will perform light housework: putting things away, sorting socks, that kind of thing. I hate housework because it's so mindless; telephone-time is the ideal time to do this work because I can carry out these almost subconscious tasks while engaging my conscious effort on my conversation with my friend. That's the real value of learning something so well that it takes little mental effort; we can carry out the dumb task while also performing some other more mentally challenging work.

But this is not how kids play videogames. There's always a new skill to master, so the kid devotes his entire mental resource to the learning process. All his mentation is concentrated in that low-level processing. And this causes something most curious to happen: conscious processing shuts down. Parents can readily attest to this phenomenon; calling the kid to dinner yields a muttered acknowledgement and no action. A kid can start playing a videogame at eight in the evening and still be there at midnight, unaware of the passage of time. "Johnny, there's a lion loose in the room" will elicit an "Okay, Mom" and nothing more. Some parents report that only physically interposing themselves between player and screen can break the kid's trance.

Altered States of Consciousness

It's not quite correct to refer to this phenomenon as a *loss of consciousness*; it's really an altered state of consciousness. And just as the hippies of the 60s were entranced (literally) by drug-induced altered states of consciousness, so too are kids today entranced (literally) by videogame-induced altered states of consciousness.

This alarming analogy gains strength with deeper consideration. There are several particulars in which the analogy between videogame and drugs rings true.

First is the element of pleasure. We are programmed to learn, and successful learning is intrinsically pleasurable. Just as the "runner's high" is triggered by endorphins released by a certain level of exercise, there seems to be some kind of "videogamer's high" attained at a certain level of proficiency. Videogames are carefully designed to provide the player with a steady stream of learning successes; it's called the *learning curve* of the game. At each point in the game, the player has only to make a small improvement in his performance to earn an explicit and often dramatic reward. It's like eating popcorn; each piece is small but tastes so good that you readily move on to the next piece, until you suddenly realize that you have consumed a gallon of popcorn.

Videogamers have difficulty describing the precise nature of their pleasurable experience, although they will readily confirm just how much they enjoy the game. Perhaps this is due to the inarticulateness intrinsic to kids; perhaps it is because the experience has no parallel in the real world. They describe their state of consciousness in terms frighteningly similar to those used by drug addicts. They are "in tune with the game" or "in the groove of the game." They feel that they are united with the game; they anticipate its behavior so intimately that they almost identify with it.

Second, videogamers report the same sense of power and invulnerability that drug users experience. Drug users report the feeling that they are smarter, more creative, and able to see more deeply into the mysteries of their souls. Videogamers report similar experiences of power and invulnerability. When they are playing in a videogame high, dangers rush at them, but they flow along with the game, unwounded, untouched, and incapable of being injured.

Third is the loss of awareness of the dull, depressing world in which they live. Just as some people drink to forget, some videogamers slip out of a world of overbearing parents, demanding teachers, and dismal failure, to enter a world of simple challenges and frequent glorious success. Their loss of awareness of the world around them is no happenstance; it's an important part of the appeal of the experience.

Lastly, there is the addictive nature of videogames. As with drugs, addiction is not an inevitable outcome of use; some personalities seem more resistant to addiction, others less so. But there is no question that some kids become addicted to videogames. They partake of videogame pleasures to the detriment of other activities in their lives. Their sense of priorities is distorted in favor of the games. They are unable to stop. Let's face it: This is addiction.

There are, of course, many differences between the videogame experience and the drug experience: the absence of any outright chemical influence the large number of videogamers who do not fall victim to addiction and the greater subtlety of videogame mental effects. I am not claiming that all videogamers are no different from drug users; rather, I'm claiming that *some* of the more extreme videogamers share *some* symptoms with drug users.

It is only a matter of time before some researcher carries out a detailed study of brain activity in videogamers and compares it with brain activity in drug users. When that study is published, you do NOT want to be holding stock in any videogame company!

Spatial Reasoning

There really isn't any such thing as a pure sensorimotor challenge; a certain amount of spatial reasoning is necessarily involved. In other words, when the player sees a bad guy pop up, the player must perform a certain amount of spatial reasoning to estimate the amount of danger posed by the bad guy, the likelihood of successfully shooting him, and so forth. Some spatial reasoning is performed directly in the visual cortex in the back of the brain; some is so everyday in nature as to be easily performed in other areas; some is so specific to a game that it must be performed in the most general (and therefore slowest) manner. Much of the learning process of a fast game is a matter of moving the spatial reasoning process into lower regions of the brain.