The Illusion of Smoothness

Scott Clark

In sport, in dance and music, and in many other fields of human striving, we often aim for a smoothness of action that can provide a foundation for much that we consider good form: efficient, graceful, even beautiful. We do not realise that, in fact, truly smooth movement is impossible. In this respect, we are living in illusion. Oddly enough, what actually *is* possible for us is another illusion, this time intentional — the illusion of smoothness. The relation of these two illusions can reveal something very exciting about how we move, and how we can hope to improve.

Are you sitting while reading this? If so, just as you are, raise one shoulder, hold it there for a couple of cycles of your breathing, then let it slowly and gradually fall back down.

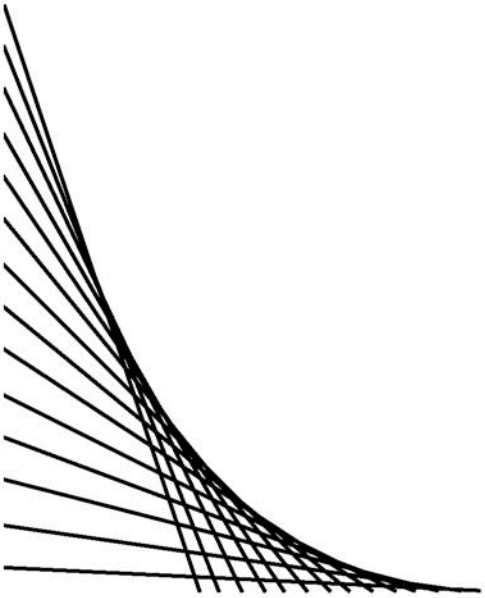
'Slowly and gradually' is the key, because you can't do both. They compete; the slower you go, the more obvious it becomes that the movement isn't gradual. Instead, it is a series of little pieces, some more gradual or smoother, but many very jerky.

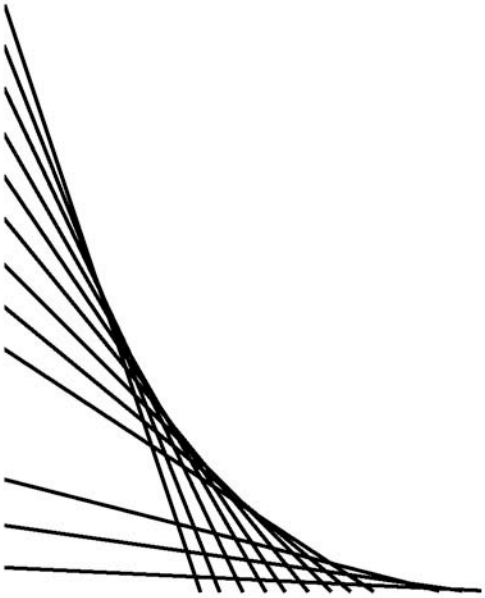
Do this with both shoulders at the same time; the comparison may show up the jerky parts more clearly. Or, to notice this even more easily, lie on your back and lift a shoulder toward the ceiling, then let it slowly and gradually fall back toward the floor.

Trying to control the jerkiness doesn't work, it only makes you more tense. What is happening? Why isn't the movement smooth? The shoulders are balanced between the pull of the muscles above, that lift, and the downward pull of the muscles below. In this movement, you contract the muscles above in order to lift the shoulders, then let go gradually. Is it really not possible for the muscles to let go smoothly?

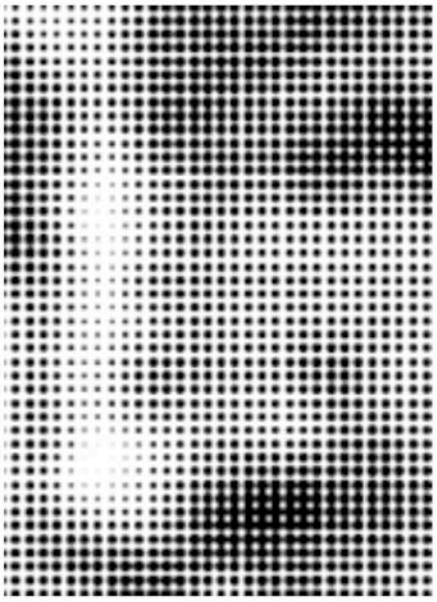
If we study physiology in order to understand how muscles work, one of the first things we learn is the All-or-None Principle: A bit of muscle fibre either contracts with its full strength or it doesn't contract at all; there is nothing in between. But let me be a little more precise. When I speak of 'a bit of muscle fibre' here, I actually mean the smallest grouping of muscle that is regulated by a single motor nerve. The motor nerves are the messengers that tell muscles when to work, and, like muscles, they do one of two things: They either say 'work' or 'don't work;' nothing in between. The number of individual muscle fibres regulated by a single motor nerve can different in different places; in the large muscles of the leg that propel us against the pull of gravity, a single nerve may control a thousand muscle fibres, while in the delicate muscles of the eye, the number is down to two or three.

This idea of yes-or-no, off-or-on is almost completely at odds with our intuitive feeling that we can move with at least some smoothness. But our experience is rich with many other analogous situations. Perhaps you remember those concoctions of string and nails that were popular in the sixties, that looked something like the picture on the left:
The straight lines of the string create the illusion of a curved line — if there are enough of the straight lines, and if they are well-spaced. If, as in the picture above on the right, we remove a couple of the lines, the resultant curve is less smooth, though the difference may be just barely perceptible.





I am suggesting that the way that we physically use many off-or-on muscle fibres to construct the illusion of smooth action is similar to the use of many straight lines to construct a smooth curve. Another metaphor could be drawn from the kind of printing used by both computers and newspapers. The picture below on the left seems, at first glance, to contain white, black, and almost infinite tones of grey between those two. But if I enlarge a detail of the boy's nose, as in the picture below on the right, we see the usual strategy that printers employ to represent infinite gradation with very finite means.



(Of course, I cheated by processing the image; the way this page is produced makes that necessary. But you can do the experiment yourself with any newspaper picture, by holding the paper close or even using a magnifying glass.)

The picture is made of dots that are slightly more complex than muscle fibres, in that they can have different sizes, but otherwise the analogy is quite similar. An illusion of smoothness — in this case, smooth gradation of tone — is created using materials that, individually, have almost the opposite quality. Ultimately, no movement can be truly smooth, precisely because the materials for constructing that movement are a limited number of muscle fibres that either contract or don't. One way to develop our abilities is to construct the best *illusion* of smoothness that we can.

So how do we do that? Consider the experience of weightlifters and others doing strength training. They found that strengthening the muscle in one part of the range of a joint doesn't make much difference to the strength in other parts of the range. It is as if each part of the range of movement is controlled by a specific bit of muscle, like an old-fashioned line of firemen passing buckets of water. Each person does his small part, and the movement of the bucket toward the fire is the result. Here it is clear that while the strength of each individual firemen is helpful, a separate but equally important issue is the coordinated passing-on of the bucket.

Lie on your back and bend both legs, so that your feet are flat on the floor. Then lift one leg, more or less straight and more or less pointing toward the ceiling. Slowly and gradually, bend the knee, so that the lower leg yields to gravity, bit by bit. Leave your thigh where it is, and leave the ankle relaxed, so that the folding of the knee can have your whole attention. How smoothly does each bit give way to the next?

This is really just a fancy way to talk about coordination — the way in which each set of muscle fibres passes on the movement to the next set. But looking at it this way may make it easier to see what is involved in learning better coordination, or, as we might think of it, mastering the illusion of smoothness. It couldn't be more different than working for strength. That requires that we push hard, beyond what we can already do, beyond what is already easy. To improve coordination means going the opposite direction — easier and easier— and always means discovering something new. Both are necessary, but they compete for our attention; they can't really be done at the same time.

Put one hand on your knee (I am assuming that you are sitting) and tap one finger against the knee a few times, then the next, and so on. Is each finger as able to do this? Perhaps your second-smallest finger is a little different, drags the adjacent fingers along a little bit. Now do the same thing with the toes of that foot. Tap one against the floor or the inside of your shoe, then the next, and so on. Is it at all possible?

I'm sure you felt a difference with at least the second smallest finger; musicians and typists and many others who work with their hands know that this finger is less independent of the others. The 'wiring' itself, the connection of nerves and muscles, is different. Still, we can learn to make better use of that finger through practice; the current situation has a great deal of unrealised potential.

With the toes, the situation is more extreme. Most of us have never needed much independent movement of our toes, but if circumstances required, we could learn a great deal

more than we now have. In fact, *most* of the capacity for individuality of the toes is latent, unrealised potential. For our usual purposes it is good enough to use all the toes together, almost like a single clump.

Tap one finger at a time, softly and deliberately. Imagine that you are doing the same action with the corresponding toe — but without any movement of the toe; just imagine. Do this for each finger, with its corresponding toe.

What do you notice, after this? Regardless of whether you could succeed in imagining each toe, the very attempt may have changed your sense of your toes, and even of the foot itself. How does your basic sense of aliveness in that foot compare with the other foot?

If you compare this exercise with the first one — lowering your shoulder — or the next one — bending your leg — it may be clearer that the usual way we use our muscles is often very much like the way we use our toes. We pass the action, not from the smallest possible group of muscle fibres to the next, but from one larger and more approximate clump of undifferentiated fibres to another. For our usual purposes, it is good enough. Here again, most of our potential is latent and unrealised.

When we learn any physical skill, we proceed from relatively crude and awkward attempts to finer and more detailed versions of the same movements. Perhaps it would be accurate to say that we begin with efforts of large groups of muscle and refine these by dividing them into efforts of smaller and smaller groupings of muscle fibre, connecting them together into relatively smoother chains of action. We are probably never more than part of the way down the road of our potential refinement of any action, limited only by our appetite for learning.