The Coordinated Action, Part 2: Instinctive Responses

by Robert Dew

Shown here is the average angle formed by the axis of the fingers and that of the stick. Note the balancing positions of the first, third, and fourth fingers.

Back, shoulder, arm, and elbow

It is absolutely essential for the player to be able to "get into the string," that is, to get the string to vibrate fully with a minimum of effort and, in particular, without resorting to mechanisms which reduce flexibility. An inability to get into the string diminishes intensity and consequently the variability of intensity by rendering the effects of changing bow pressure and speed inaudible. Getting into the string is generally recognized as a major element of the "big sound," which is something all the great string players have.[1] The word "big" is somewhat misleading because it can be misconstrued to mean only "loud". Actually, the big sound is better characterized as being penetrating and focused; it is therefore also "big" at low volume. It is largely the result of allowing the weight of the light arm to generate bow pressure without applying excessive pressure through the shoulder joint or by forceful pronation (counter-clockwise rolling) of the right forearm and hand. Forceful attempts to apply pressure in this way may not only result in "squeezing," but also interfere with freedom of motion in the elbow joint, wrist, and fingers. This, in turn, prevents the subtle adjustments that permit smooth bow changes, variations in intensity, and uniform sound production from frog to nut. Also, by keeping the shoulder joint as relaxed as possible and the right arm and hand flexible, an unimpaired sensory pathway is maintained from the string up through the arm into the body. This enables one to "feel" as well as hear the sound as it is being produced. Snorts of skepticism notwithstanding, there is no question that one may appreciate keenly the finest frictional vibrations as the bow is drawn through the string. This is very much a visceral sensation, a feeling in the depths of the chest, much like the vibrations of one"s own singing. It is truly one of the great sensual joys of playing. Those sensations provide an indispensable stream of information that makes possible the continuous, minuscule automatic and voluntary mechanical adjustments necessary for maintaining the sound, executing the articulations, and varying the intensity. The penetrating, centered qualities of the sound result from the fact that the optimum pressure and speed and, hence, string vibration are exquisitely regulated.

As we have said, the key thing in all of this is the weight, i.e., passive downward force of the arm, which, being due to gravity, comes free of effort. But, to take advantage of this, the arm, specifically from the elbow down, needs to be somewhat above or at the least at the level of the wrist. Should the elbow drop lower, toward the side of the body, the advantage of the arm"s weight would be largely lost. This relationship of the elbow to the wrist is, however, not rigid. For example, in order to maintain bow balance and pressure as one changes direction at the frog, the elbow drops slightly toward the level of the wrist. This is because as one approaches the frog, the weight of the arm comes more directly to bear over the string. To compensate for this and thereby avoid a gross increase in pressure which would create an audible and ugly sound at the change, the weight of the arm is partially nullified by allowing the elbow to fall toward (but not below) the level of the wrist. The importance of the elbow not falling below the wrist is that, at the frog, the weight of the bow above the pivot of the string also becomes significant.[2] If this is not compensated for, the same undesirable sound will be

generated when the down-bow is initiated. To prove this to yourself, try starting a down-bow with your elbow at your side. It will be difficult to produce a credible sound without "scratching." Approaching the upper end of the bow, the elbow rises to its highest position relative to the wrist. This has the effect of maintaining pressure and sustaining the sound; otherwise, there is a tendency for both volume and intensity to "die away." Many players appear either to accept this part of the bow altogether.[3] There is a further essential technique in the slow, legato down-bow, which preserves the capacity for intensity and expressiveness toward the top of the bow. The "re-pull" is discussed later.

Just visible on the other side of the stick opposite the thumb is the side of the pad of the middle finger. These two digits are essentially responsible for holding and carrying the bow.

With the initiation of the up-bow, the elbow begins a downward scooping action. As the up-stroke begins, the elbow is at its highest and the wrist is slightly rolled or pronated in preparation for the scoop. In this way, all the structures and forces are in place for getting into the string from the very onset of the stroke. One thereby avoids the reciprocal of the problem just mentioned (i.e., losing sound on the way to the tip) which is that of beginning the up-stroke with a weak sound. Most important in this is the action of the shoulder blade (scapula). Tuttle states that "the impulse for the up-bow comes from the back." She simultaneously cautions that the student, with the idea of "getting his back into it" in mind, will mistakenly raise the shoulder. This action will hinder the very movement and sensation one wishes to take place, so it is vital to understand just what is involved (and what isn't). The "impulse" part means that just before actual movement of the bow begins, one feels a release in the back. Then, as the up-stroke proceeds, the scapula slides forward freely over the upper back. Seen from behind, the, "winging" of the scapula, normally observed with the shoulder drawn back, disappears. The bulge of the shoulder blade flattens out and a smooth rounding of the right thorax occurs as more of the ribs in the back are "uncovered."

From the front, the head of the humerus (top of the arm bone which forms the knob of the shoulder) rotates slightly forward in a gentle, sensuous "yielding" motion. To put it another way, the back, by "opening up", (scapula sliding forward), allows the pectoral muscle to rotate the upper arm forward with a minimum of tension. The deltoid muscle, which primarily holds the arm (and elbow) up, relaxes as the elbow swings downward along the path of the stick. This is important! The elbow does not come from behind or from the side of the body, but from above the plane of the stick, and well out in front of the instrument. A lateral movement of the elbow causes a diversion of some of the energy that would normally get the string to vibrate. If the elbow has come from around the side, it means, first, that toward the end of the previous down-bow it has swung in that direction. This may be due to a failure of the elbow joint to open up completely, or worse, a tightening of the back musculature that draws the scapula, and thus the arm, back toward the spine. Retraction of the shoulder backward (as in a position of military "attention") suggests extraneous actions in muscles of the upper back (*rhomboidius latissimus dorsum*) attached to the shoulder blade.

This misalignment creates a particular problem in sound production in the approach to the tip because, even if the player opens up the elbow in the down-bow, the backward movement of the shoulder changes the angle at which the bow intersects the string. The bow hairs "cut" best at a right angle to the string, i.e., at that angle, the most friction with/vibration from the string is attained. If this angle is reduced, a loss of sound results at the top of the bow and the sideways displacement of the bow along the string amounts to loss of bow control. This is quite different from the intentional technique of drawing the bow away from the bridge to obtain a change in timbre. In that case, it is a matter of choice rather than a symptom.[4]

If the intersection of bow and string is thought of as the eye of a needle, then it should seem as if one is slowly thrusting (or "threading") the stick of

the bow through that eye. The way things feel when the up-stroke is done properly is that there is a sense of power emanating from the back, which is transmitted into the string through the downward scooping action of the elbow. One has a strong feeling of stability combined with the luxury of traction to spare. And yet, this comes without strain and with little effort. The upper arm, forearm, and wrist should be felt as passive rather than being forced to "produce" the sound. Instead, they function mainly to steer the bow and regulate the pressure which itself is simply "available" because of the weight of the arm. Of course, as the up-stroke is made, the bow is propelled by the closing of the elbow joint as the biceps muscle operates; the unitary and flexible action of the scapula, shoulder joint, and upper arm effectively positions the weight of the arm throughout the stroke so that all the pectoralis and biceps muscles need do is move the bow upward on the string, thereby minimizing the work of producing the sound.

As with just about any pedagogical system, there are risks of misunderstanding and misapplication. So, before going further, we should direct a few remarks toward "troubleshooting." Everything we have suggested so far requires that the musculature of the shoulder girdle be supple and free of extraneous or excessive contractions. The suspension of the elbow at the proper level depends on just one muscle: the deltoid. If the elbow is held too high, this muscle will begin to hurt and there will be a loss of endurance. Furthermore, if the deltoid does not release with initiation of the up-bow, the scapula will not be free to slide forward; as Tuttle puts it, "The back will not go in on the stroke." Also, the downward scooping action of the elbow will be hampered. Elevation of the shoulder indicates involvement of the trapezius (the "ducking" or shoulder-shrugging muscle), which will have the same negative effects. This is part of a chronic holding posture often seen in string players; but it may also result from a misguided effort to "get one's back" into the up-stroke, or to "get" the shoulder to roll forward. On this latter point: the "gentle, sensuous" forward rolling of the shoulder comes not from "taking" action, but rather from a passive releasing, i.e., as a consequence of the scapula sliding freely. In this, the scapula and upper arm are drawn forward solely by the pectoralis muscle during the up-stroke. The pectoralis is a large muscle, with a good deal of mechanical advantage;" that is, a small shortening of this muscle easily moves the arm a long way. Thus it should never become hard even as the up-stroke reaches the frog.

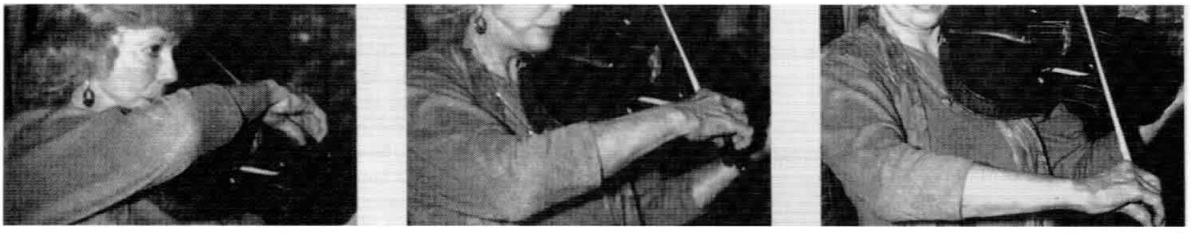
Mobility at the shoulder joint will be impaired by excessive tension in the pectoralis, and when, as is frequently the case, this is combined with elevation of the shoulder, playing not only becomes a torture but will lead to bursitis or tendonitis of the biceps and deltold. So an important checkpoint is the tone of the pectoralis. This is easily determined by grasping the muscle between thumb and forefinger high up and at the frog. Most significant is that any of these distortions will interfere not only with sound production, but also with releases immediately essential to coordination.

Wrist and fingers: the "re-pull"

The movements of the wrist and fingers are matters of the utmost delicacy and importance in the regulation of sound production, particularly where changes in bow direction are concerned. To fully appreciate this, one might, as a test, first attempt an up-to-down change at the frog with the wrist and fingers rigid. One quickly realizes that a smooth change with consistent bow pressure is virtually impossible under these circumstances. This extreme example illustrates a major point. Since the wrist and fingers are the terminus of all the bowing actions of the elbow and arm, rigidity or awkward positioning in holding the bow will greatly interfere with the coordination function, even if the movements of the arm and elbow are essentially correct. The hold must be at once solid and secure while at the same time supple enough to permit fine and rapid adjustments. We recommend that the stick be held mainly between the last joint of the middle finger and the opposing thumb; this gives solidity.

Balance is provided by the index and third fingers and is considerably helped by having the fourth finger poised on the top of the stick (see second photo in the top sequence on p. 66). Whether the fingers are close together or far apart is more a function of the size of the hand, although it is obvious that the broader the "base" provided by these fingers, the better will be the control. On the other hand, if the fingers are stretched too far apart, there will be a loss of flexibility. There is some latitude with regard to the "depth" of the positioning; that is, the stick may lie against the pads of the first three fingers (shallow) or as far up as the first joints (deep). There has been a lot of discussion about the

This sequence shows what happens in the course of a slow down-stroke. The "drawing" position of the fingers near the frog is particularly apparent in the second picture. In the third, the re-pull has just been initiated and the bow is roughly at its middle (balance) point on the string with the fingers beginning to extend. This slow down-bow swiveling action of the fingers is superimposed on the down-stroke produced by the arm. The last picture, with the bow near the tip, shows the completed re-pull with the fingers fully extended. Note also the pronation of the wrist and position of the elbow above.



Another view of the down-stroke illustrates the flexed fingers at the frog and the position of the elbow and wrist. The first picture shows the arm well out in front of the instrument, so that the bow intersects the string at a right angle even near the tip (see picture 3). In some of the pictures the elbow appears to be below the wrist. From the perspective of height from the floor, this may be true. However, considered from the point of view of the plane of the stick, the elbow is higher. The weight of the arm will be effective in bow balance and sound production if this condition is met.

position of the first finger. Some advocate pronating the hand so that the stick lies in the second joint of the index, even to the extent of curling the finger under the stick. Heifetz did quite well with this grip. But while it may confer some degree of security in one sense, it also sacrifices much of the mechanical advantage of the index finger in the matter of balance and control. Avoid this much pronation. As a general rule, at rest, the angle formed by the axis of the fingers with that of the stick is most natural at around 60 degrees. However, this constantly changes as the flow is drawn up and down.

A most crucial action of the wrist and fingers occurs at the frog during the legato bow change. In this, the behavior of the hand and fingers resembles that of the bristles of a paintbrush in a side-to-side stroke. Even as the arm begins the change of direction (from up to down), the relaxed wrist allows the hand and fingers to lag behind so that, momentarily, they continue to draw the stick upward. Then, almost immediately after the initiation of the down-stroke by the arm, the hand and fingers reverse and follow. A number of things occur around the actual joint of the change in direction:

1. The finger-to-stick angle mentioned above is at its smallest during the up-stroke because the frictional force of hair against the string causes the hand and fingers to drag the stick, thus closing up the angle.
2. The angle opens up or increases with the down-stroke (for the same reason) and the fingers become almost vertical to the stick. It is apparent from both these actions that, from the point of view of the hand and fingers, the bow is always drawn or dragged regardless of the direction of the stroke. The bow is not pushed in the legato (or in any of its derivative strokes, e.g., detache); in fact, it cannot be pushed if the fingers and wrist remain supple. The brushing action of the hand and fingers smooths out the change by minimizing the duration and magnitude of the frictional forces at the instant of change.
3. With the up-bow component of the brush-stroke, the fingers flex. Without this, the action of the wrist and hand would tend to swing the stick back toward one's head. As a consequence, extraneous frictional forces would be incorporated into the change, because the down-stroke

would then begin at a different angle from the bridge than did the up-stroke. Scratching or an interruption of the sound will result. The flexing action of the fingers not only maintains bow alignment; it also exerts a slight lifting force at the very end of the up-stroke, which gives the change a "buttery" quality. This is one reason why, on recordings, fine players seem never to change bows. Another reason is that intensity is sustained through the down-to-up change.

Down to up: the "re-pull"

The down-to-up change at the tip, of course, involves actions similar to those already described, but in reverse order. In the down-stroke itself, the shoulder rotates backward and downward as the scapula slides back. And again, because the elbow starts level with the wrist and rises, the sound comes easily from the weight of the entire arm. The change at the tip is generally experienced as being easier because the weight of the bow is not a factor and balance is consequently less difficult. Many players even let the fourth finger briefly leave the stick. However, there is also a greater difficulty in sustaining the intensity of the sound through the change. This is where the technique of the "re-pull" comes in. The re-pull begins in the course of the down-bow as the balance point (just below the middle of the bow) is reached. As we have said, the finger-to-stick angle has already opened up as a consequence of the frictional force generated by bow against string. Preparation for the re-pull involves a small additional flexing of the fingers. This flexing gives more potential distance to the re-pull, like a cat crouching before springing. As the down-stroke continues, the fingers are gradually extended outward and backward (in the down-bow direction). The wrist will simultaneously and automatically roll (pronate)—a reflex, which is facilitated by the elbow rising as one approaches the upper end of the bow. The extension of the fingers and rolling of the hand act like a swivel. This swiveling does not merely help to propel the stick downward. The essential action of the re-pull—its raison d"etre—is to increase pressure and friction so that volume and intensity are preserved. This allows sustaining of the sound into the upper half of the bow; the re-pull even makes possible a rise in intensity and volume where it is ordinarily becoming most difficult to produce. The end of the re-pull, when the fingers complete their extension and the wrist fully pronates, can be thought of as the ultimate extension of the down-bow. It is very much an analogue of what one does at the frog in that the fingers continue to propel the stick through the remainder of the down-stroke just as the arm has all but stopped its downward movement. This allows a sustaining of sound over the down-to-up change, which not only makes the change itself less audible, but also gives added flexibility in phrasing. There is also a neck release just before the end of the re-pull, which adds considerably to a sense of assurance in the upper bow in that the desperate feeling of "running out of gas" (volume and intensity) is avoided.

Breathing

Our discussion of the prerequisite bow technique for successful coordination would not be complete without mentioning breathing. Many people hold the breath while playing, often to a length that would shame a Japanese pearl diver. Frequently players are not even aware of doing this. More rarely, the fear is expressed that daring to breathe will disrupt bow control, particularly when pianissimo is required or when approaching the frog with a slow-moving bow. This may very well be the case if the elbow is too low, because this position creates instability in balance. Also, rigidity in any part of the shoulder joint, arm, wrist, or hand will tend to magnify movements of the chest and transmit them onto the stick.

Frequent and particularly harmful concomitants of holding the breath are stiffening of the neck and glottal closure. These may affect sensation and motivity in the upper extremities. Playing becomes strained and endurance reduced. Of specific concern in the present context is that breath-holding or jerky respiration may either prevent the release in coordination or, should it occur, prevent it from doing its work. Thus, the effects of holding the breath will overlap due to failure of coordination. The problems of disturbed respiration may go beyond these. Holding the breath is associated with a state of tension or fright. Part of the vital apparatus "freezes" so as to reduce excitation and sensation. If it is chronic, inhibited breathing may eventually cripple one"s inherent capacity for the generation and transmission of excitement; spontaneity and freedom of movement suffer. In effect, one becomes less alive. These consequences are, of course, antithetical to everything required of us in musical expression.

Certainly, one has no chance of correcting the situation unless one is aware of the problem with

respiration in the first place. But, while it is possible for the teacher to point it out, it may be far more difficult to overcome. This can be readily understood if one recognizes that the source of the problem is anxiety. It is not within the province of the teacher to deal with chronic anxiety. From years of experience, Tuttle has concluded that the simplest approach is to get the player to "let the belly down"—to encourage the release of air from the chest. Phonation, or making vocal sounds, during practice sometimes also helps; but the danger here is that it will become habitual, noticeable, and distracting during performance.[5] Tuttle has found it futile to attempt integrating breathing with bow changing in any systematic way. She does recommend in this regard something she learned from Casals, and that is to exhale before initiating the bow stroke (up or down) commencing a piece or a phrase. The benefit of this technique is that one establishes tempo and rhythmic character even before the bow starts to move on the string. This is because during exhalation, the chest, spine and pelvis are most free to move; hence the rhythmic impulse is most readily felt and conveyed—again by means of a physical release movement. Sometimes Casals would reinforce this by stamping his foot before giving the actual down-beat. The other advantage to exhaling is also related to the relaxation of the chest, which allows a more assured attack and bow stroke. The argument has been made that singers and wind players always inhale before starting anything. In our estimation, however, this is a restriction, not a choice; and, even in this case, the rhythmic impulse is more firmly established on the exhale before the essential inhale.

Teaching coordination

Coordination probably cannot be taught—not, at least, in the usual didactic sense. The release, for example, is not entirely accessible through verbal description, any more than mathematics can fully capture the flight of a bird. Linguistically, one can only resort to metaphor. A teacher may pick up the instrument and demonstrate coordination to the student, but these illustrations will seem meaningless or strange to those who do not have some sense of it in themselves; they simply will not "get it." Coordination is a function that depends on an innate capacity for release. The teacher might only bring out whatever capacity exists by helping the student to eliminate those things that interfere with it. These obstacles may be legion; in addition to those we have discussed concerning bow technique and sound production are those relating to the left hand—notably vibrato and shifting—as well as postural misalignments or simply the positioning of the instrument, Any of these, should it create instability and insecurity, will become a source of tension—which makes coordination difficult or impossible. Of course, not all technical problems are equally significant. The lack of a down-bow staccato, shabby fingered octaves, etc., will not necessarily interfere with coordination. But to the extent that a technical weakness creates tension or discomfort, the performer will be more preoccupied with "getting through" the piece than with making music. In such a psychological and physical atmosphere, coordination will at best be haphazard.

Another obstacle would be a lack of musical passion. This simply means that the player experiences no inner excitement from the music. This, in turn, may be because the piece itself is drivel or because the player lacks imagination. In this case, the capacity for coordination might be there, but it is rather like having wings on a potato. A last and most serious impediment is that of muscular rigidity or tension due to emotional inhibition. Here the passion may be felt, but the pathway to the instrument is blocked. In a sense this operates very much like a technical block; however, its greater seriousness lies in the underlying conflicts, which do not allow the individual to surrender to the passage of his own excitement. These people are often deeply disturbed or frightened by the phenomenon of the release, which poses a threat to an already anxious equilibrium. If very inhibited, their playing will seem flat or boring. Or, if less so, they may bang away at or squeeze the instrument with much impassioned scratching, attempting to "get out" by force what the gentlest caress would easily achieve. Emotionally caused muscle tension also causes technical problems; but, in as much as these are ultimately tied to the student's inner life, the task facing the teacher is even more formidable than the resolution of pure bad mechanics. In fact, it takes a skilled and sensitive teacher to just differentiate emotional from mechanical problems. If he diagnoses the former, and respects the potential frustration and hazards for the student, he will not attempt to handle with teaching that which really requires a therapist. It is important to emphasize that if the student has both passion and capacity

and a teacher who understands coordination, he will have opened to him a previously inaccessible world of musical expressiveness.

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Editor's Note: This article is the second in a series on Karen Tuttle's ideas on the coordinated action. Dr. Robert Dew, M.D., studied with Karen Tuttle and Ivan Galamian at the Curtis Institute.

NOTES

1. Heifetz once boasted and proved that he could cut through an entire orchestra, at full tilt.
2. Those of you with a bent for physics will recognize the principle of the moment arm here. With the string as the pivot, the bow acts like the plank of a seesaw. But, since the bow moves, the pivot (string) position is constantly changing relative to the plank (bow). To maintain bow balance and, therefore, consistent pressure anywhere in the bow, the player must continuously adjust the vertical forces due to the right arm and the bow itself.
3. This is analogous to the "fear" of going to the frog.
4. Anatomically, it is less awkward in drawing the down-bow to allow the elbow to swing back as the top of the bow is approached and, similarly, as a consequence, starting the up-bow from the same position. Children, beginners, and indeed many veteran players do this automatically. Unfortunately, this is one of those instances in which a natural tendency is not in the best interests of the sound.
5. Glenn Gould and Errol Garner are two famous cases in point. But here, the musical product is exciting enough to overcome most objections.