I Can’t Shorten If You Don’t Lengthen

**Reciprocal Inhibition and Other Reflexes**

We’re very close to putting together all of our neuromuscular pieces, but there’s one thing that doesn’t make sense: How is a muscle expected to concentrically contract (shorten) if its opposing muscle doesn’t lengthen? For instance, while lying in bed you hear a strange sound and decide to raise your head. In order for your sternocleidomastoid (SCMs) to flex your neck, your posterior neck muscles must relax and lengthen (11.17). Otherwise, agonists and antagonists would find themselves co-contracting, creating a struggle that results in no net movement. What gives?

Solving this dilemma is **reciprocal inhibition**, a fancy term that describes the neurological reflex whereby one muscle relaxes when its opposing muscle contracts. Movement, especially smooth and coordinated actions, couldn’t happen without it. In our example, if your trapezius and levator scapulae muscles weren’t amenable to stretching while your SCMs shortened, your head wouldn’t leave the pillow.

![Image of reciprocal inhibition](image1)

**A Rubber Band Around a Stick**

In this respect, oppositional muscles are intrinsically related; for analogy purposes, let’s replace the above scenario with a rubber band looped around a flexible stick (11.18). Place tension on one side of the strap by pulling on it (the action of your SCMs) and the stick (your neck) bends (11.19).

However, this “neck flexion” could only occur because the opposite side of the rubber band (your posterior neck muscles) lengthened. No elongation equals no motion. Release the rubber band and “your neck” returns to neutral. Just as the rubber band is one piece of material, in a sense so are opposing muscle bellies—certainly their fascial elements. All of this leads to the notion that we should stop thinking of myofascial units as isolated units, because they’re not.

One more anatomical example: You bring a cookie to your mouth. Your brachialis receives an excitatory message saying, “Contract” (11.20). Your triceps brachii, the antagonist muscle, simultaneously gets an inhibitory signal (via reciprocal inhibition) to relax, and is thus able to lengthen. But the triceps doesn’t just collapse into flaccidity. It gradually down-modulates its muscle tone, which allows its fibers to elongate in a way that ensures the joint movement is smooth and synchronized. This type of teamwork between oppositional muscles will prove crucial for rhythmic actions such as walking, running and chewing.

![Image of reciprocal inhibition](image2)

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**11.17 Engaging the SCMs must happen with the reciprocal inhibition of the other muscles.**

**11.18 Wrapping a rubber band around a stick.**

**11.19 Pulling on one side of the band stretches the opposing side of the band.**

**11.20 She might only be lifting a cookie (and the weight of her forearm), but for the brachialis to shorten, the triceps brachii must lengthen.**
Tonus

Muscle tone—that small quantity of passive tension found in a belly generated by weak, involuntary contractions—is closely interrelated with spindle cells and GTOs. But what is the “proper” tone or length in a muscle—and what decides such matters?

Let’s say you do a lot of arm curls at the gym. Due to all of that flexion, your central nervous system has taken this persistent behavior as a strong hint to “rewrite the program” for your brachialis and increase its overall muscle tone. This excessive tone is like a car idling at 250 rpm, instead of the usual 100, and now your elbow rests in a visibly flexed position. (Observe bodybuilders for this all-too-common phenomenon, above.)

With such hypertonicity (excessive tone), the brachialis, which should rest—let’s say—at 6° (15 cm) in length, now sits at 5° (12 cm). Realizing that your elbows are chronically flexed, you decide to stretch your elbow flexors. But not so fast. Your muscles’ spindle cells, taking their cue from the CNS, are of the mind that your brachialis is supposed to be 5° long (right). For all they know, you’re going to damage the tissue with an excessive stretch. In order to sidestep the stretch reflex so you can reeducate your brachialis’ spindle cells, you have to slowly and gently coax the tissues surrounding your elbows to a more proportionate tonicity.

Equilibrium Above All Else

Aside from muscle bellies, tendons and joints, we’ll also want to place some sensory gadgets inside your inner ears and the muscles at the base of your head. Why there? Because we want you to keep your head on straight—literally.

The sensory structures in your ear will register any degree of head tilt, as well as linear and rotational acceleration of your cranium. This information, combined with stimuli from your eyes, will be critical in maintaining balance. Obviously, you will be best able to do this when the head is level. (Just walk around with your noodle cocked and note how quickly your equilibrium gets cattyswampus.)

How your head remains steady is with the righting reflex, an involuntary response that directs muscles below the cranium to shift the body however necessary to keep the head plumb (left).

Assisting greatly in this reflex will be the suboccipital muscles at the base of the head. We’ll be sure to insert a boatload of muscle spindles and GTOs inside these eight little muscles. Their mission will be twofold: generate slight movement of the head and monitor its position.

All of this cranial surveillance will prove essential since the body follows where the head leads. You know this instinctively when you bomb your bike down a hill and keep your eyes (and head) directed toward the trail instead of the tree that you wish to avoid.

Reflexes

For us humans, basic reflexes such as reciprocal inhibition (page 158) are deeply ingrained in our evolutionary heritage—and for good reason. Set your hand accidently on a hot stove and in an instant your flexor withdrawal reflex will pull it away. Like all reflexes, this instantaneous, unconscious gesture stems from the spinal cord. It produces a flexion movement that withdraws a part of your body from a source of pain. Reciprocal inhibition assists this protective mechanism by relaxing your extensors when your flexors are signalled to contract. Set your right toe on a thumbtack and, before you realize it, you’ve withdrawn your toe and shifted your weight to your left foot. The flexor withdrawal reflex is responsible for the flexion of your right knee and hip, but the crossed extensor reflex (so named because the reflex message is sent to the opposite side of the body) contracts your left leg’s extensor muscles to support the extra weight.
Putting It Into Practice

The Neuromuscular System in Action

All this talk about proprioceptors isn’t just for toots and tickles but can actually be useful in your table or mat work. Here’s how: in your practice, you’ll likely focus on affecting the length, resting tone or strength of your client’s muscles. Since each movement pattern performed by the body is based on a sequence of muscle contractions (11.21), this intention makes sense. In other words:

Balanced muscles
+ Optimal neurological patterning
= Coordinated movement

Theoretically, we could utilize—even manipulate—the characteristics of proprioception that we introduced on the previous few pages to encourage proper range of motion and balanced posture in your clients.

Let’s do exactly that and put theory into practice. We’ll head into the Movement Lab to test out various concepts and techniques that might work to change the state of your client’s muscle tissue. But first, a few physiological realities.

Proprioceptive (In)Accuracy

As we’ve mentioned, your muscles are seldom fully relaxed. Even when napping on the couch (11.22), your body’s muscles—in your arms, legs, everywhere—possess a small but continuous amount of contraction (tone). Primarily designed to stabilize joint alignment (and prevent dislocation), this background tone is like a car in neutral—the engine is idling on low, yet ready to shift into gear when called upon.

Muscle tone, of course, can increase or decrease. Swim a hundred laps and it increases (11.23). Go under full anesthesia and it decreases to nearly zero. What we’re concerned about here is the resting tone of muscle bellies—their state when you’re sleeping, lying on a massage table or sitting with a book. In those situations, your muscles are generally relaxed, but still "on."
Levator Goes from 5 to 8.5

This leads to the $64,000 question: In these passive situations, how "on" should be a muscle? Continuing our car analogy, should it be idling at 100, 200 or 300 rpm? That answer is always in flux, based on the recalibrations of your proprioceptors (muscle spindles and Golgi tendon organs) and your central nervous system (CNS). Recent activity, injury, old "muscle memory" and more will affect your resting muscle tone; your "tonal blueprint" is continually being redrawn based on the neurological dance between your sensory input and motor output.

For instance, let's say that last week your left levator scapula was resting with a tone of five. But this week, after your dog died (11.24) and you helped a friend move his extensive rock collection (11.25), it's now revving at eight-and-a-half. Something about those emotional and physical experiences sent your proprioceptors "back to the drawing board" to rewrite the blueprint for your levator's resting tone.

This is just one example of how a muscle can hold itself like a hyper-taut strap when it should ideally be relaxed. For you (and the rest of the hyperactive modern world), the therapeutic objective of table or mat work is probably to lower the resting tone of muscle tissue. In truth, a more effective treatment plan might be to lower the tone of certain muscles, while raising it in others. (See page 131, X Marks the Spot.)

It would be wonderfully convenient if you could just lower or raise the resting tone of a muscle with a mere thought. Yet that capacity lies safely tucked away beneath your conscious control. There, your CNS determines the set length for your muscles' spindle cells and, in turn, formulates the tone of your muscle bellies. Thus each of your muscles will possess a tone that is either ideal, excessive (facilitated) or diminished (inhibited). And those conditions persistently readjust based on posture, behavior, emotions and actions. Ya' know—life.

Using Muscle Tissue's Properties

As despairing as this Tale of Muscle Tone might sound, all is not lost. To begin with, you can achieve a dramatic change in resting muscle tone (either yours or your clients') simply by applying the properties of muscle tissue outlined on page 104. It turns out that you can adjust the tone of a muscle by taking advantage of its properties of contractility and extensibility.

For instance, let's say that your rhomboids possess a less-than-optimal tone. You can contract and shorten them, causing them to strengthen and increase their resting tone (11.26). Conversely, if your serratus anterior has a higher-than-optimal tone, you can stretch and lengthen it to produce a softer resting state (11.27).

You might already encourage these sorts of tonal transformations at the gym or in yoga class. And while you do, your proprioceptors—for all of their regulatory tendencies—are listening. Encourage a muscle to relax and it takes your cue. Place a muscle belly in a shortened, strained position, however, and don't be surprised if its pain receptors come knocking on your door. The point is this: by employing the properties of muscle tissue, you can affect the length, resting tone and strength of bellies.
Putting It Into Practice

Stretch Reflex Versus Styles of Stretching

If we recall, the stretch reflex (page 154) is the instantaneous response produced by muscle spindle cells that causes contraction of muscle fibers in response to the lengthening of that same muscle. In other words, stretch a muscle and the spindles respond by initiating with simultaneous contraction. This protective mechanism is present in all elongating circumstances, but is affected by three variables of a stretch:

- **force**
- **duration**
- **speed**

Let's test out these different conditions and see which is most conducive to a healthy stretch for muscle tissue. An obvious choice for our test model is the hamstrings.

First, let's play with the **force** of the stretch (11.28). If we use our body weight to **jam** our client's leg beyond the limit of his ROM, no surprise—he yelps in pain. This is not very effective, as the stretch reflex sounds an alarm message in the muscle tissue (remember, its job is to help protect) and the thigh "bucks back." Instead, if we **ease** into the stretch with mild effort and just begin to engage the tissue, the stretch reflex doesn't resist and the muscle is afforded space to lengthen.

Second, it might help to change the **duration** of the stretch. That is to say—let's give it some time. If we stretch the hams gently for only a few seconds, the spindle cells can't sufficiently adjust to the new length. Yet maintaining the stretch for thirty seconds or more seems to warm the tissue to its new proportion.

Third, we should note that even when using modest force, a rapid stretch will still send a panic message to the spinal cord and again the muscles resist the lengthening. Thus, we'll slow down the **speed** of the stretch and ease into it nice and gently (11.29).

Our perfect combination of factors seems to include moving slowly, using **gentle force** and a **longer** period of engagement. (Perhaps that's no surprise.) With these in place, the stretch reflex is kept at bay and the muscle tissue is receptive to our imposed elongation. Once we break it all down, the qualities of these components seem practically obvious.

11.28 A stretch delivered with excessive force ignores the tissue's warning signals.

11.29 A nice and easy stretch—slower, gentler and longer.
Using the Stretch Reflex to Your Advantage

Did you notice something interesting in the previous scenario? Remember how the muscle spindles responded to the forceful and rapid stretches with a counter-contraction? Well, here’s an idea: What if we harnessed that stretch reflex reaction for a swing, stroke or kick of a ball?

A little experiment is in order. Let’s go out to the tennis courts and knock the ball around. The moment the ball approaches, you—without even thinking about it—instinctively and quickly pull your racket into a backswing before swatting the ball across the net with a forward swing.

Your windup not only produces two types of tension (as discussed on page 134), but also brings a third element into the mix: By stretching the muscles that will produce your forward swing, the backswing “tricks” the muscle spindles’ stretch reflex into believing that your tissue is going to be damaged. The muscles receive the message to “Contract!” at the exact moment you’re wanting the tissues to engage (during your forward swing) (11.30).

Let’s try it differently this time. Instead of preceding your forward swing with a rapid backswing, just hit the ball with no windup. Note the discernible lack of strength in the maneuver. It’s hard to “get your teeth into the ball” because you’ve shut out not only the active and passive components of the stretch-induced tension in your muscles, but also the benefits conferred by the stretch reflex (11.31).

Relax with Your Golgi Tendon Organs

Since Golgi tendon organs (GTOs) detect and respond to changes in muscle tension, we could take advantage of this attribute to relax muscle tissue. After all, they send inhibitory messages based on the tautness of a muscle, “Oh, there’s too much tension, relax.”

Let’s begin with a slow, gentle stretch that places continuous tension on a muscle belly. (For this case, we’ll laterally flex the neck, stretching the upper trapezius.)

A pulling sensation is felt in the traps and is registered at the musculotendinous junction where the GTOs are located. Even though there isn’t a dangerous level of tension being placed on the belly, over the course of the stretch, the GTOs monitor this tension and respond to it by evoking inhibitory (relaxing) signals that are sent back to the muscle belly (11.32).

At the same time, however, the muscle spindles (which have the polar-opposite task of gauging the length of the stretch, not the tension of the muscle) are detecting this elongation as well and are sending contractile messages to the muscle.

There is a second, more dramatic option to facilitate your GTO. It’s a bit Frankensteinian at first glance, but we’ll place electrodes on your body that will send an electrical current through your muscle. Such stimulation will imitate the neurological current that would usually elicit muscle contractions. This continuous engagement (usually lasting ten minutes) puts tension on the tendon and triggers the Golgi tendon organs. Over time, the muscle—tired of being inundated by “relaxation messages”—gets the hint to soften. Actually, we don’t really need to test out this method; it’s called electrical muscle stimulation (EMS or E-stim) and is used successfully by rehabilitative specialists in just such a capacity.

11.30 Using the stretch reflex to your advantage.

11.31 No windup = no passive tension.

11.32 Rupert’s “Inner GTO technician” (above on the phone) monitors the tension on the tendon of the upper trapezius as the neck is laterally flexed.
Putting It Into Practice

Post-Isometric Relaxation and Reciprocal Inhibition

You might not have noticed it, but after a muscle contracts, there is a naturally occurring relaxation response that follows its engagement. Figuratively, we could say that the muscle starts at a Size 6, gently contracts to a 4 and then—after it stops engaging—relaxes to a Size 6.1. This working theory is the basis of post-isometric relaxation (PIR).

Here's an idea: What if we built a stretching technique around this physiological premise? For instance, let's say your partner is supine and you flex his hip, lengthening out the hamstrings.

We could ask him to contract his hamstrings ("gently extend your hip against my resistance") for a short period, say five seconds (11.33). Then, when the muscles stop engaging—and the tissue's relaxation reaction commences—we could slowly stretch the hamstrings a bit farther. In other words, we could take advantage of a muscle's own neuromuscular tendency to lengthen after a contraction and generate greater length of its myofascial tissues.

Let's kick it up a notch to an even better idea: What if we combine the methodology above with some reciprocal inhibition (RI)? If you recall from page 158, RI is the neurological reflex that relaxes one muscle when its opposing muscle contracts. What if there was a way to involve the antagonist muscles (in this case, the quadriceps femoris group) in the above scenario?

Let's pick it up where we left off. Your partner was supine, you had flexed his hip and asked him to extend against your resistance. Then, after he relaxed, you gently stretched the hamstrings a bit farther. At this point, what if you asked him to engage his quadriceps (11.34)? ("Gently pull your thigh closer to your chest by contracting these muscles on the top of your thigh.")

Now the hamstrings are receiving another neurological message which says, "The quads are contracting, so please relax." (Technically, this would engage only the rectus femoris muscle—since it is the only quad that crosses the hip joint—but even the engagement of the other three quads would extend the knee and send another relaxing message to the hamstrings.) Depending on your partner's condition, you perform two or three of these stretches to facilitate an even greater response from not only the muscle tissue but also its fascial elements (11.35).

This combined technique (PIR plus RI) is sometimes known as CRAC—short for "contract-relax-antagonist-contract."

All of the practical application discussed over the last few pages is a great lead-in to the biomechanical laws and concepts in our next chapter. Isaac Newton, here we come.