A Brief General Outline of some of the Neurophysiology which is The Basis of Facilitatory Techniques

By N. LENNARD, B.Sc.(Phys.) (Rand)

(1) THE AIM OF THE PAPER

The aim of the paper is to give a brief outline of some of the neurophysiology which is the basis of many facilitatory physiotherapy techniques. An indication will be given of how these neurophysiological principles are used for practical techniques. The paper is intended to be a preparation for the visit of Miss Rood to South Africa.

(2) THE NEUROPHYSIOLOGICAL BASIS FROM WHICH PRACTICAL TECHNIQUES HAVE BEEN DEVELOPED

Techniques are based on the knowledge and use of:

(i) Sensory motor systems of the body.
(ii) The developmental sequence.
(iii) The stimulus of the Psyche.
(iv) Sensory and proprioceptive stimulation.
(v) The developmental reflexes and reactions.
(vi) Repetition and repetitive rhythm patterns.

(a) The Sensory Motor Systems of the Body

Practical Techniques facilitate:

(i) the sensory motor system which stimulates voluntary muscle, its postural responses and patterns of fine co-ordination.

and

(ii) the autonomic nervous system which relates to the protection of the body and the maintenance of the body.

In order to clarify some of the techniques developed by Miss Rood the following classification of voluntary muscle is given.

Miss Rood divides the voluntary muscles into

(i) Heavy work muscles.
(ii) Light work muscles.

Some of the points relevant to this classification are listed below.

Heavy Work Muscles

Red muscles, i.e. anti-gravity long acting postural muscles.
Usually one-joint extensors.
Lower threshold to stretch.
Static response to stretch.
Lower innervation rate.
In tonic neck reflexes the heavy work muscles respond first.

Light Work Muscles

White muscles, i.e. paler than the red muscles of fine co-ordination.
Usually two-joint flexors.
Higher threshold to stretch.
Phasic response to stretch.
Higher innvervation rate.
Respond in the flexor withdrawal reflex.

Miss Rood's technique stresses the difference between the autonomic responses of the sympathetic and the parasympathetic nervous systems.

Some of the differences are listed below.

Miss Rood makes the point that hypotonic somnolent patients respond well to stimulation of the sympathetic nervous system whereas athetoids become wilder. She has used stimulation of the parasympathetic nervous system to terminate a seizure or for hyperkinetic, hyperexcitable patients or for athetoids.

SYMPATHETIC-protection of the Body

(i) Heightened emotions due to increase in glandular output. Increased alertness and vitality due to increased blood supply to the brain and spinal cord.
(ii) Inhibition of peristalsis—due to decreased blood supply to the viscera.
(iii) Improved function of voluntary muscle—due to increased blood supply.
(iv) Increase in breathing rate and depth.

PARASYMPATHETIC-maintenance of the Body

(i) Dimunition of awareness of sensory stimuli and the promotion of sleep due to decreased blood supply to the brain and the spinal cord.
(ii) Increased peristalsis, increased metabolism and increased body temperature—due to increase in blood supply to the viscera.
(iii) Relaxation of voluntary muscle—due to decreased blood supply.
(iv) Slow regular shallow breathing.

(b) The Developmental Sequence

Many physiotherapy techniques have for many years recognised the significance of the following points:

(*a*) Control of the body develops in a cephalo-caudal direction.
(*b*) Each stage of development is a preparation for the next stage.
(*c*) Movements are inter-related and interdependent, e.g. (1) *if the head control is poor, arm function will be poor.* (2) *in the adult patient the hand gives direction to the arm.*
(*d*) Limb control develops from proximal to distal.
(*e*) Sensory stimuli are responsible for the first reflex responses.
(*f*) Sensory stimuli activate the first developmental reflexes and responses which preceed voluntary movement.
(*g*) The first movements are simple and progress to become more complex.

Miss Rood believes that:

(1) Movements come under control in the following order:
(*a*) flexion (*c*) adduction (*e*) rotation.
(*b*) extension (*d*) abduction
(2) Limbs come under control in the following order:
(*a*) Static positions.
(*b*) Bi-lateral movements.
(*c*) Antagonists reciprocally.
(*d*) Antagonists and agonists synergistically, e.g. heavy grasp pattern.
(*e*) Torsion, i.e. pronation and supination and rotation.

Miss Rood refers to developmental sequences as onto-genetic motor patterns, *see Chart No.* 1.

(c) The Stimulus of the Psyche

All therapists are aware of the fact that patients need motivation. They also need to be protected from frustration and failure. They need the reward of success in reaching the goals set and it is therefore very important to work within the limit of the patient's ability. Miss Rood has said that patients become belligerent or withdrawn depending on whether "fight or flight" are dominant, if they are not wisely and kindly handled. Physically handicapped patients are often emotionally or even intellectually handicapped and self control needs to be developed in all planes.

ONTOGENETIC DEVELOPMENTAL PATTERNS

Reproduced from notes from Miss Rood's course.

1. Withdrawal-supine

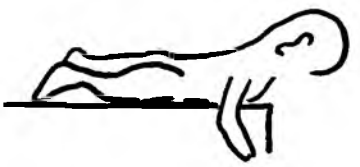
   Heavy work of trunk, neck, proximal regions of extremities; motion occurs towards T10; reciprocal innervation pattern.

2. Roll over

   Flexion of upper and lower extremities on the same side.

3. Pivot prone

   Bilateral holding of proximal extensors in shortened range; reciprocal innervation pattern.



4. Cocontraction of neck

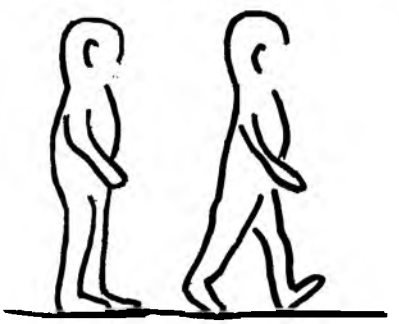
   Cocontraction of neck extensors and flexors; thoracic extension.

5. On elbows

   Scapular cocontraction; glenohumeral joint cocontraction; pushing backward.

6. All fours

   Weight shifting backward-forward, side to side, alternate arm and leg; creeping



7. Standing

   Static
   Shifting weight

8. Walking

   Stance
   Push off
   Pick up
   Heel strike.

Chart 1

(d) Sensory and Proprioceptive Stimulation

The statement that sensory stimuli activate the first motor responses has already been made.

Therapists who use sensory stimulation bombard the sensory motor system with more afferent impulses than normal.

Therapists who use the term facilitatory sensory stimulation are talking of summation in neurophysiological terms, i.e. when two or more subliminal afferent impulses arrive at a synapse simultaneously, the effects may overlap and summate and together reach threshold level. This is known as spatial summation. When several stimuli arrive at a synapse one after the other, the electrical effects summate—and may reach threshold. This is temporal summation.

A threshold stimulus results in a motor response.

Sensory stimulation is directed towards:

(1) *Dermatones*—area of skin supplied by a single segment.
(2) *Myotomes*—group of muscles supplied by a single segment.
(3) *Schleratomes*—area of bone supplied by a single segment.

Sensory receptors which have been successfully used by Miss Rood and others are:

Pain and temperature.
Light touch.
Pressure and proprioception and stretch.
Auditory and visual.

Pain Stimulation:

Miss Rood uses noxious stimuli, which are unpleasant stimuli below the threshold of pain, in order to stimulate the flexor withdrawal reflex and the crossed extensor reflexes, to stimulate flexor synergies and to stimulate the sympathetic nervous system.

The sensory motor effects of noxious stimuli—e.g. pinching may be summated with the effects of developmental reflexes and the effects of other sensory stimulation of flexor muscles, in order to facilitate the best results.

Miss Rood believes that stimulation of the crossed extensor reflex is basic to the reciprocal walking pattern, e.g. she places rather sharp pads on tricycle pedals in order to facilitate the reciprocal crossed extensor reflex response.

Temperature Stimulation

There are various ways of stimulating a response with ice, which is an extreme temperature.

Miss Rood uses ice cubes in two ways:

(i) Stroking with pressure in a distal to proximal direction and
(ii) three to four quick strokes.

In both instances the drops must be carefully blotted and the patient should be a neutral warmth, before starting.

The dermatome is all important.

(i) Miss Rood believes that ice cube stroking with pressure stimulates unmyelinated C fibres which conduct at $\frac{1}{2}$-2 mm per second and that the effect lasts 30-40 minutes. She stops before pain is experienced or the results are predominantly flexor withdrawal. The effect is for continuous contraction of voluntary muscle and for stimulation of the sympathetic nervous system. Superficial muscles respond best.

(ii) Three to four quick strokes with an ice cube are believed to stimulate A fibres. This technique is used mainly for patients with an inspiration problem. The dermatome T.7. on the anterior abdomen is the effective area and the effect is gasping. Miss Rood sometimes uses this technique on patients with rigidity where she wants a quick response from a muscle with reciprocal inhibition of the antagonist.

Other therapists have used ice packs for their sympathetic effects, chiefly for increasing circulation and reducing swelling.

Ice towels have been used in the belief that spindle activity is decreased by cold and superficial muscles are inhibited. Miss Rood believes that the effects of this technique do not last long and the inhibition must be reinforced with resistance techniques.

Complete immersion in ice is used for the same reasons as ice towels. Icing should be used with care over the posterior primary rami because of the effect on the autonomic nervous system, i.e. heart rate.

Light Touch Stimulation

Miss Rood uses two methods of stroking:

(1) Quick brush stroking—fast and repetitive in character and
(2) Slow light rhythmical stroking.

(1) Quick brush stroking is done according to dermatomes in order to facilitate muscle contraction and the stroking is in a distal to proximal direction. Two strokes per second at least 10 times is the best timing. Stop and repeat this later 3-5 times. The maximum reaction occurs 30-40 minutes later. This type of stimulation should precede other sensory stimulation because of the time factor.

Miss Rood believes that this type of stroking stimulates unmyelinated C fibres from the sensory receptors in the hair follicles. Fibres project to both sides of the cortex and the first results may be seen in the corresponding muscles on the opposite side of the body. The reaction is slow to start because the threshold is high but the after discharge is of long duration. Repetitive stimulation is important.

This type of stimulus is most effective for light work muscles but may be used over the belly of the muscle for muscles which do light and heavy work.

(2) Slow, light rhythmical stroking down the cutaneous distribution of the posterior primary rami for 3-5 minutes activates the autonomic nervous system. This type of stimulation has parasympathetic nervous system effects (see parasympathetic nervous system).

Miss Rood also believes that brushing of the mucous membranes of the tongue and palate and uvula stimulates some sucking and swallowing muscles.

Pressure and Proprioception and Stretch

This kind of stimulation is mainly for producing facilitation of heavy work muscles, according to Miss Rood. The application is proximal to distal. This technique may be facilitatory or inhibitatory according to how they are used.

A list of various kinds of stimulation which Miss Rood believes is effective follows:

(*a*) Finger or hand pressure on the muscle or its tendinous insertion facilitates the muscle. This is called Local sign by one technique.
(*b*) Mechanical pressure from a pad—convexity towards the muscle—placed on the muscle or its tendinous insertion facilitates.
(*c*) Dental Dan bands facilitate.
(*d*) Stretch pressure rubbing or squeezing facilitates.
(*e*) Pounding bone or muscle with the fist, a ball or sponge rubber button, facilitates according to the schelrotome or myotome.
(*f*) Joint compression of the bony prominences above the joint facilitates extension synergies.
Below the joint it facilitates flexion.
(*g*) Joint compression in weight bearing, equal to or less than body weight, facilitates flexion. More than body weight facilitates extension.
(*h*) Pressure over flexor muscles inhibits extensors.
(*i*) Lack of stretch inhibits a contracting muscle. Contraction against gravity or resistance facilitates.
(*j*) Traction facilitates flexors.
(*k*) Tapping muscles and tendons facilitates.
(*l*) Tapping a limb upward against gravity initiates a stretch response, when the limb drops due to the pull of gravity.

Much of the neurophysiology of the above techniques is common to one or more facilitation techniques.

Auditory and Visual Stimulation

Many physiotherapy techniques use auditory and visual stimulation in order to raise the general level of stimulation in the sensory and motor areas of the cortex so that the threshold will be lowered for desirable sensory motor responses, which the therapist is facilitating.

Miss Rood believes that fixation of the eyes is an important part of the optical righting reflex.

Many therapists believe that visual stimuli are an important part of hand-eye co-ordination and looking at and manipulating objects is usually relative to the morale of the patient.

A reflex response to light is to look towards the light and this may be used to facilitate head control. Bright objects attract infant attention and are a valuable adjunct to therapy.

Infants often look towards noise and clear cut commands effectively facilitate muscle responses.

(e) The Developmental Reflexes and Reactions

It has been previously stated that developmental reflexes and reactions often form the pattern of voluntary movements.

The following chart is an example of how the effects of several reflexes and reactions can summate in order to facilitate head control (see chart No. 2).

Many therapists and particularly Mrs. Bobath as well as Miss Rood have very effectively used the facilitatory and inhibitory effects of the developmental reflexes. Miss Rood uses the effects of pathological tonic neck reflexes and other primitive reflexes in order to augment a response which she feels is desirable for a patient.

(f) Repetition and Repetitive Rhythm Patterns

Almost all therapy techniques make use of either:

(i) phylogenetic developmental patterns—relating to the evolution of the species.

or

Developmental Progression	Position	Reflex	Method of Elicitation	Responses	Use
HEAD CONTROL	PRONE	SENSORY MOTOR RESPONSE	Sensory stimulation—icing stretch pressure tapping. Stroking dermatone for extensors of neck and back.	Reflex contraction of the extensor muscles stimulated	To promote extension of the head and neck
		AVOIDANCE RESPONSE	Tapping, tickling and stroking of the facial area applied:		
			(*a*) bilaterally	Extension of head and stabilisation of head and neck.	(i) Hypotonic infants unable to extend the head in prone. (ii) Hypertonic patients with increased flexor tone in prone, i.e. tonic labyrinthine reflex.
			(*b*) unilaterally	Extension and contralateral rotation of head neck and trunk.	A. infants who show signs of smothering B. Patients who rotate the head to a preferred side.
		MASS PATTERN EXTENSION	In prone lying the arms are held above the head and controlled from the shoulders. Slight elevation of arms and trunk causes stretch on the neck muscles and this initiates extension of the head. Small shaking movements are used to stimulate an additive stretch response.	Extensor pattern is completed and the head extends.	Extension of the head as above because the head tends to complete the extensor pattern of the rest of the body.
		LABYRINTHINE RIGHTING REACTION	In the mass extension position the patient is also moved up and down and laterally flexed and rotated, i.e. the head is moved through space.	The head extends into the vertical plane.	Reinforces the technique above.
		REFLEX AUDITORY AND VISUAL	To shine a light above the patient's head with the verbal command "Look at the light".	Extension of the head and neck.	Often used to reinforce the techniques above.

Chart No. 2

(ii) ontogenetic developmental patterns—relating to the developmental sequences in man.

Therapy techniques use phylogenetic and ontogenetic patterns because they are favoured by the synapses. The older phylogenetic patterns are even more favoured than ontogenetic patterns. J. C. Eccles experiments suggest that each succeeding time a stimulus passes a synapse, the terminal bouton becomes more efficient at producing chemical transmittor and the stimulus passes more easily. If a response can be facilitated once it will be facilitated more easily with each repetition. Repetition has an important place in every technique and the repetitive quality of reciprocal rhythm patterns is very effective because rhythm is also facilitatory.

3. CONCLUSION

Therapists who wish to use facilitatory techniques effectively must be familiar with both the background neurophysiology and with practical aspects of the technique.

Because Miss Rood's technique has such a vast coverage many facets of this fascinating technique have been omitted and readers are recommended to pay careful attention to the bibliography.

BIBLIOGRAPHY

American Journal of Physical Medicine, Vol. 46, February 1967, No. 1. Williams and Wilkins Co., Baltimore, U.S.A., 21202.

An Exploratory and Analytical Survey of Therapeutic Exercise. North Western University Special Therapeutic Exercise Project.

Neurophysiological Mechanisms utilised in the treatment of Neuro-muscular dysfunction. Margaret Rood, O.T.R.; R.P.T. Ajot × 4 1956, Part II.

Occupational Therapy in the Treatment of the Cerebral Palsied. Margaret Rood, M.A., O.T.R., P.T.R.

The Physical Therapy Review, Vol. 32, No. 2, Feb, 1952, Sept., 1954.

Neurophysiological Reactions as a Basis for Physical Therapy.

American Physical Therapy Association conference at Los Angeles. July, 1954.

Evaluation, *Physical Therapy Journal*, 511 and P.T. 368. Margaret S. Rood.

Concept of Response Mechanisms from Selective Stimulation of Sensory Receptors, P.T. DPT. U.S.C. Summer session, 1966. Margaret S. Rood.

Sequences of Stimulation for the Developmental Patterns. J. Huss, O.T.R., R.P.T. IUMC—Riley Hospital OT. Compiled May, 1962. Revised January 1964; January 1967.

Copenhagen Address of 1958 AJOT Convention Proceedings November-December, 1959. Margaret S. Rood.

Everyone Counts. Margaret S. Rood, November-December, 1959, AJOT.

Neurophysiological Review as a Better Basis for Understanding of the Rood Technique in treating Cerebral Palsy. Major R. Gregg, M.C., Physical Medicine Service, W.R.A.M.C., November, 1958.

A Study of Abnormal Postural Reflex Activity in Patients with Lesions of the C.N.S. Berta Bobath, F.C.S.P. Principal of the Western Cerebral Palsy Centre, London.

Proprioceptive Neuromuscular Facilitation. M. Knott and D. E. Vos. Hoeber Harper book.

Handbook of Physiology. Neurophysiology, Book. III, Skilled Movement, Paillard.

Concept of Normal Muscle Tone, Hypo- and Hypertonia. Walter C. Stolov, M.D.

Physical Medicine and Rehabilitation, March, 1966, Vol. 47, No. 3.

Rood's techniques: notes and diagrams lent to me by Freda Muller, O.T. (Rand).

Typing and checking. Miss G. Wilkinson, B.Sc. (Rand).

RECEPTORS IN MUSCLE

By P. B. C. MATTHEWS, M.A., M.D., D.Sc.
Lecturer in Physiology, University of Oxford, Student of Christ Church

(Reprinted with Author's permission and acknowledgement *to* Physiotherapy *Journal of C.S.P., June*, 1968, *Vol.* 54, *No.* 6)

We are normally quite unaware that we have 'sensory' receptors embedded in our muscles, yet they play a continuous part in the nervous control of our movements and they are also involved in the production of symptoms in certain neurological diseases. An example of their potency is provided by the recent finding that when a massage vibrator is firmly applied over the tendon of a normal human muscle, then the muscle contracts, or any pre-existing contraction is made more powerful than before. This occurs independently of any 'volition' on the part of the subject, though by an effort of will he can prevent a movement occurring. In a partially paralysed patient with a spastic paresis the effect of tendon vibration may sum with the effects of volition and allow a 'voluntary' movement to be produced which could not be produced before, and which is much stronger than any movement produced by the vibration alone. The effect of vibration is certainly a reflex from muscle receptors, and those responsible are probably the primary endings of the muscle spindles (see later). Again, if a patient with Parkinson's disease has dilute procaine solution injected at the motor point of one of his muscles, then the muscle will lose its characteristic rigidity even though its voluntary power is fully retained. Procaine injection thus produces a definite improvement in the state of the patient, albeit a temporary one. This effect results from a selective paralysis by the local anaesthetic of the specialised small motor nerve fibres to the muscle spindles, while the ordinary large motor fibres to the main mass of the muscle remain unaffected; local anaesthetics are well known to have a preferential action on small nerve fibres. In spastic children the epidural injection of dilute alcohol can produce a similar alleviation of the hypertonus lasting for a few weeks or months. Any massage of a muscle or manipulation of a joint must excite a variety of intramuscular receptors, and their activity may play a part in the alleviation of symptoms. Thus a knowledge of the nature and behaviour of muscle receptors is essential for a full understanding of much neurological disease and may provide a rationale for certain procedures in physiotherapy, though it must be admitted that a great deal more research needs to be done into 'clinical physiology' before we can claim at all a deep knowledge of such things. The rest of this article outlines the present state of knowledge about muscle receptors. Most of it has been obtained from electrophysiological studies on the cat, but in view of the similarity of their structure it is probable that human receptors behave in much the same way. In both man and cat less than half the medullated nerve fibres in a muscle nerve are ordinary motor fibres to the muscle fibres, while the rest are either motor or sensory to various muscle receptors.

TENDON ORGANS

The simplest of the receptors signalling the mechanical state of a muscle is the tendon organ which was first fully described by Camillo Golgi in 1880 and is now often given his name. Golgi tendon organs lie at both ends of a muscle at the musculo-tendinous junctions where the muscle fibres fuse with the tendon, or with the fascia from which they arise. It is important to realise that tendon organs are not restricted to the anatomically obvious portions of a tendon, and indeed it is doubtful if many at all are to be found in the main tendon. In structure, the tendon organ consists of a simple spray of nerve terminals arising from a large medullated afferent nerve fibre (Fig. 1). The spray lies on the strands of tendon and may be up to 1 mm. long. The function of the tendon organ is to record the tension set up