

Sherringtonian Concepts & Practical Application

I. History & overview of PNF (proprioceptive neuromuscular facilitation)

II. Review of Neuroanatomy

a) Sensory proprioceptors

▲ Muscle spindle and its components

⇒ Bag

⇒ Chain

⇒ Afferent nerve fibers

• Primary Ia's

• Secondary II's

▲ GTO's (golgi tendon organs)

b) Motor Neurons

▲ Alpha motor neuron

▲ Gamma motor neuron (static and dynamic gamma)

III. Definition of pertinent terms:

▲ Physiological Flexors

▲ Physiological Extensors

IV. Wiring Diagrams for:

▲ Physiological Flexors

▲ Physiological Extensors

V. PNF—Sherringtonian Concepts

▲ Irradiation (overflow)

▲ Reciprocal Innervation (inhibition)

▲ Successive Induction

VI. PNF—Practical Application

a) Demonstration to ↑ flexibility in hamstrings using above concepts

b) Advantages in using Sherringtonian principles

Physiological Classification of Muscles

- For the purposes of this lecture, the significance of knowing whether a muscle is a physiological extensor (tonic) or a physiological flexor (phasic) will ultimately dictate a muscle's response (facilitatory or inhibitory) during stretching or strengthening.
- Muscles can be classified according to their anatomical, metabolic or physiologic characteristics. Few muscles can be categorized as pure "flexors" or "extensors" because of the varying degrees in physiological and metabolic compositions. For example, the hamstrings are considered an anatomical extensor, but are physiological flexors due to their physiological characteristics (see below). The significance of knowing this is important because physiological flexors are facilitated when stretched.
- The significance of knowing whether a muscle is a primarily a "physiological flexor" or a "physiological extensor" ultimately dictates the type of therapeutic exercise prescribed. For example, the soleus is a physiological extensor which in turn, is built more for stability and thus is "tonic" in nature. Therefore, closed kinetic chain (CKC) exercise would be more sensible in training this muscle.

PHYSIOLOGICAL FLEXOR AND EXTENSOR MUSCLES ARE THEREFORE DEFINED AS FOLLOWS:

Flexor—Phasic

- "Mobilizers"
 - Multiarthrodial
 - Superficial
 - Anaerobic
(Fast glycolytic fibers)
 - Initiate movement
 - Best suited for OKC exercise
 - LOVES the lengthened range because it's facilitatory extensors
- (Ia primary fibers turn them on, thus causing movement)
- Techniques best suited for promoting motion: SRH, SR

Ex>Hamstrings

Rectus Femoris
Erector Spinae
Gastrocnemius
Long head triceps

Extensor—Tonic—Postural

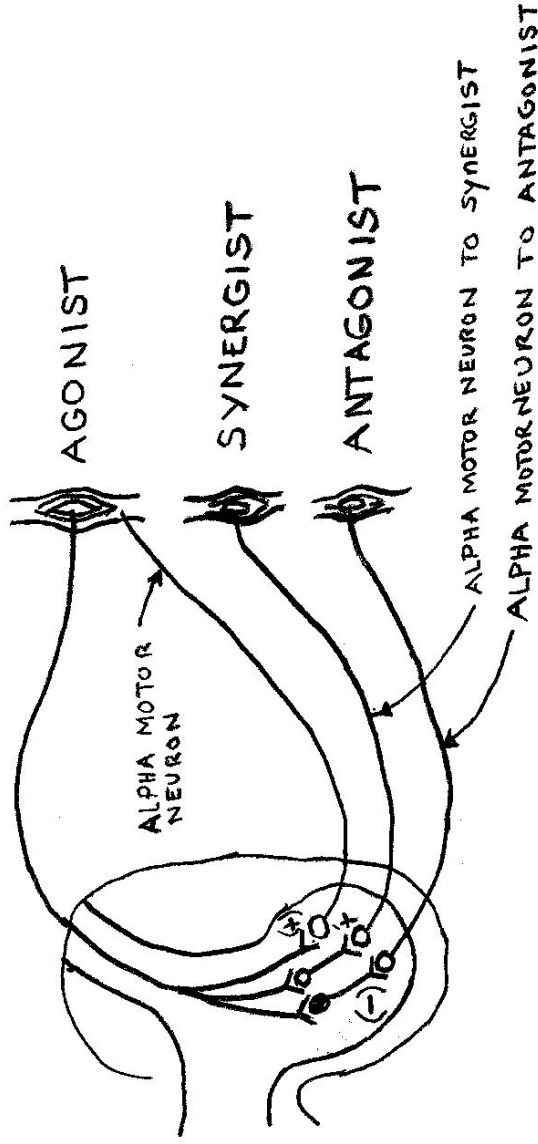
- "Stabilizers"
 - Uniarthrodial
 - Deep
 - Aerobic
(Slow oxidative fibers)
 - Performs holding
 - Best suited for CKC exercise
 - HATES the lengthened range because this range inhibits
- (secondary fibers turn them off)
- Techniques best suited for promoting static stability: SHRC, AI, RS

Ex> Gluteus maximus

Vasti (of quad)
Rotatores, Multifidus
Soleus
Medial & lateral triceps

Wiring Diagram

For the primary (Ia) and secondary (II) afferent nerve fibers when referring to PHYSIOLOGICAL FLEXORS.



□ Excitation of the Ia sensory nerves via a quick stretch or maintained stretch or a slow and sustained stretch to the secondary (II) fibers results in:

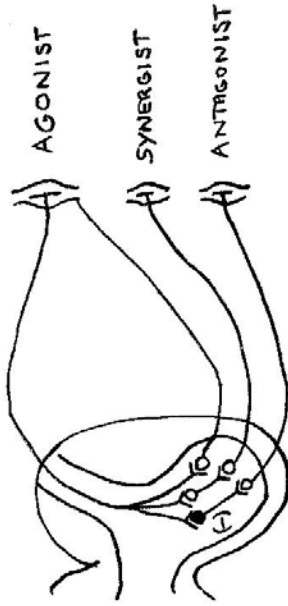
- ✕ AUTOGENIC FACILITATION TO AGONIST/SYNERGIST
- ✕ RECIPROCAL INHIBITION TO ANTAGONIST

★ This phenomenon occurs with the Ia's and the secondary II fibers when referring to physiological flexors.
 ★ Effect is transient with the primary Ia's and is reinforced by the II's influence.

* Practical Significance - Passively stretching the hamstrings (which are physiological flexors) by quick or maintained/sustained stretch excites the primary Ia's and the secondary (II's) which in turn causes autogenic facilitation to hamstrings, which is what you want to avoid when the goal is stretching

Wiring Diagram

for The primary (Ia) and Secondary (II) afferent nerve fibers when referring to PHYSIOLOGICAL EXTENSORS

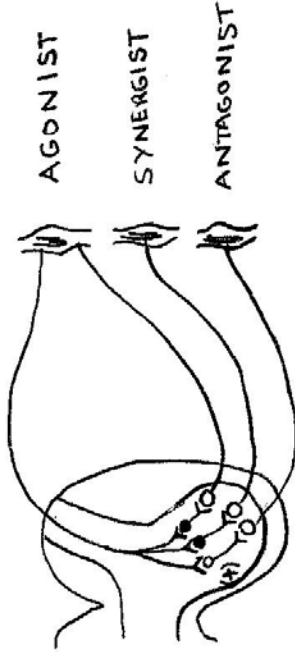


⇒ Excitation of the Ia sensory nerves via a quick stretch or maintained stretch or a slow and sustained stretch to the secondary (II) fibers results in:

- ▲ AUTOGENIC FACILITATION TO AGONIST/SYNERGIST
- ▲ RECIPROCAL INHIBITION TO ANTAGONIST

⇒ This phenomenon **ONLY** occurs with the Ia's influence but if the stretch is sustained the secondary (II) fibers override the primary Ia's influence (see picture on right).

⇒ Effect is transient.



⇒ Excitation of the secondary nerve fibers via a sustained stretch results in:

- ▲ RECIPROCAL FACILITATION TO AGONIST/SYNERGIST
- ▲ AUTOGENIC INHIBITION TO ANTAGONIST

This is also the wiring diagram for the GTO which is excited via sustained tension.

* Practical Significance—On a flexibility standpoint, the quadriceps (specifically the vasti) are physiological extensors and are thus easy to inhibit, so passive stretch to these muscles can be effective. On a strength standpoint, however, the quadriceps (vasti) do not like the lengthened range because they are inhibited via the secondary fibers influence*, so it would be unwise to work a weak patient in the lengthened range (i.e., sit to stand) in the beginning. A better strategy is to work in shortened range first, then ↑ range gradually.

PNF Concepts—Sherringtonian Concepts

Sherrington's Concepts consists primarily of 3 key principles:

- Irradiation
- Reciprocal innervation
- Successive induction

Our demonstration utilizes all 3 principles in order to promote an increase in hamstring length.

The definition of Sherrington's principles will make more sense, however, if they relate to a concrete example, which in this case, to increase hamstring length. Thus, the following definitions take into account the intent to increase hamstring length.

Note: The position in which we chose to improve hamstring length is one that utilizes a mass pattern of movement—chop to the right in long sitting.

IRRADIATION—Taking advantage of strength to help weakness (overflow). By using Timing for emphasis (TE) in the stronger segments of the chop (i.e., head and right extremity*) you can accomplish "overflow" to weaker segments (i.e., hip flexors*).

RECIPROCAL INNERVATION (INHIBITION)—When one set of motor neurons is stimulated, those neurons that control antagonistic muscles are inhibited. By flexing the trunk/head/neck during the chop to the right you promote reciprocal inhibition to the antagonistic pattern. This leaves the extensors inhibited and strengthens the flexor side which is what you want which promotes active motion to support NEW range. Reversing techniques are best suited for promoting reciprocal inhibition (SR, SRH).

SUCCESSIVE INDUCTION—This law states that if I move a patient in one direction it will facilitate the other side. So an active contraction in one direction helps the active contraction of the other. By preceding the agonist pattern (chop to the right) with the antagonist pattern (reverse chop to the left) you strengthen the agonistic side.

*The stronger and weaker segments may differ from patient to patient.

Advantages in using Sherringtonian concepts (compare and contrast to passively stretching hamstrings)

- If you stretch the hamstrings passively (with leg on shoulder) or do a hold/relax technique and then passively stretch you can get more motion but you leave the hamstrings facilitated. This can give the patient more of a stretch during a treatment session but by the next session the patient may be just as tight or even tighter because you left him/her facilitated in the hamstrings through Ia and II facilitation, especially if you passively stretch and hold him.
- It would be better to leave the patient facilitated on the flexor side by doing a SLR than doing it passively because patient will keep the stretch longer due to reciprocal inhibition (i.e., hold/relax to the agonist [hip flexors] with matching resistance, not max resistance as this would promote GTO firing and would shut down the hip flexors).
- When doing hold/relax and then passive stretch, since this is unilateral, you have to take the time to do both legs individually. Whereas, with the mass pattern technique, you get both legs at once.

Summary

If you do hold/relax to the antagonist or hamstrings (autogenic inhibition), that is fine, but immediately follow it with hold/relax to the agonist or hip flexors (reciprocal inhibition). This promotes inhibition to the hamstrings via a contraction of the hip flexors. This will help the patient keep the result for a longer time because the patient is left facilitated on the correct side (hip flexors) and functionally you are promoting strength in the new range that has been achieved.

BOTTOM LINE

WHAT GOOD IS STRETCHING A MUSCLE PASSIVELY (EITHER ON YOUR OWN OR HOLD/RELAX TO THE ANTAGONIST [HAMSTRING]) IF YOU CAN'T SUPPORT THIS NEW RANGE ACTIVELY.