

THE CRAFTSMAN

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For Alan and Lindsay

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The Hand

Technique has a bad name; it can seem soulless. That's not how people whose hands become highly trained view technique. For them, technique will be intimately linked to expression. This chapter takes a first step in investigating the connection.

Two centuries ago Immanuel Kant casually remarked, "The hand is the window on to the mind."¹ Modern science has sought to make good on this observation. Of all the human limbs, the hands make the most varied movements, movements that can be controlled at will. Science has sought to show how these motions, plus the hand's varied ways of gripping and the sense of touch, affect how we think. That link between hand and head I will explore among three sorts of craftsmen whose hands become highly trained: musicians, cooks, and glass-blowers. Advanced hand technique of their sort is a specialized human condition but has implications for more ordinary experience.

The Intelligent Hand

How the Hand Became Human

Grip and Touch

The image of "the intelligent hand" appeared in the sciences as early as 1833 when, a generation before Darwin, Charles Bell published

*The Hand.*² Bell, a devout Christian, believed the hand came from God the Creator perfectly designed, a fit-for-purpose limb like all of his works. Bell accorded the hand a privileged place in creation, using various experiments to argue that the brain receives more trustworthy information from the touch of the hand than from images in the eye—the latter so often yielding false, misleading appearances. Darwin dethroned Bell's conviction the belief that the hand was timeless in form and function. In evolution, Darwin surmised, the brains of apes became larger as their arms hands were used for other purposes than steadying the moving body.³ With greater brain capacity, our human ancestors learned how to hold things in their hands, to think about what they held, and eventually to shape the things held; man-apes could make tools, humans make culture.

Until recently, evolutionists thought that it is the *uses* of the hand, rather than changes in its structure, that have matched the increasing size of the brain. Thus a half-century ago Frederick Wood Jones wrote, "It is not the hand that is perfect, but the whole nervous mechanism by which movements of the hand are evoked, coordinated, and controlled" which has enabled *Homo sapiens* to develop.⁴ Today we know that, in the near history of our species, the physical structure of the hand has itself evolved. The modern philosopher and medical doctor Raymond Tallis explains part of the change by contrasting chimpanzee and human freedom to move the thumb at the trapezio-metacarpal joint: "As in chimpanzees, the joint is composed of interlocking concave and convex surfaces which form a saddle. The difference between ourselves and chimpanzees is that the saddle interlocks more in chimpanzees, and this restricts movement; in particular, it prevents opposition of the thumb to the other fingers."⁵ Research by John Napier and others has shown how, in the evolution of *Homo sapiens*, the physical opposition between thumb and fingers has become ever more articulate; the opposition of thumb to other digits has combined with subtle changes occurred in the bones that support and strengthen the index finger.⁶

Such structural changes have allowed our species a distinctive physical experience of grip. Grips are voluntary actions; to grip is a decision, in contrast to involuntary motions like the blinking of the eyelids. The ethnologist Mary Marzke has usefully sorted out three basic ways we grip things. First, we can pinch small objects between the tip of the thumb and the side of the index finger. Second, we can cradle an object in the palm and then move it around with pushing and massaging actions between thumb and fingers. (Though advanced primates can perform these two grips, they cannot perform them as well as we can.) Third is the cupping grip—as when a ball or other biggish object is held by the rounded hand, thumb and index finger placed opposite the object—and is even more developed in our species. The cupping grip allows us to hold an object securely in one hand while we work on it with the other hand.

Once an animal like ourselves can grip well in these three ways, cultural evolution takes over. Marzke dates *Homo faber's* first appearance on earth to the moment when, as it were, someone could grip things securely in order to work them over: "Most of the unique features of the modern human hand, including the thumb, can be related to . . . the stresses that would have been incurred with the use of these grips in the manipulation of stone tools."⁷ Thinking then ensues about the nature of what one holds. American slang advises us to "get a grip"; more generally we speak of "coming to grips with an issue." Both figures reflect the evolutionary dialogue between the hand and the brain.

There is, however, a problem about grips, especially important to people who develop an advanced hand technique. This is how to let go. In music, for instance, one can play rapidly and cleanly only by learning how to come off a piano key or how to release the finger on a string or on a valve. In the same way, mentally, we need to let go of a problem, usually temporarily, in order to see better what it's about, then take hold of it afresh. Neuropsychologists now believe that the physical and cognitive capacity to release underlies the ability of people to let go of a

fear or an obsession. Release is also full of ethical implication, as when we surrender control—our grip—over others.

One of the myths that surround technique is that people who develop it to a high level must have unusual bodies to begin with. As concerns the hand, this is not quite true. For instance, the ability to move one's fingers very rapidly is lodged in all human bodies, in the pyramidal tract in the brain. All hands can be stretched out through training so that the thumb forms a right angle to the first finger. A necessity for cellists, pianists with small hands can likewise develop ways to overcome this limit.⁸ Other demanding physical activities like surgery do not require special hands to begin with—Darwin long ago observed that physical endowment is a starting point, not an end, in any organism's behavior. This is certainly true of human hand technique. Grips develop in individuals just as they have developed in our species.



Touch poses different issues about the intelligent hand. In the history of medicine, as in philosophy, there has been a long-standing debate about whether touch furnishes the brain a different kind of sensate information than the eye. It has seemed that touch delivers invasive, "unbounded" data, whereas the eye supplies images that are contained in a frame. If you touch a hot stove, your whole body goes into sudden trauma, whereas a painful sight can be instantly diminished by shutting your eyes. A century ago, the biologist Charles Sherrington reformatted this discussion. He explored what he called "active touch," which names the conscious intent guiding the fingertip; touch appeared to him proactive as well as reactive.⁹

A century on, Sherrington's research has taken a further turn. The fingers can engage in proactive, probing touch without conscious intent, as when the fingers search for some particular spot on an object that stimulates the brain to start thinking; this is called "localized"

touch. We've already seen an instance of it, for this is how the medieval goldsmith made an assay; his judgments were made by the fingertips rolling and pressing the metallic "earth" until a particular spot that seemed impure was found. From this localized sensate evidence, the goldsmith reasoned backward to the nature of the material.

The calluses developed by people who use their hands professionally constitute a particular case of localized touch. In principle the thickened layer of skin should deaden touch; in practice, the reverse occurs. By protecting the nerve endings in the hand, the callus makes the act of probing less hesitant. Although the physiology of this process is not yet well understood, the result is: the callus both sensitizes the hand to minute physical spaces and stimulates the sensation at the fingertips. We could imagine the callus doing the same thing for the hand as the zoom lens does for the camera.

About the hand's animal powers, Charles Bell believed that different sense limbs or organs had separate neural channels to the brain and thus that the senses could be isolated from one another. Today's neural science shows his belief to be false; instead, a neural network of eye-brain-hand allows touching, gripping, and seeing to work in concert. Stored information about holding a ball, for instance, helps the brain make sense of a two-dimensional photograph of a ball: the curve of the hand and the hand's sense of the ball's weight help the brain think in three dimensions, seeing a flat object on paper in the round.

Prehension

To Grasp Something

To say that we "grasp something" implies physically that we reach for it. In the familiar physical gesture of grasping a glass, the hand will assume a rounded shape, suitable for cupping the glass, before it actually touches the surface. The body is ready to hold before it knows

whether what it will hold is freezing cold or boiling hot. The technical name for movements in which the body anticipates and acts in advance of sense data is *prehension*.

Mentally, we "grasp something" when we understand the concept, say, of an equation like $a / d = b + c$ rather than simply perform the operations. Prehension gives a particular cast to mental understanding as well as physical action: you don't wait to think until all information is in hand, you anticipate the meaning. Prehension signals alertness, engagement, and risk-taking all in the act of looking ahead; it is in spirit the very opposite of the prudent accountant who does not exert a mental muscle until he or she has all the numbers.

Human newborns begin to practice prehension as early as their second week by reaching for baubles held in front of them. Since the eye and the hand act in concert, prehension increases when the baby can hold up its head; with the neck more under control, an infant can better see what it is reaching for. In the first five months of life, the baby's arm develops the neuromuscular capacity to move independently toward what the eye sees. In the next five months, the baby's hand develops the neuromuscular capacity to shape itself into different grasping positions. Both skills are tied to the development of the pyramidal tract in the brain, a pathway between the primary motor region of the cortex and the spinal cord. By the end of the first year, in Frank Wilson's words, "the hand is ready for a lifetime of physical exploration."¹⁰

The verbal results of prehension are illustrated by an experiment the philosopher Thomas Hobbes conducted in tutoring the young children of the Cavendish family. Hobbes sent the young Cavendishes into a darkened room into which he'd placed all sorts of unfamiliar objects. After they'd groped about, he asked them to leave the room and describe to him what they "saw" with their hands. He noted that the children used sharper, more precise language than the words they used when they could see in a lit space. He explained this in part as a matter of them "grasping for sense" in the dark, a stimulus that served them

to speak well later, in the light, when the immediate sensations had "decayed."¹¹

Reaching for something, in the prehensive way, establishes facts on the ground. For instance, when a conductor gives directive hand gestures a moment ahead of the sound. If the hand gesture for a down-beat came exactly in time, the conductor would not be leading, since the sound would already have happened. Batsmen in cricket get the same advice: "get ahead of the swing." Beryl Markham's remarkable memoir *West through the Night* provides yet another example. In the days when pilots lacked much guidance from instruments, she flew through the African night by imagining that she had already made the lift or turn she was about to make.¹² All these technical feats are based on what anyone does in reaching for a glass.

Raymond Tallis has given the fullest account we now have of prehension. He organizes this phenomenon into four dimensions: anticipation, of the sort that shapes the hand reaching for the glass; contact, when the brain acquires sense data through touch; language cognition, in naming what one holds; and last, reflection on what one has done.¹³ Tallis does not insist that these must add up to self-consciousness. One's orientation can remain focused on the object; what the hand knows is what the hand does. To Tallis's four I'll add a fifth element: the values developed by highly skilled hands.

Hand Virtues

At the Fingertip

Truthfulness

In learning to play a string instrument, young children do not know at first where to place their fingers on the fingerboard to produce an accurate pitch. The Suzuki method, named after the Japanese music educator Suzuki Shin'ichi, solves this problem instantly by taping thin plastic strips onto the fingerboard. The child violinist places a finger on

a color strip to sound a note perfectly in tune. This method emphasizes beauty of tone, which Suzuki called "tonalization," from the start, without focusing on the complexities of producing a beautiful tone. The hand motion is determined by a fixed destination for the fingertip.¹⁴

This user-friendly method inspires instant confidence. By the fourth lesson, a child can become a virtuoso of the nursery tune "Twinkle, Twinkle, Little Star." And the Suzuki method breeds a sociable confidence; an entire orchestra of seven-year-olds can belt out "Twinkle, Twinkle, Little Star" because the hand of each knows exactly what to do. These happy certainties erode, however, the moment the strips are removed.

In principle, habit should have ingrained accuracy. One might imagine that the fingers would simply go down on the unmarked fingerboard exactly where the tape had been. In fact, habit of this mechanical sort fails—and for a physical reason. The Suzuki method has stretched small hands laterally at the knuckle ridge but has not sensitized the fingertip that actually presses down on the string. Because the fingertip doesn't know the fingerboard, sour notes appear as soon as the tapes come off. As in love, so in technique; innocent confidence is weak. A further complication ensues if the player looks at the fingerboard, trying to see where the fingertip should go. The eye will find no answer on this smooth, black surface. Thus, a child orchestra when first untaped sounds like a howling mob.

Here is a problem of false security. The musical child's problem recalls Victor Weisskopf's caution to adult scientific technicians that "the computer understands the answer but I don't think you understand the answer." Another adult analogy to taping would be the "grammar-check" functions of word-processing programs; these give the button-pusher no insight into why one grammatical construction is preferable to others.

Suzuki well understood the problem of false security. He counseled removing the tapes as soon as the child feels the pleasure of

making music. A self-taught musician (his interest in the late 1940s began when he heard a recording by Mischa Elman of Franz Schubert's "Ave Maria"), Suzuki knew from his experiments that truthfulness lies at the fingertips: touch is the arbiter of tone. There is a parallel here also to the goldsmith's assay, the slow, probing touch of materials at the fingertips that eschewed instant, false security.

We want to know what sort of truth is this, which casts off false security.

In music, the ear works in concert with the fingertip to probe. Put rather dryly, the musician touches the string in different ways, hears a variety of effects, then searches for the means to repeat and reproduce the tone he or she wants. In reality, this can be difficult and agonizing struggle to answer the questions "What exactly did I do? How can I do it again?" Instead of the fingertip acting as a mere servant, this kind of touching moves backward from sensation to procedure. The principle here is reasoning backward from consequence to cause.

What follows for someone acting on this principle? Imagine an untaped boy struggling to play in tune. He seems to get one note exactly right, but then the ear tells him that the next note he plays in that position sounds sour. There's a physical reason for this trouble: in all stringed instruments, when the pressed string becomes shorter in length, the width between the fingers must also diminish; feedback from the ear sends the signal that lateral adjustment is needed at the knuckle ridge (a famous exercise in Jean-Pierre Duport's *Études* explores the interplay between diminishing lateral width and maintaining the rounded hand as the cellist moves across all strings for their entire two-foot length). Through trial and error the untaped neophyte might learn how contract at the ridge, yet still no solution will be in sight. He may have held his hand at a right angle to the fingerboard. Perhaps now he should try sloping the palm to one side, up toward the pegs; this helps. He can produce an accurate sound because the slope equalizes the relations between the first and second fingers, which are unequal

in length. (Moreover, a perfectly right-angle address to the string strains the second, longer finger.) But this new position makes a hash of the lateral ridge problem he thought he had solved. And on it goes. Every new issue of playing in tune causing him to rethink solutions arrived at before.

What could motivate a child to pursue such a demanding path? One school of psychology says that the motivation is lodged in an experience fundamental to all human development: the primal event of separation can teach the young human to become curious. This research is associated with, in the mid-twentieth century, D. W. Winnicott and John Bowlby, psychologists interested in humans' earliest experiences of attachment and separation, beginning with the infant's disconnection from its mother's breast.¹⁵ In pop-psychology, the loss of that connection begets anxiety and mourning; the British psychologists sought to show just why it is a much richer event.

Winnicott posited that once no longer one with the maternal body, the infant is newly stimulated, directed outward. Bowlby went into the nursery to study the difference separation makes in the ways young children touch, weigh, and turn around inanimate objects. He observed with care daily activities that before him had been taken to be of little consequence. For us, one aspect of this research is particularly valuable.

Both psychologists emphasized the energies children come to invest in "transitional objects"—technical jargon for the human capacity to care about those people or material things that themselves change. As psychotherapists, this school of psychologists sought to aid adult patients who seemed fixated in infantile traumas of security to dwell more easily in the realm of shifting human relationships. But the idea of the "transitional object" more largely names what can truly engage curiosity: an uncertain or unstable experience. Still, the child submitting to the uncertainties of tone production, or indeed any highly demanding hand activity, is a special case: he or she seems confronted by

what might seem an unending, mushy process yielding only provisional solutions that give the musician no sense of increasing control and no emotional experience of security.

Matters don't quite become so dire because the musician has an objective standard to meet: playing in tune. Like the policy wonks described in Chapter 1, it might be argued that high levels of technical skill can be reached only by people with fixed objective standards of truth. Musically we need simply observe that *believing* in correctness drives technical improvement; curiosity about transitional objects evolves into definitions of what they should be. The quality of sound is such a standard of correctness—even for Suzuki. This is why he begins with tonalization. The belief in and search for correctness in technique breeds expression. In music, this passage occurs when standards modulate from physical events liking playing with a good tone to more aesthetic measures of, for instance, a well-shaped phrase. Of course, spontaneous discoveries and happy accident inform what a musical piece should sound like. Still the composer and the performer must have a criterion to make sense of happy accidents, to select some as happier than others. In developing technique, we resolve transitional objects into definitions, and we make decisions based on such definitions.

Both composers and performers are said to hear with the "inner ear," but that immaterial metaphor is misleading—famously for composers like Arnold Schoenberg, shocked by the actual sounds of what they've written on the page, equally for the performer whose study of scores is necessary but not sufficient preparation for putting bow to string or lips to reed. The sound itself is the moment of truth.

This is therefore also the moment when error becomes clear to the musician. As a performer, at my fingertips I experience error—error that I will seek to correct. I have a standard for what should be, but my truthfulness resides in the simple recognition that I make mistakes. Sometimes in discussions of science this recognition is reduced to the cliché of "learning from one's mistakes." Musical technique shows that

the matter is not so simple. I have to be willing to commit error, to play wrong notes, in order eventually to get them right. This is the commitment to truthfulness that the young musician makes by removing the Suzuki tapes.

In making music, the backward relationship between fingertip and palm has a curious consequence: it provides a solid foundation for developing physical security. Practicing that attends to momentary error at the fingertips actually increases confidence: once the musician can do something correctly more than once, he or she is no longer terrorized by that error. In turn, by making something happen more than once, we have an object to ponder; variations in that conjuring act permit exploration of sameness and difference; practicing becomes a narrative rather than mere digital repetition; hard-won movements become ever more deeply ingrained in the body; the player inches forward to greater skill. In the taped state, by contrast, musical practice becoming boring, the same thing repeated over and over. Here handwork, not surprisingly, tends to degrade.

Diminishing the fear of making mistakes is all-important in our art, since the musician on stage can't stop, paralyzed, if she or he makes a mistake. In performance, the confidence to recover from error is not a personality trait; it is a learned skill. Technique develops, then, by a dialectic between the correct way to do something and the willingness to experiment through error. The two sides cannot be separated. If the young musician is simply given the correct way, he or she will suffer from a false sense of security. If the budding musician luxuriates in curiosity, simply going with the flow of the transitional object, she or he will never improve.



This dialogue addresses one of the shibboleths in craftsmanship, the employment of "fit-for-purpose" procedures or tools. Fit-for-purpose seeks to eliminate all procedures that do not serve a predeter-

mined end. The idea was embodied in Diderot's plates of *L'Anglée*, which showed no litter or wasted paper; programmers now speak of systems without "hiccups"; the Suzuki tape is a fit-for-purpose contrivance. We should think of fit-for-purpose as an achievement rather than a starting point. To arrive at that goal, the work process has to do something distasteful to the tidy mind, which is to dwell temporarily in mess—wrong moves, false starts, dead ends. Indeed, in technology, as in art, the probing craftsman does more than encounter mess; he or she creates it as a means of understanding working procedures.

Fit-for-purpose action sets the context for prehension. Prehension seems to prepare the hand to be fit and ready, but this is an incomplete story. In making music we certainly prepare yet cannot recoil when our hand does not then fit its aim or purpose; to correct, we have to be willing—more, to desire—to dwell in error a bit longer in order to understand fully what was wrong about the initial preparation. The full scenario of practice sessions that improve skill is thus: prepare, dwell in mistakes, recover form. In this narrative, fit-for-purpose is achieved rather than preconceived.

The Two Thumbs

From Coordination, Cooperation

An abiding virtue of craftsmen appears in the social imagery of the workshop. Diderot idealized cooperation in the images of papermaking at *L'Anglée*, its employees laboring together in harmony. Is there some bodily basis for working cooperatively? In the social sciences, that question has been most recently and most often addressed in discussions about altruism. Debate has focused on whether altruism is programmed into human genes. I want to tack in a different direction: What might experiences of physical coordination suggest about social cooperation? This is a question that can be made concrete in exploring how the two hands coordinate and cooperate with each other.

The digits of the hands are of unequal strength and flexibility, impeding equal coordination. This is true even of the two thumbs, whose capabilities depend on whether one is right- or left-handed. When hand skills develop to a high level, these inequalities can be compensated; fingers and thumbs will do work that other digits cannot perform for themselves. The colloquial English usages of "lending a hand" or the "helping hand" reflect such visceral experience. The compensatory work of the hands suggests—perhaps it is no more than a suggestion—that fraternal cooperation does not depend on sharing equally a skill. I'm going to use music again as a medium for exploring coordination and cooperation among unequal members, but I'll shift instruments from strings to the piano.



Independence of the hands is a big issue in piano playing, as is independence of the fingers. Simple piano music often assigns the starring melodic role to the fourth and fifth fingers, the weakest in the right hand, and the rock-bottom harmonic role to the equally weakest two fingers in the left hand. These digits must strengthen, and the thumb, the strongest finger in each hand, has to learn to work with them by holding back power. The music vouchsafed beginners will most likely give the right hand a more important role than the left. So, at the outset, the player's hand coordination encounters the problems of reconciling inequalities.

In jazz piano, this physical challenge becomes even more difficult. Modern jazz piano today seldom separates melody and harmony between the two hands, as they were in barrelhouse blues. In modern jazz piano, rhythms are often set by the right hand rather than, as they once were, by the left. When he first began playing jazz, the pianist and philosopher David Sudnow discovered just how difficult the resulting problems of coordination could be. In his remarkable book *Ways of the Hand*, Sudnow, classically trained, recounts how he began to trans-

form himself into a jazz pianist. He began by taking a logical but wrong path.¹⁶

In jazz piano playing, the left hand more often has to execute wide lateral palm stretches or scrunch up its fingers into bundles to achieve the harmonies peculiar to this art. Sudnow began logically enough by sequencing the movements from stretch to scrunch. Correspondingly, he worked separately on the rapid lateral movement of his right hand across wide spaces on the keyboard, the hopping hand that in traditional jazz "strides"; in more modern jazz, getting quickly to the piano's upper registers keeps the rhythmic pulse flowing at the top.

Breaking his technical problems into parts proved counterproductive. The separation did little to help him scrunch on the left and stride on the right together. Worse, he overprepared the separate practices, which can be fatal for improvisation. More subtly, working with the two hands separately created a problem for his thumbs. These are the jazz pianist's most valuable fingers, the anchors on the keyboard. But now, anchoring as it were different-sized ships, each traveling its own course, the thumbs couldn't work together.

A eureka moment came to him when he discovered that "a single note would perfectly well suffice" to orientate him. "One note could be played during one chord's duration and another right next to it for another's, and melodies could be done that way."¹⁷ In terms of technique, this means that all the fingers begin to work like thumbs, and the two thumbs begin to interact, taking on each other's roles when needed.

Once Sudnow had his eureka moment, he changed his practice procedure. He used all the fingers as true partners. If physically one of these partners was too weak or too strong, he asked another to do the job. Photographs that show Sudnow at work horrify conventional piano teachers; he looks contorted. But hearing him, one senses how easily he plays. He does so because he had at a certain point made coordination his goal whenever he practiced.

There is a biological reason why coordination between unequal members works. The corpus callosum in the brain is a gateway connecting the brain's right motor cortex to its left motor cortex. The gateway passes information about the control of bodily movement from one side to the other. Practice that divides handwork into parts weakens this neural transfer.¹⁸

Compensation also has a biological foundation. *Homo sapiens* has been described as the "lopsided ape."¹⁹ Physical prehension is lopsided. We reach for things with one hand more than the other—in most humans, with the right hand. In the cupping grip described by Mary Marzke, the weaker hand cups the object on which the stronger hand works. The French psychologist Yves Guiard has studied how to counter lopsidedness—with some surprising results.²⁰ Strengthening the weaker limb is, as we might expect, part of the story, but exercises aimed at achieving this alone will not make the weaker hand more dexterous. The stronger hand has to recalibrate its strength to permit dexterity to develop in the weaker partner. The same thing is true of fingers. The index finger has to think, as it were, like a fourth finger to "help out." So, too, with the two thumbs: we hear Sudnow's two thumbs working together as one, but physiologically, his stronger thumb is holding back tensile force. This is even more necessary when the thumb helps the weak fourth finger; it needs to behave like a fourth finger. Playing an arpeggio in which the strong left thumb reaches out to assist the weaker right little finger is perhaps the most demanding physical task in cooperative coordination.

Hand coordination confronts a great delusion about how people become skilled. That is to imagine that one builds up technical control by proceeding from the part to the whole, perfecting the work of each part separately, then putting the parts together—as though technical competence resembles industrial production on an assembly line. Hand coordination works poorly if organized in this way. Rather than the combined result of discrete, separate, individualized activities, co-

ordination works much better if the two hands work together from the start.

The arpeggio also provides a hint about the sort of fraternity idealized by Diderot, and after him Saint-Simon, Fourier, and Robert Owen, the fraternity of people who share the same skill. The real test of their bond comes when they recognize that they share it in unequal degree. The "fraternal hand" represents finger restraint among stronger digits that Yves Guiard sees as the crux of physical coordination; has this a social reflection? This hint can be taken further by understanding better the role of minimum force in developing hand skills.

Hand-Wrist-Forearm

The Lesson of Minimum Force

To make sense of minimum force, let's look into another kind of skilled handwork, the chef's hand.

Archaeologists have found sharpened stones used for cutting that are 2.5 million years old; bronze knives date back at least six thousand years, and hammered iron at least 3,500.²¹ Raw iron was simpler than bronze to cast and an improvement in knives because it could be more easily sharpened. Today's tempered-steel knives consummate that rude quest for sharpness. The knife, notes sociologist Norbert Elias, has always represented "a dangerous instrument . . . a weapon of attack," which all cultures must surround with taboos in peaceable times, especially when knives are used for domestic purposes.²² Thus, in setting a table, we place the knife with its sharp edge inward rather than facing outward and so threatening our neighbor.

Because of its potential danger, the knife and its use have long been associated symbolically with self-control. For instance, C. Calviac, in his treatise *Civilité* of 1560, counsels a young person to "cut his meat into very small pieces on his cutting board," then lift the meat to his mouth "with his right hand . . . with three fingers only." This

behavior replaced a prior use of the knife as a spear to hold up great chunks of food so that the mouth could gnaw on them. Calviac criticized that way of eating not only because juices were likely to dribble down one's chin or that one ran the risk of inhaling snot and fluids from the nose but also because it sent no signal of self-restraint.²³

At the Chinese table, chopsticks have for thousands of years replaced the knife as a peaceable symbol; its use enables small pieces of food to be eaten in the hygienic, disciplined way recommended a mere five hundred years ago by Calviac. The Chinese craftsman's problem was how to deliver food that could be consumed with the peaceable chopsticks rather than the barbaric knife. Part of the solution lies in the fact that, as a killing instrument, the sharpened tip of a knife matters; as a cooking instrument, the side of the blade counts for more. When China emerged into the hammered-iron age in the Chou dynasty, specialized knives meant only for cooking appeared, notably the cleaver, with its razor-sharp edge and squared-off tip.

The cleaver chef in China, from the Chou dynasty up to recent times, prided himself on using the cleaver as an all-purpose tool, cutting meat into parts, slices, or mince (*hsiao, tsu, or hui*), whereas less skillful cooks resorted to several knives. The *Chuang-tzu*, an early Taoist text, celebrated the cook Ting, who used the cleaver to find "the gaps in the joints," a fine dissection that will ensure that human teeth can get to all the edible meat in an animal.²⁴ The cleaver chef sought precision in slicing fish and dicing vegetables, increasing edible yield; the knife created regular sizes in animal and vegetable pieces so that they could be cooked more equally in a single pot. The secret enabling these aims is the calculation of minimum force, through the technique of fall and release.

Ancient cleaver technique derived from the same kind of choice a home carpenter faces today in deciding how to hammer a nail into wood. One option is to put one's thumb on the side of the hammer's shank in order to guide the tool; all the strength of the blow will then

come from the wrist. The alternative wraps the thumb around the shank; now one's whole forearm can provide the force. If the home carpenter chooses the second, he or she will increase the raw power of the blow but will also risk losing accuracy in aiming it. The ancient Chinese cleaver chef opted for the second position but worked out a different way to use the combined forearm, hand, and cleaver in order to cut food finely. Instead of hammering a blow, he or she guided from the elbow joint the fused forearm, hand, and cleaver so that the knife edge *fell* into the food; the moment the blade made contact, the forearm muscles contracted to *relieve* further pressure.

Recall that the chef holds the cleaver with the thumb around the shank; the forearm serves as an extension of the shank, the elbow as its pivot. At the minimum, the weight of the falling cleaver would provide the only force, which would cleave soft food so that it is not crushed—rather as though the chef is playing pianissimo. But raw food can be harder, and the cook must play, as it were, louder, applying more pressure from the elbow to create a culinary forte. Still, in chopping food, as in sounding chords, the base line of physical control, the starting point, is the calculation and application of minimum force. The cook turns the pressure down rather than scales it up; the chef's very care not to damage the materials has trained him or her to do so. A crushed vegetable cannot be recovered, but a piece of meat that has not been severed can be salvaged by a repeated, slightly harder blow.

The idea of minimum force as the base line of self-control is expressed in the apocryphal if perfectly logical advice given in ancient Chinese cooking: the good cook must learn first to cleave a grain of boiled rice.

Before teasing out the implications of this craft rule, we need to understand better a physical corollary of minimum force. This is the release. If the cook, like a carpenter, holds the cleaver or hammer down after striking a blow, it works against the tool's rebound. Strain will occur all along the forearm. For physiological reasons that are still not

well understood, the ability to withdraw force in the microsecond after it is applied also makes the gesture itself more precise; one's aim improves. So in playing the piano, where the ability to release a key is an integral motion with pressing it down, finger pressure must cease at the moment of contact for the fingers to move easily and swiftly to other keys. In playing stringed instruments, as we go to a new tone, our hand can make the move cleanly only by letting go, a microsecond before, of the string it has pressed before. In the musical hand, for this reason, it is harder to produce a clear, soft sound than to belt out loud notes. Batting in cricket or baseball requires that same prowess in release.

In hand-wrist-forearm movement, prehension plays a significant role in the release. The arm assemblage must do the same sort of anticipation as in reaching for a cup but in reverse. Even as the blow is about to occur, the arm assemblage is preparing for the next step, in the microsecond before contact—reaching for release, as it were. The accounting of objects that Raymond Tallis describes proceeds in this step, as the arm assemblage now undoes the tension involved in gripping, and the hammer or cleaver is held more loosely.

"Cleave a grain of rice" thus stands for two bodily rules intimately connected: establish a base line of minimum necessary power, and learn to let go. Technically the point of this connection is control of movement, but it is indeed full of human implication—to which ancient Chinese cookery writers themselves were attuned. The *Chuang-tzu* advises, do not behave like a warrior in the kitchen, from which Taoism derives a broader ethics for *Homo faber*: an aggressive, adversarial address to natural materials is counterproductive. Zen Buddhism in Japan later drew on this heritage to explore the ethics of letting go, embodied in archery. Physically this sport focuses on release of tension in letting go of the bowstring. The Zen writers evoke the lack of physical aggression, the tranquil spirit, which should attend that moment; this frame of mind is necessary for the archer to hit the target accurately.²⁵

In Western societies, knife use has also served as a cultural symbol of minimal aggression. Norbert Elias found that Europeans in the early Middle Ages viewed the dangers of the knife rather pragmatically. What Elias calls "the civilizing process" began as the knife took on a more symbolic importance, summoning to collective mind both the evils and the remedies for spontaneous violence. "Society, which was beginning at this time . . . to limit the real dangers threatening people . . . placed a barrier around the symbols as well," Elias observes. "Thus the restrictions and the prohibitions on the knife increased, along with the restraints on individuals."²⁶ He means by this, for instance, that in 1400 knife fights might have been a normal event at a supper party but that by 1600 these eruptions were frowned on. Or again, that in 1600 a man encountering a stranger on the street did not automatically put his hand to his hilt.

A "well-bred" person disciplined the body in the most elementary of biological necessities—unlike boors, bumpkins, peasants taken to be, in American slang, "slobs" who farted freely or wiped runny noses on their sleeves. One consequence of such self-control was to relieve people of aggressive tension. The chef's chopping makes this quixotic proposition more comprehensible: self-control pairs with ease.

In examining the emergence of court society in the seventeenth century, Elias was struck by how this coupling had come to define the gracious aristocrat, easy with others and in control of himself; eating properly was one of the aristocrat's social skills. This mark of good manners at table was possible only because the dangers of physical violence were retreating in polite society, the dangerous skills associated with the knife ebbing. In the surging of bourgeois life in the eighteenth century, the code passed downward a grade in social class and changed again in character; easy self-restraint became a mark of the "naturalness" celebrated by the philosophes. The table and its manners still made for social distinction. For instance, the middle class observed the rule that one should cut, with a knife, only the food that

one cannot slice or pierce with the more delicate but blunter edge of a fork, and snooted the lower orders for using the knife as a spear.

Elias is an admirable historian, but he errs, I think, as an analyst of the social life he so vividly describes. He treats civility as a veneer beneath which lies a more the solid, more personal experience: shame—the real catalyst of self-discipline. His histories of nose blowing, farting, or pissing in public, like the evolution of table manners, all originate in shame over natural bodily functions, shame over their spontaneous expression; the “civilizing process” inhibits spontaneity. Shame appears to Elias as an inward-turning emotion: “The anxiety that we call ‘shame’ is heavily veiled to the sight of others . . . never directly expressed in noisy gestures. . . . It is a conflict within his own personality; he recognizes himself as an inferior.”²⁷

This strikes a false note applied to aristocrats but rings truer about middle-class mores. Still, this is not an explanation that could in any way apply to the ease or self-control the craftsman seeks; shame does not motivate the craftsman learning minimum force and release. Just considered physically, he or she cannot be so driven. There is indeed a physiology of shame, which can be measured by muscular tension in the stomach as well as in the arms—shame, anxiety, and muscular tension form an unholy trinity in the human organism. The physiology of shame would disable the freedom of physical movement that an artisan needs to work. Muscular tension is fatal to physical self-control. Put positively, as muscles develop in bulk and definition, the reflexes that cause them to tense become less pronounced; physical activity becomes smoother, less jerky. This is why people whose bodies are physically strong are more capable of calibrating minimum force than people whose bodies are weak; a gradient of muscle force has developed. Well-developed muscles in the body are equally more capable of release. They maintain shape even when they let go. Mentally, the craftsman of words could no more explore and use them well if he or she were full of anxiety.

To be just to Elias, we might imagine that self-control has two

dimensions: one a social surface beneath which there lies personal distress, the other a reality at ease in itself both physically and mentally, a reality that serves the craftsman's development of skill. This second dimension carries its own social implication.

Military and diplomatic strategy must constantly judge degrees of brute force. The strategists who used the atomic bomb decided that overwhelming force was needed to achieve Japanese surrender. In current American military strategy the “Powell doctrine” proposes an intimidating number of soldiers massed on the ground, while the doctrine of “shock and awe” substitutes technology for men—a massive amount of robot missiles and laser-guided bombs thrown hard against an enemy all at once.²⁸ A contrary approach has been proposed by the political scientist and diplomat Joseph Nye, dubbed by him “soft power”; it is more the way a skilled craftsman would work. In hand coordination the issue turns on inequalities of strength; the unequal hands working together rectify weakness. Restrained power of the craftsman's sort, coupled with release, takes a further step. The combination provides the craftsman's body self-control and enables accuracy of action; blind, brute force is counterproductive in handwork. All these ingredients—cooperation with the weak, restrained force, release after attack—are present in “soft power”; this doctrine, too, seeks to transcend counterproductive blind force. Here is the craft contained in “state-craft.”

Hand and Eye *The Rhythm of Concentration*

“Attention deficit disorder” currently worries many teachers and parents, focused on whether children can pay attention for sustained periods rather than attend to short moments. Hormonal imbalances account for some of the causes of attention deficit, cultural factors for others. About the latter, the sociologist Neil Postman spawned a large body of research on the negative effects watching television produces

in children.²⁹ Students of expertise often define attention span, however, in terms that may not seem entirely useful in responding to such adult worry.

As mentioned at the outset of this book, ten thousand hours is a common touchstone for how long it takes to become an expert. In studies of "composers, basketball players, fiction writers, ice skaters, . . . and master criminals," the psychologist Daniel Levitin remarks, "this number comes up again and again."³⁰ This seemingly huge time span represents how long researchers estimate it takes for complex skills to become so deeply ingrained that these have become readily available, tacit knowledge. Putting the master criminal aside, this number is not really an enormity. The ten-thousand-hour rule translates into practicing three hours a day for ten years, which is indeed a common training span for young people in sports. The seven years of apprentice work in a medieval goldsmithy represents just under five hours of bench work each day, which accords with what is known of the workshops. The grueling conditions of a doctor's internship and residency can compress the ten thousand hours into three years or less.

The adult worry about attention deficits, by contrast, is much smaller in scale: how a child will manage to concentrate even for one hour at a time. Educators frequently seek to interest children mentally and emotionally in subjects in order to develop their skills of concentration. The theory on which this is based is that substantive engagement breeds concentration. The long-term development of hand skills shows the reverse of this theory. The ability to concentrate for long periods comes first; only when a person can do so will he or she get involved emotionally or intellectually. The skill of physical concentration follows rules of its own, based on how people learn to practice, to repeat what they do, and to learn from repetition. Concentration, that is, has an inner logic; this logic can, I believe, be applied to working steadily for an hour as well as for several years.

To fathom the logic we might explore further the relations between

the hand and the eye. The relations between these two organs can organize the process of practicing in sustainable ways. We could find no better guide than Erin O'Connor about how the hand and eye together learn to how to concentrate.³¹ A philosophical glassblower, she has explored the development of long-term attention through her own struggles to fashion a particular kind of wineglass. She reports in the pages of an august scholarly journal that she has long enjoyed the Barolo wines of Italy and therefore sought to fashion a goblet big and rounded enough to support the fragrant "nose" of the wine. To accomplish this, she had to expand her powers of concentration from the short- to the long-term.

The frame for this learning was the critical moment in the craft of glassblowing when molten glass is gathered at the end of an extended narrow pipe. The viscous glass will sag unless the pipe is constantly turned. In order to get a straight bead, the hands have to do something akin to twirling a teaspoon into a pot of honey. All the body is involved in this handwork. To avoid strain when twirling the pipe, the glassblower's back must incline forward from the lower rather than upper torso, like a rower reaching for the beginning of a stroke. This posture also steadies the craftsman in drawing back molten glass out of the furnace. But critically important is the relation of hand and eye.

In learning to make a Barolo goblet O'Connor passed through stages that resemble those we've explored among musicians and cooks. She had to "untape" habits she'd learnt in blowing simpler pieces in order to explore why she was failing, discovering, for instance, that the easy way that had become her habit meant that she scooped too little molten glass at the tip. She had to develop a better awareness of her body in relation to the viscous liquid, as though there were continuity between flesh and glass. This sounds poetic, though poetry was perhaps dispelled by the shouted comments of her mentor, "Slow it down there, cowgirl, keep it steady!" O'Connor happens to be small and demure; wisely, she took no offense. Her coordination thereby increased.

Now she was better positioned to make use of the triad of the "intelligent hand"—coordination of hand, eye, and brain. Her coach urged, "Don't take your eyes off the glass! It [the molten gob at the blow-tip] is starting to hang!" This had the effect of her loosening her grip on the tube. Holding it more lightly, as a cleaver chef would his knife, she increased her control. But she still had to learn how to lengthen her concentration.

This stretch-out occurred in two phases. First, she lost awareness of her body making contact *with* the hot glass and became all-absorbed in the physical material as the end in itself: "My awareness of the blowpipe's weight in my palm receded and in its stead advanced the sensation of the ledge's edge at the blowpipe's mid-point followed by the weight of the gathering glass on the blowpipe's tip, and finally the gather towards a goblet."³² The philosopher Maurice Merleau-Ponty describes what she experienced as "being as a thing."³³ The philosopher Michael Polanyi calls it "focal awareness" and recurs to the act of hammering a nail: "When we bring down the hammer we do not feel that its handle has struck our palm but that its head has struck the nail. . . . I have a subsidiary awareness of the feeling in the palm of my hand which is merged into my focal awareness of my driving in the nail."³⁴ If I may put this yet another way, we are now absorbed *in* something, no longer self-aware, even of our bodily self. We have become the thing on which we are working.

This absorbed concentration now had to be stretched out. The challenge O'Connor met was the result of a further failure. Though her well-positioned, relaxed, absorbed self had succeeded in gathering the glass into a bubble and forming it into the desired Barolo-friendly shape, the glass, when left to cool, turned out "lopsided and stout," a thing now dubbed by the master craftsman a "globlet."

The problem, she came to understand, lay in dwelling in that moment of "being in a thing." To work better, she discovered, she needed to anticipate what the material should next become in its next, as-yet

nonexistent, stage of evolution. Her instructor called this simply "staying on track"; she, rather more philosophically minded, understood that she was engaged in a process of "corporeal anticipation," always one step ahead of the material as molten liquid, then bubble, then bubble with a stem, then stem with a foot. She had to make such prehension a permanent state of mind, and she learned to do so, whether she succeeded or failed, by blowing the goblet again and again. Even had she succeeded the first time by chance, she would have practiced it, in order to ensure the acts of gathering, blowing, and turning in her hands. This is repetition for its own sake: like a swimmer's strokes, sheer movement repeated becomes a pleasure in itself.

We might think, as did Adam Smith describing industrial labor, of routine as mindless, that a person doing something over and over goes missing mentally; we might equate routine and boredom. For people who develop sophisticated hand skills, it's nothing like this. Doing something over and over is stimulating when organized as looking ahead. The substance of the routine may change, metamorphose, improve, but the emotional payoff is one's experience of doing it again. There's nothing strange about this experience. We all know it; it is *rhythm*. Built into the contractions of the human heart, the skilled craftsman has extended rhythm to the hand and the eye.

Rhythm has two components; stress on a beat and tempo, the speed of an action. In music, changing the tempo of a piece is a means of looking forward and anticipating. The markings *ritardando* and *accelerando* oblige the musician to prepare a change; these large shifts in tempo keep him or her alert. The same is true of rhythm in miniature. If you play a waltz strictly in time using a metronome, you will find it increasingly hard to focus; the act of regularly stressing a beat requires micro-pauses and microspurts. To recur to the discussion in the previous chapter, repeated stress on a beat establishes the type-form. Tempo shifts are like the varied species that emerge within this generic rubric. Prehension is focused on the tempo; the musician concentrates productively.

The rhythm that kept O'Connor specifically alert lay in her eye disciplining her hand, the eye constantly scanning and judging, adjusting the hand, the eye establishing the tempo. The complexity here is that she was no longer conscious of her hands, she no longer thought about what they were doing: her consciousness focused on what she saw; ingrained hand motions became part of the act of seeing ahead. For the musician, the conductor appears visually just slightly ahead, indicating the sound, the executant registering that signal again just in the microsecond before making the sound happen.

I fear that my descriptive powers have reached their limit in describing the rhythm involved in concentration, and I have certainly made this experience seem more abstract than it is. The signs of a person who concentrates in practicing are concrete enough. A person who has learned to concentrate well will not count the number of times he or she repeats a motion at the command of the ear or the eye. When I am deep into practicing the cello, I want to do a physical gesture again and again to make it better but also do it better so that I can do it again. So too with Erin O'Connor. She is not counting how often; she wants to repeat breathing down the blowpipe, holding and turning it in her hands. Her eye, however, sets the tempo. When the two elements of rhythm combine in practicing, a person can stay alert for long periods, and improve.

What then of the substance one practices? Does one practice a three-part invention by J. S. Bach better than an exercise by Ignaz Moscheles just because the music is better? My own experience is, no; the rhythm of practicing, balancing repetition and anticipation, is itself engaging. Anyone who has learned Latin or Greek as a child might reach the same conclusion. Much of this language learning was "rote," its substance remote. Only gradually did the routines that enabled us to learn the Greek language help us gain interest in a long-vanished, foreign culture. As for other apprentices who have not yet fathomed

the content of a subject, learning to concentrate has to come first. Practicing has its own structure and an inherent interest.

The practical value of this advanced handwork to people dealing with attention deficit disorder consists in focusing attention on how practice sessions are organized. Rote learning is not in itself the enemy. Practice sessions can be made interesting through creating an internal rhythm for them, no matter how short; the complicated actions performed by an advanced glassblower or cellist can be simplified while preserving the same structuring of time. We do a disservice to those who suffer from attention deficit disorder by asking that they understand before they engage.



The view of good practicing may seem to slight the importance of commitment, but commitments themselves come in two forms, as decisions and as obligations. In the one, we judge whether a particular action is worth doing or a particular person is worth spending time with; in the other, we submit to a duty, a custom, or to another person's need, not of our own making. Rhythm organizes the second kind of commitment; we learn how to perform a duty again and again. As theologians have long pointed out, religious rituals need to be repeated to become persuasive, day after day, month after month, year upon year. The repeats are steady, but in religious practice they are not stale; the celebrant anticipates each time that something important is about to happen.

I moot this large point in part because the practicing that occurs in repeating a musical phrase, chopping meat, or blowing a glass goblet has something of the character of a ritual. We have trained our hands in repetition; we are alert rather than bored because we have developed the skill of anticipation. But equally, the person able to perform a duty again and again has acquired a technical skill, the

rhythmic skill of a craftsman, whatever the god or gods to which he or she subscribes.



This chapter has pursued in detail the idea of the unity of head and hand. Such unity shaped the ideals of the eighteenth-century Enlightenment; it grounded Ruskin's nineteenth-century defense of manual labor. We haven't followed quite in their path, for we've charted forms of mental understanding that emerge from developing specialized and rarified hand skills, whether these be playing perfectly in tune, cleaving a grain of rice, or blowing a difficult goblet. But even such virtuoso skills are based on fundamentals of the human body.

Concentration consummates a certain line of technical development in the hand. The hands have had before to experiment through touch, but according to an objective standard; they have learned to coordinate inequality; they have learned the application of minimum force and release. The hands thus establish a repertoire of learned gestures. The gestures can be further refined or revised within the rhythmic process that occurs in, and sustains, practicing. Prehension presides over each technical step, and each step is full of ethical implication.

Expressive Instructions

The Principle of Instruction

Show, Don't Tell

This is a short chapter on a vexing subject. Diderot found printers and typesetters inarticulate in explaining what they did; I found myself unable to put clearly into words how hand and eye coordinate. Language struggles with depicting physical action, and nowhere is this struggle more evident than in language that tells us what to do. Whoever has tried to assemble a do-it-yourself bookcase following written instructions knows the problem. As one's temper rises, one realizes how great a gap can exist between instructive language and the body.

In the workshop or laboratory, the spoken word seems more effective than written instructions. Whenever a procedure becomes difficult, you can immediately ask someone else about it, discussing back and forth, whereas when reading a printed page you can discuss with yourself what you read but you cannot get another's feedback. Yet simply privileging the speaking voice, face-to-face, is an incomplete solution. You both have to be in the same spot; learning becomes local. Unscripted dialogue, moreover, is often very messy and wandering. Rather than getting rid of print, the challenge is to make written instructions communicate—to create expressive instructions.