Proprioceptive Neuromuscular Facilitation

An Historical Perspective

Proprioceptive Neuromuscular Facilitation (PNF) is an approach to patient care, which as originated in the 1940's by Herman Kabat, M.D. Maggie Knott joined him in his efforts to discover and define the approach in the late 1940's. They soon began to teach PNF to graduate physical therapists from all over the world. Dorothy Voss was one of the first students in this program and upon completion of the program, she joined Maggie's staff and together they wrote the first edition of the PNF book.

The principles, philosophy and procedures of PNF were developed from and are based on the principles of human anatomy, physiology, growth and development, kinesiology, behavioral sciences and neurophysiology. To be effective in the application of the principles and procedures of PNF, one must understand efficient function and develop the skill to assess posture and movement. From this assessment, one determines the identified dysfunction through manual and observational means. This assessment directly influences treatment, which is a coordination of manual and verbal skills to facilitate improvement in the patient's function. Intuitive and problem solving abilities are necessary to adapt treatment to each patient's needs.

PNF was not only intended to be a neuro-developmental approach. In fact, the first edition of the PNF text was categorized by Physical Therapy educator's as therapeutic exercise. It was not until the second edition in the 1950's that the true potential of PNF in the rehabilitation of neurologic dysfunction was recognized. Many therapists continue to consider PNF a neuro-developmental approach. In truth, PNF is a movement system approach, reaching across all diagnoses to focus on the restoration of function. PNF, through its sensory augmentation and techniques of application, retrains the characteristics of neuromuscular efficiency, thereby enhancing balance, posture, motion, and intention.

PNF is based on the premise that sensory input in often distorted for patients with movement system dysfunctions. This distortion leaves the patient with inadequate information with which to respond. Through PNF, the therapist makes a sensory experience to facilitate the appropriate motor response. PNF cannot restore synaptic connections. It can, however, capitalize on the existing

or residual pathways and allow the expression of the patient's true potential as opposed to his apparent potential.

Poor sensory input is not the only inhibitor of function. Habits, genetic pre-determinants, musculoskeletal variance and the environment can compromise the efficiency of the movement system. There is not a single patient that comes into his present dysfunction without pre-dysfunction inefficiencies in balance, posture, motion, and intention

PNF assumes nothing about the patient, except that each patient has untapped potential for improvement. The assessment hinges on identifying what the patient has that relates to what the patient needs.

The PNF motto is guidance, resistance, and repetition. Treatment is progressed in a logical, structured manner. Every activity relates to the goal of that specific treatment. Each activity is a logical progression from the preceding activity and leads to the next activity.

PNF:

Utilizes the patient's strengths to reconnect with the patient's untapped capacity
Progresses to training the deficient element directly
Simplifies the function into its sub-component when necessary, then rebuilds the sub-components back to the complex task
Reduces sensory augmentation systematically
Reinforces independent function through repetition.

The Name PNF

Proprioceptive: Sensory receptors which are stimulated by some aspect of muscle length or tension, joint angle, either stationary or moving, and by head position.

Neuromuscular: Pertaining to nerves and muscles.

Facilitation: Increase ease of performance of any action.

It is unfortunate that Dr. Kabat named this approach Proprioceptive Neuromuscular Facilitation. That name has served as a source of confusion for far too long. The proprioceptors play a role in the approach's sensory modulation, but are a small part of the total sensory input controlled through

PNF. Cutaneous receptors, muscle spindles, golgi tendon organs, joint receptors, vestibular receptors, visual and auditory channels and the conscious will of the patient are brought into play with each application of PNF. "Facilitation" is also misleading, for the strength of this approach lies as much in its ability to inhibit errant responses as in its ability to heighten deficient ones.

PNF in The Treatment Of The Movement System

The premise of the movement system is that movement is not as elementary as the simple transition from place to place. Rather, movement is an integrated system of subcomponents. Each sub-component supports the system as a whole. For function to occur, all sub-components must interact and reinforce the functional attempt. It is the quality of the sub-components that must be assessed and treated.

The sub-components of the movement system are:

1. Balance: Controlling the center of mass over the base of support during both static and dynamic activities.

2. Posture: The alignment of the body's segments trunk and extremities to support efficient function and prevent injury.

3. Motion: The position adjustment of a body segment in preparation for/contributing to function goal attainment.

4. Intention: The conscious or kinesthetic perception of the desired motion.

The Premises and Practices of PNF are Supported by the Current Literature

1. Sensory input serves as a fundamental component of motor learning (Asanuma, 1984)

2. Somatosensory combined with visual input appears to lay an important role in motor learning, while auditory input plays a far lesser role

3. Complex motor tasks are learned in movement segments, which are then retrieved/combined to form the complex task. (Asanuma, Keller, Kami)

4. Motor retention is enhanced by progressively increasing the degree of difficulty of the motor task. (Jarus)

5. Improvement of synaptic efficacy, through the development of long term potentiation occurs through repetition, and produces and more skilled performance. (Sakamoto, Asanuma, Iriki)

6. Inhibition of unnecessary muscle activation allows skilled performance to develop. (Basmajian, Hultborn)

7. The conscious involvement/participation of the learner enhances functional recovery. (Robertson)

PNF: The Basic Principles

The basic principles are the foundation for the evaluation and treatment of the patient. While they serve as the foundation for PNF, they can be easily integrated with the principles of other schools of manual therapy and neuro-developmental treatment. The reason for the utilization of the basic principles is to enhance the postural response or movement patterns of the patient, improve manual skills, and create consistency in treatment, thereby decreasing potential for error. The goal of treatment is to facilitate or "make easy" the desired movement or posture.

1. Manual Contacts
Motor responses are influenced by manual contacts in the cutaneous region related to the specific muscle or motion desired. The therapist can enhance the power and direction of the response through the appropriate use of manual contacts to stimulate the skin and deeper receptors. The specific contact must be directly over the desired muscle or on the skin surface relating to the direction of the desired motion. Contact with the adjacent or antagonistic surfaces reduced the patient's response and ability. Additionally, the patient's level of confidence in a therapist is often influenced by the manner in which a therapist touches a patient.

Appropriate manual contact is best accomplished by using the intrinsics of the hand and avoiding the use of the long finger flexors. This intrinsic grip is referred to in PNF as the lumbrical grip. The lumbrical grip decreases the potential for grabbing the patient or touching too many surfaces. The contact surfaces should be the palm, especially the thenar and hypothenar eminences and the finger pads-- not finger tips. The amount of contact depends on the body part being treated and the size of the patient. The grip should be comfortable and not painful -- pain inhibits appropriate response!

The appropriate location for manual contact should be identified. The correct contact is that specific point which facilitates the desired contraction in the

desired direction. A general guideline is to choose a surface, which faces directly into the desired line of movement.

Therapist Body Position and Mechanics

Proper manual contact allows the therapist to most efficiently move the body segment or the apply resistance. The therapist should be positioned in line with the motion, taking care to position the center of gravity behind and in line with the direction of the motion. In this manner, resistance comes from the body. This allows for smoother modulation of resistance than the arms can accomplish. The relaxed arms of the therapist can better translate the resistance and evaluate the patient's motion response. The slightest deviation from the correct position can alter the motor response.

1. The therapist's body should be positioned at either end of the desired movement, with the therapist's shoulders and hips facing in the direction of that movement.
2. The therapist's forearms should always be pointed in the direction of the desired movement.
3. The therapist's spine should be positioned in neutral throughout the movement.
4. The therapist's body moves through the same excursion and arc of motion as the body part being treated.

Appropriate Resistance

Through the application of appropriate and variable resistance, the therapist evaluates the patient's response to real life situations. When the challenge of an activity is low, the Human response has infinite variety. When a true challenge is presented, each individual responds according to his own preferred pattern of recruitment. How he balances and moves have been developed over a lifetime and are often inefficient.

Resistance is used in PNF to clarify the desired recruitment pattern and to facilitate the desire smooth and coordinated contraction.

1. Resistance is used to evaluate and facilitate two different types of muscular contraction-isotonic and isometric.

A. Isotonic contraction is a contraction in which the intention is movement.

1. Concentric-shortening contraction
2. Eccentric-controlled lengthen contraction
3. Stabilizing Isotonic -concentric contraction in which the therapist allows only minimal motion to occur. Typically considered a PNF term" which is often confused with isometric. The difference is that the intention is movement.

B. Isometric contraction is a contraction in which the intention is to maintain a position in space against resistance.

2. Resistance serves as the means of creating the reinforcement tool of irradiation. Irradiation is defined as the overflow of excitation from stronger components to weaker or inhibited components. Irradiation cannot occur without effort. Effort can be carefully directed through appropriate resistance, positioning and pattern selection. Effort can be misdirected through uncontrolled habits that are allowed to continue.

3. Resistance is varied by the therapist to facilitate the appropriate response depending on the functional goal. Treatment can be directed toward the improvement of coordination, ROM, strength, initiation, stabilization, or relaxation.

Traction and Approximation

Traction is an elongation force to the segment utilized to facilitate motion. This stretch placed on the muscles serves as a reflex enhancement of the voluntary response to resistance. It is unclear whether traction also serves as distraction and thereby acts on the joint receptors as well.

Approximation is a compression force to the segment utilized to facilitate stability. Nerve endings within the joint capsule and ligaments are stimulated during approximation and reinforce co-contraction.

Both traction and approximation rely on muscle and joint receptors and must be combined with resistance to produce a volitional response. In both cases, pain is avoided and underlying pathology in considered.

Quick Stretch

Volitional control can be enhanced through the use of spinal reflexes. PNF combines stretch stimulus with the stretch reflex to produce a facilitator cue termed quick stretch.

Stretch stimulus, as defined by Gelhom, refers to the muscle's increased responsiveness to stimulation via muscle elongation. Stretch reflex is a monosynaptic spinal reflex whereby the rapid elongation of a muscle stimulates the muscle spindles within the muscle, which subsequently cause that muscle to contract.

By placing the muscle in an elongated position and superimposing a further quick but gentle stretch, a reflex contraction can be elicited. This stretch is only a reflex and cannot produce a volitional response unless combined with resistance. The quick stretch must always be given to a taut muscle and may be applied at the beginning of the range or superimposed upon a pre-existing contraction.

Verbal Commands

Verbal commands, combined with manual contact, provide the therapist with one of the primary tools for establishing communication and cooperation. Verbal commands should be simple, concise, audible, and specific to the desired contraction. The quality of the verbal command significantly influences the appropriateness of a person's response.

The tone of the verbal command is perhaps more important than the command itself Soft and soothing or crisp and commanding produce two very different responses. The intention of the verbal commands should be selected as carefully as the manipulation of a spinal segment.

Visual Cues

Teaching a motor activity relies heavily on the ability of the learner not only to feel, but also to watch the motor performance being executed. During PNF, vision is incorporated whenever, possible, directing the patient's gaze to an appropriate landmark. This inclusion of the head in functional activities reinforces the incorporation of the entire trunk and extremities.

Patterns of Facilitation

The natural arcs of motion in PNF are in keeping with the anatomical way muscles spiral from origin to insertion. The patterns of PNF were first identified by watching athletes perform under high demand situations. It was found that the maximal response to resistance, quick stretch traction, and approximation are found in specific patterns or positions.

While most therapists think of patterns when they think of PNF, these patterns were the last addition to the approach. Exercise up to that point had solely been carried out in cardinal planes. Cardinal plane motion is much more "forced" than that found in human motion.

The patterns are narrow in relationship to the central axis of the trunk. Each pattern consists of three components: Flexion/extension (lengthening /shortening in the trunk) Abduction/adduction (Crossing of midline in the trunk).

Proprioceptive Neuromuscular Facilitation

Trunk Patterns

Anterior Depression of the Scapulae/D2 Ext-Add-Int Rotation

Facilitates:
1. Anterior trunk shortening
2. Anterior chest muscle relaxation
3. Abdominal recruitment
4. Irradiation to upper trunk, pelvic girdle, neck flexion, LE flexion, and UE extension

Functional Activities:
1. Use of assistive device
2. Forward rolling
3. Sitting/standing balance
4. Abdominal bracing
5. LE Swing phase

Posterior Elevation of the Scapulae/D2 Flex-Abd-Ext Rotation

Facilitates:
1. Anterior trunk lengthening
2. Irradiation to upper trunk, pelvic girdle, neck extension, UE flexion
3. Cervical-thoracic mobilization

Functional Activities
1. Backward gaze and reaching
2. Backward rolling
3. High posterior reaching (sports)
4. Posterior grooming

Anterior Elevation of the Scapulae/DI Flex-Add-Ext Rotation

Facilitates:
1. Posterior trunk elongation
2. Irradiation to upper trunk, UE high reaching, neck extension with rotation, pelvic girdle depression, LE extension
3. Shoulder elevation on a stable trunk

Functional Activities:
1. High anterior reaching
2. Forward arm swing
3. Reciprocal trunk motion
4. Forward rolling

Posterior Depression of the Scapulae/ DI Ext-Abd-Int Rotation

Facilitates:
1. Posterior trunk shortening
2. Efficient rest position of shoulder girdle
3. Irradiation to tonic spinal stabilizers

Functional Applications:
1. Reciprocal trunk motion in gait
2. Pushing up from a chair
3. Backward reaching
4. Carrying objects safely

Anterior Elevation of the Pelvis/ DI Flex-Add-Ext Rotation

Facilitates:
1. Anterior lower trunk shortening
2. Abdominal and hip flexor recruitment
3. Irradiation to neck flexors, upper trunk flexion, anterior depression of shoulder girdle

Functional Activities:
1. Sitting/standing balance
2. Abdominal bracing
3. Swing Phase in gait
4. Forward rolling

Posterior Depression of the Pelvis/ DI Ext-Abd-Int Rotation

Facilitates
1. Trunk lengthening
2. Extension of the LE
3. Irradiation to anterior elevation of scapulae, UE extension

Functional Activities

1. Come to stand
2. Stance phase, toe off
3. Sitting/ standing balance
4. Weight shift/ weight acceptance

The Techniques of PNF

1. Rhythmic Initiation
Applications: Relaxation Initiation Speed Variability Directional Control Power and Strength of the Response Smoothness of the Motion Crossing of Midline Awareness of Position in Space Method: Motion begins passively, progresses to active-assisted, to active, then resisted. Progression is allowed only at the rate that the patient can maintain the speed, power, and direction as set by the therapist. In this manner, the patient is given a kinesthetic template for the motion.

II Reversal of the Agonist
Applications: Reciprocal movement Endurance Active and Resisted Range of Motion Smoothness of the Motion Concentric Control Method: Concentric performance of one direction of a pattern, followed at its end range by a demand to perform the antagonistic direction of motion. A "hold" can be performed at the end of a direction prior to the reversal.

III. Repeated Quick Stretch Applications: Initiation Directional Control Power and Strength of the Response Low Tone Concentric Control Motivational Endurance Crossing of Midline Method: From the elongated portion of the range: The segment is brought into the fully lengthened range. A quick stretch is applied and followed immediately by resistance. As the response dies, the segment is brought back into the lengthened range and stretch/resisted again. With each repeated quick stretch, the segment will tend to go further into the range. In this fashion, reflexly augmented volitional range can be increased.

Quick Stretch Superimposed on an Existing Contraction: Prior to the point in the range when the movement alters direction or weakens, a quick stretch can be superimposed on the contracting muscle. This will facilitate the correct muscles to fire and add power or redirect the motion.

IV. Combination of Isotonics
Applications:

- Endurance
- Power and Strength
- Tension and Rest
- Soft Tissue and Articular Range
- Awareness of Position in space
- Directional Control

Method: Motion starts with the patient's strongest type contraction and in the patient's strongest part of the range. Once the activity is begun, the patient does not relax but rather performs concentric, eccentric and holding contractions in a sequence determined by the therapist. In this manner, irradiation has an opportunity to support the activity.

The patient gains a full experience of the motion. The muscles have a full opportunity to work and therefore, will relax more completely after the activity.

V. Stabilizing Reversals
Applications: Stabilization at any Portion of the Range Isometric Recruitment and Gradation Endurance Awareness of Position in Space Method: The patient or segment is placed in the desired position. Approximation is applied to provide reflex support to the activity. Resistance is built slowly and the patient is instructed to match the contraction, not to push.

Once the patient is responding to the resistance, the therapist always:

1) leaves one hand on the surface to supply resistance and sustain irradiation;
2) slowly decreases the resistance from the other hand until it can be removed from the surface;
3) repositions the non-resisting hand;
4) builds the resistance until the patient is again responding to both hands.

By always having at least one resisting hand, irradiation can build and recruit the patient's full potential. Positioning on antagonistic surfaces better facilitates deep tonic muscles. By positioning at random point about the segment or body, the patient gains awareness of the entire body.

VI. Relaxation Techniques
Application

Increase Range of Motion
Decrease Muscle Tone
Decrease Pain

Method: Contract -Relax-At the point of limitation within the pattern, resistance is given to a concentric contraction of either the agonist or the antagonist. All components of the pattern are resisted allowing a few degrees of motion. The contraction is followed by complete and total

relaxation. Then, either passively or actively, the segment is moved into the increased range.

Hold-Relax-This technique utilizes an isometric contraction, therefore, the contraction is built and released slowly. All components of the pattern are resisted with the appropriate amount and duration of resistance for the patient. The contraction is followed by complete and total relaxation. If appropriate, the segment may then be moved actively or passively to a new range or the techniques may be repeated without motion to gain further relaxation or pain reduction.

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Upper Extremity Patterns

D-1 Flexion-Adduction-External Rotation

- Fingers Flex and Adduct
- Thumb Ext. Rotates, Flexes, Adducts
- Wrist Supinates and Flexes
- Forearm Supinates
- Elbow Flexes (or Extends)
- Shoulder Flexes, Adducts, Ext Rot.
- Scapular Anteriorly Elevates

D-1 Extension-Abduction-Int. Rotation

- Fingers Extend and Abduct
- Thumb Extends, Abducts, Int. Rotates
- Wrist Pronates
- Forearm Pronates,
- Elbow Extends (or Flexes)
- Shoulder Extends, Abducts, Int Rotate
- Scapular Posteriorly Depresses

D-2 Extension-Adduction-Int Rotation

Fingers Flex and Adduct
Thumb Flexes, Abducts, Int Rotates
Wrist Pronates and flexes
Forearm Pronates
Elbow Remains Straight (or Flexes)
Shoulder Extends, Adducts, Int Rotate
Scapular Anteriorly Depresses

D-2 Flexion-Abduction-External Rotation

Fingers Extend and Abduct
Thumb Extends, Adducts, Ext Rotates
Wrist Supinates and Extends
Forearm Supinates
Elbow Remains Straight (or Flexes)
Shoulder Flexes, Abducts, Ext Rotate
Scapula Posteriorly Elevates

Lower Extremity

D-1 Extension-Abduction-Int Rotation

- Toes Flex
- Foot and Ankle Plantar Flex
- Knee Remains Straight (or Flexes)
- Hip Extends, Abducts, and Int Rotates
- Pelvis Posteriorly Depresses

D- 1 Flexion-Adduction-External Rotation

- Toes Extend
- Foot and Ankle Dorsiflex and Invert
- Knee Remains Straight (or Flexes)
- Hip Flexes, Adducts, Ext Rotates
- Pelvis Anteriorly Elevates

D-2 Flexion-Abduction-Internal Rotation

- Toes Extend
- Foot and Ankle Dorsiflex and Evert
- Knee Remains Straight (or Flexes)
- Hip Flexes, Abducts, Int Rotates
- Pelvis Anteriorly Depresses

D-2 Extension-Adduction-Ext Rotation

- Toes Flex
- Foot and Ankle Plantar Flex & Invert
- Knee Remains Straight (or Flexes)
- Hip Extends, Adducts, Ext. Rotates
- Pelvis Posteriorly