Chapter 6

Do it yourself

I have put before you a lot of pages of theory and argument. It is time to give you relief from stretching your imagination and let you stretch something with your hands. I will describe a few games you can play with a friend. I urge you to do them. The games will give you some experience with (a) consciously observing yourself controlling, and (b) observing another person controlling. You will get an understanding of the basic principles that words alone cannot convey. My description here follows very closely Powers's Chapter 5 in his 1998 book, even to using many of his sentences (for which thanks).

THE RUBBER BANDS

Get two rubber bands just alike, three or four inches long. Knot them as shown in Figure 6–1 by passing one through the other and pulling them tight. You will also want a table where you can sit across from your friend or side by side. And you will need a mark on the table between the two of you. You could put a mark on a piece of paper and lay the paper between you. Or use a dent or mark already on the table. (You can do this exercise without a table, but a table is comfortable.) Each person now hooks a finger through an end of the rubber bands, stretching them horizontally an inch or so above the paper. If you sit side by side, use your outside hands to avoid bumping into each other.

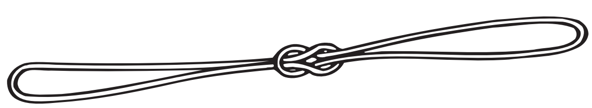

Figure 6–1. The Rubber Bands

Designate one person as **E**xperimenter and the other as **C**ontroller. (Change roles from time to time so that both people can see what's going on from both viewpoints.)

The task of the **C**ontroller (**C**) is simply to keep the knot that joins the rubber bands exactly over the mark. The *internal standard* that **C** must adopt to perform this task is the relation between the knot and the dot—namely, the knot holding directly over the dot.

The **E**xperimenter (**E**) uses **E**'s end of the rubber bands to disturb the position of the knot. **E** can do that by moving the finger forward or back, left or right—in any horizontal direction (not up toward the sky or down toward the earth). **E** should understand that the object of this experiment is *not* to prevent **C** from controlling the position of the knot. You cannot keep the knot stationary (exercise control) if the other player moves faster than your natural reaction time can compensate. Move smoothly, not too fast. The lessons to be learned will be much more obvious to both of you if **C** is able to keep the knot always close to the mark. Of course, after the basic observations are made, **E** can try all sorts of things to see what control looks like under difficult conditions. But especially at first, we want to keep the conditions easy by letting **C** learn to get good control of the knot. **E** moves the disturbing end of the rubber bands around in any kind of slow pattern, while **C** concentrates on keeping the knot accurately over the dot. A few minutes' practice should be enough.

You will notice very soon that every motion of **E**'s finger is reflected exactly by a motion of **C**'s finger. When **E** pulls back, **C** pulls back. When **E** moves inward, **C** moves inward. When **E** circles left, **C** circles left. **C** must do that, of course, to keep the knot stationary. Discounting small control errors, at every moment **C**'s hand is exactly as far from the dot as **E**'s hand (if the rubber bands are identical). The action illustrates very plainly the phenomenon of control—that we act in opposition to a disturbance.

If a third observer happened on this scene, what would the first impression of these actions be? It would be that **C** is mirroring the movements of **E** symmetrically around the dot. It would not be obvious which person is putting in the disturbances and which one is counteracting them. Even if **E** confessed to being the disturber, it would still not be obvious that control is happening. Much more likely, the third observer would see **E** doing things and **C** reacting to them: stimulus and response. The third observer would say that what **E** does causes the acts of **C**. The third observer might not notice that the knot stays over the dot.

This interpretation, based on a quick judgment, would be reasonable. The third observer might well lose interest at this point, and leave with the impression that control theory is just the same old stimulus-and-response idea that's been around since great-grandfather's day. But a quick glance is not enough to grasp that control is going on.

Remember the basic organization proposed by PCT: perception, comparison of the perception with an internal standard, detection of error, and conversion of error into an action that affects the perception. **C** is perceiving the present position of the knot relative to the dot. The perceived relationship is compared with an internal standard—knot over dot. The difference (the perceived horizontal distance of the knot from the dot) is converted into an action (a motion of **C**'s end of the rubber bands) that will bring the perception of the knot-to-dot distance to the distance required by the internal standard—zero.

How could we test whether the PCT model is right, or whether the stimulus-response interpretation is just as good? According to PCT, what is being controlled is a perception of the knot and dot. The stimulus-response interpretation (in one form) says that **C** is responding to movements of **E**'s hand. So the two theories are actually claiming that **C** is responding to different perceptions of the situation, and we ought to be able to decide which claim is right.

An easy test would be to get a piece of cardboard and use it to keep **C** from seeing first **E**'s hand, and then the position of the knot. If **C** has been responding to movements of **E**'s hand, then blocking the view of **E**'s hand while still allowing the knot to be seen should greatly modify **C**'s behavior. On the other hand, if **C** is perceiving the relationship of knot to dot, blocking the view of **E**'s hand should have no effect on **C**'s actions, while blocking the view of the knot and dot should make control much worse, if not destroy it. If you want to be sure what would happen, you can get a piece of cardboard and actually do those two things, though it would be easier simply to ask **C**, "Are you watching **E**'s hand or the knot?" **C** will deny paying attention to **E**'s hand.

Doing this test more formally, using instrumentation and computers, shows that control of the knot-to-dot distance depends critically on the controller's being able to see the knot and the dot, and not at all on the ability to see the cause of disturbances of the knot. I will show several examples of this fact, demonstrated by the use of computers, in the next chapter. Recognition of this fact is one of the crucial differences between PCT and other psychological theories. Other theories try to explain how it comes about that people perform particular acts—such as moving the end of a rubber band in a particular direction. PCT tries to explain how it can come about that people maintain a particular *perception*—such as the relation between a knot and a dot. Recognizing the fact makes a huge difference in the success of the explanation.

As well as using a piece of cardboard to hide the knot, there is another way to test for control. The idea here is simply to find out whether the knot is doing what it would be doing under solely physical effects. Let **C**, for a moment, hold **C**'s end of the rubber bands stationary. Let **E** start with the rubber bands almost slack, and then pull directly away from the dot by about six inches. Watch the knot. The knot will move half as far as **E**'s end of the rubber bands moves. This shows us the effect on the knot that **E**'s disturbance has when **C** does nothing. **E** could figure this out without any help from **C** at all. **E** wouldn't need **C**'s finger to hold one end of the rubber bands in place. **C** could go to lunch, and **E** could use a dowel in the table to hold **C**'s end in one position, and **E** could watch the knot move half as far as **E**'s finger moved.

But with **C**'s finger hooked into a rubber band and with **C** acting to control the position of the knot, **E** can now apply exactly the same disturbance as before and observe what the knot does. Now, of course, pulling back by a calibrated amount will have essentially no effect on the position of the knot. The knot will move only a tiny fraction of the amount that it moved when there was no control system attached to the other end. This failure of the disturbance to have the physically predicted effect is a strong clue that there is a control system acting. It is not infallible as a proof that control exists, because you still have to rule out simpler explanations for the lack of effect, but it is infallible in the other direction. If the amount of movement of the knot is exactly what you would predict under the assumption that there is no control system, then you have ruled out the existence of a control system. This test can eliminate wrong guesses very quickly, which is almost as helpful as being told what the right guess would be. Indeed, these two tests—cutting off **C**'s sight of the knot and cutting off **C**'s control of the knot—are essential parts of the procedure known in PCT lore as The Test for the Controlled Quantity, which is the core of experimental method in PCT. You can see that this method is eminently suitable to examining control on the part of an individual. I will say more about The Test in Chapter 7.

I have mentioned in earlier chapters that PCT includes multiple levels of feedback loops, though I have not yet explained much about that. We can, however, illustrate two levels of control with the rubber-band game. To do so, let **C** make the knot move very slowly and uniformly around the dot in a circle, with a radius of about one inch. The knot should take at least ten seconds to go once around the circle. **E**, of course, continues to move the other end of the rubber bands in big, smooth, slow, random patterns. If **E** sees that **C** is having trouble, **E** should slow down the disturbances. We want to see the controller succeeding, not failing.

Obviously, the internal standard is no longer "knot on dot." Perhaps, as many theoreticians in this field have done, you unconsciously assumed that the dot was specifying the internal standard—that the knot was the controlled perception, and it was brought to the standard set by the dot. Now, however, we can see that the controlled variable was really the *relationship* between the knot and the dot. Now the knot is being maintained in an ever-changing relationship to the dot. And if you still think the dot is not simply part of the controlled perception, we can let **E** choose to move the piece of paper as well as the rubber band—the two simultaneously. **C** is controlling a relationship between two perceptions, one of the dot and the other of the knot, and keeping this relationship in a match with an internal standard that now involves continuous motion.

If you are only reading this description, this won't be obvious, but if you are actually doing the experiment, you will realize that the experimenter, all this time, has been moving the disturbing end of the rubber bands around in big continuous patterns. You may have been thinking that to make the knot move in a circle, **C** has to make the hand holding the rubber band move around in a circle—bigger than the knot's circle, but a circle. Actually, if **C** were to hold a marking pen through the loop in the rubber band so as to leave a record of hand movements on the paper (this is worth trying), the trace would show not circular movements but a random mess.

In the movements of the knot relative to the dot, we are seeing the internal standard that **C** has chosen. The internal standard determines what the controlled perception will do. But in the movements of **C**'s hand, we see a composite of the effect of the internal standard and the even larger effect of the disturbances. The hand movements correspond neither to the internal standard nor to the disturbance; they represent what has to be done to maintain control as the disturbance changes.

Let **C** now stop the motion of the knot at a point one inch to the left of the dot while **E** continues to apply disturbances. Now we are back to the original case where **C**'s hand movements are symmetrical with those of **E**—but **C** is now maintaining the knot in a different and now stationary relationship to the dot. The control process is just like the first one, but with a different internal standard. We can call this one level of control.

The second level of control is the one that perceives continuous change. When the internal standard for this kind of change is the perceptual equivalent of "one revolution every 10 seconds," the knot moves in a circle because the *internal standard for knot position is being changed* so as to maintain that perceived circular movement. The first level of control, which is concerned with maintaining a particular, relative position of the knot and dot, is being used as the output of the second level of control, which is being used to maintain a perception of circular movement. The position control system is being used as part of a motion or trajectory control system. **C** could use a different trajectory control system, and make the knot write **C**'s name. Many different higher-level control processes could be carried out using this same position-control system (although not at the same time).