Acquisition du signal. Son contrôle. EMG en recherche

Master M2 ReClip, UE 2 : Jeudi 4 Décembre

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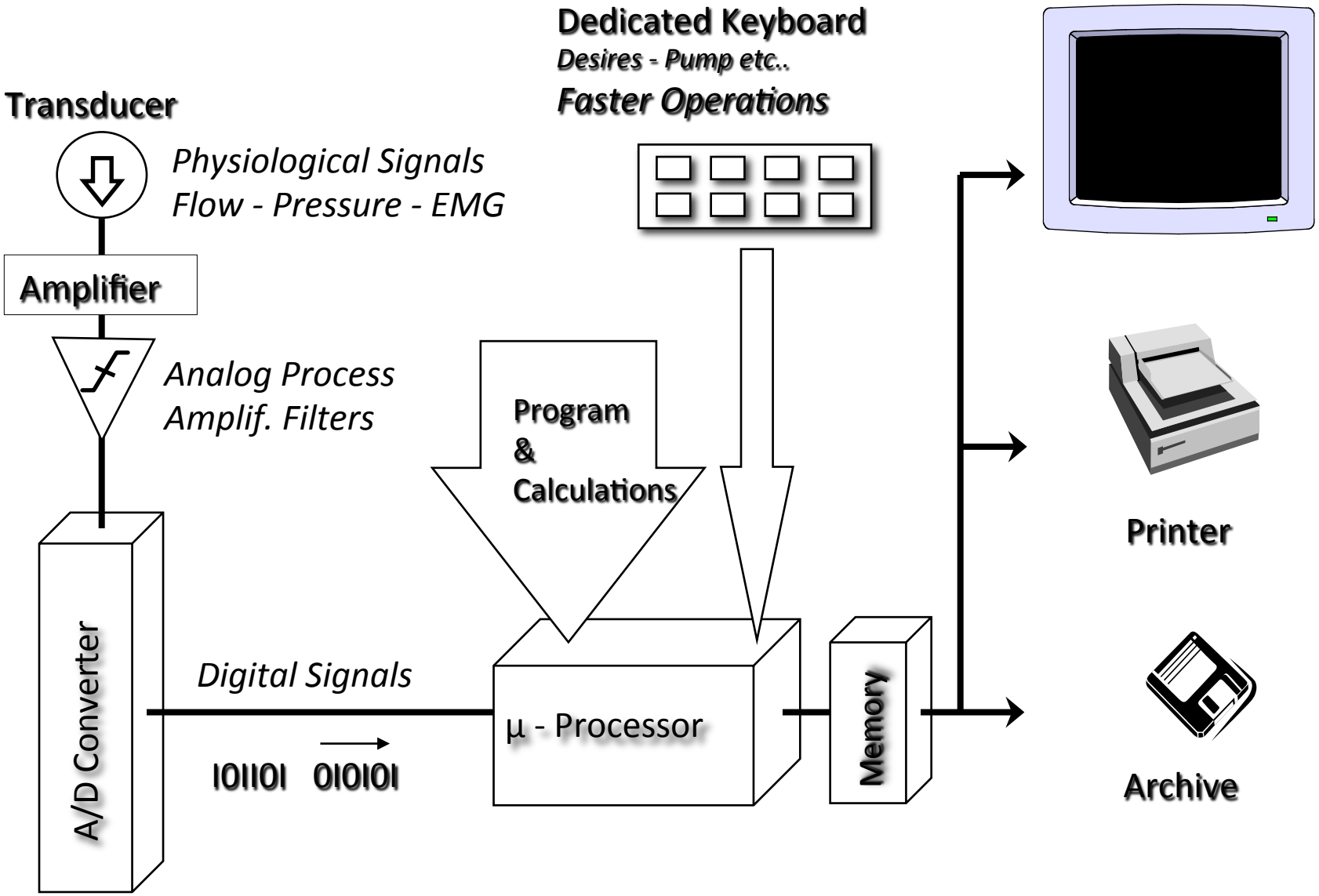
Université Pierre et Marie Curie

ASSISTANCE PUBLIQUE HÔPITAUX DE PARIS

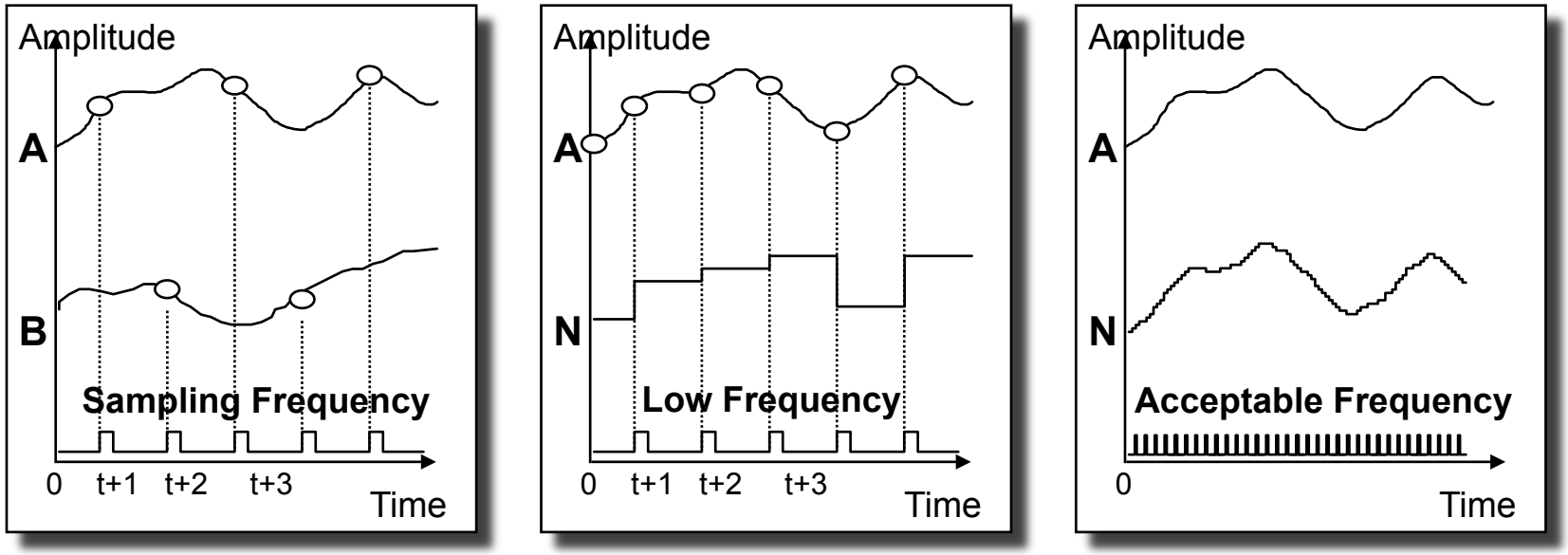
UPMC PARIS UNIVERSITAS

Equipment


Dedicated Keyboard
Desires - Pump etc..
Faster Operations
Transducer
Physiological Signals
Flow - Pressure - EMG
Amplifier
Analog Process
Amplif. Filters
Program
&
Calculations
A/D Converter
Digital Signals
IOIIOI OIOIOI
µ - Processor
Memory
Printer
Archive

Digital Conversion *Sampling*

Time Sampling of one or more magnitudes



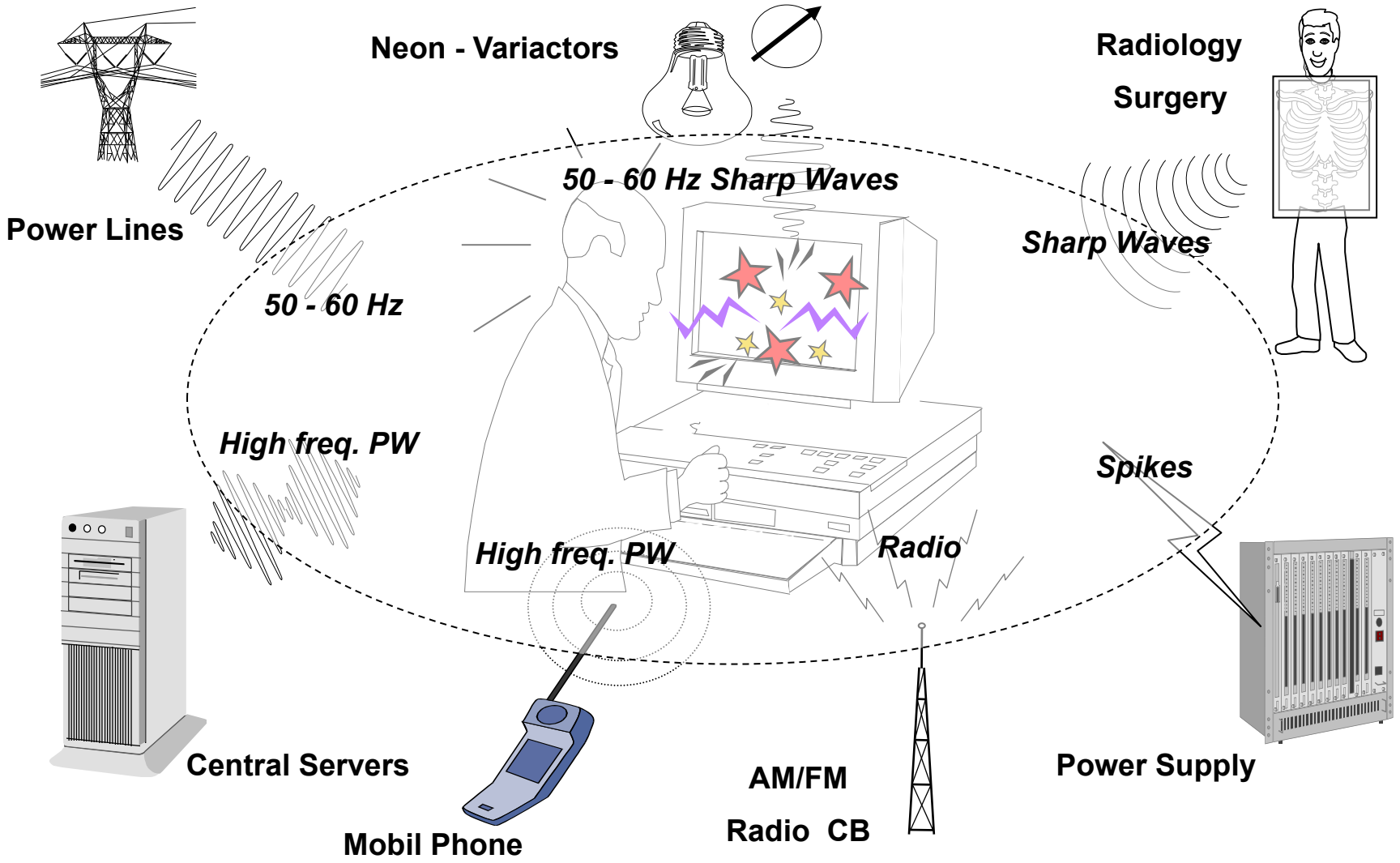
Frequency **5 times (minimum) the highest frequency to be sampling**

Binairy conversion (12 bits)

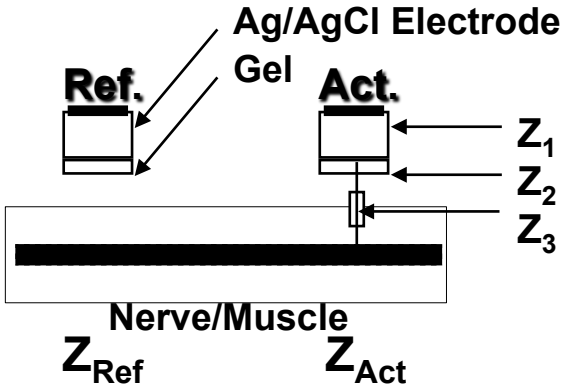
(t+1) 5mV amplitude that is **000000000101**

(t+n) 100mV amplitude that is **000001100100**

Patient is Antenna ! *Interferences are transfered*



Rec. Surface Electrode *Impedance*



Surface ⇧ = Imped. ⇩
Surface ⇩ = Focal ⇧
Imped. ⇩ = Amp. ⇧

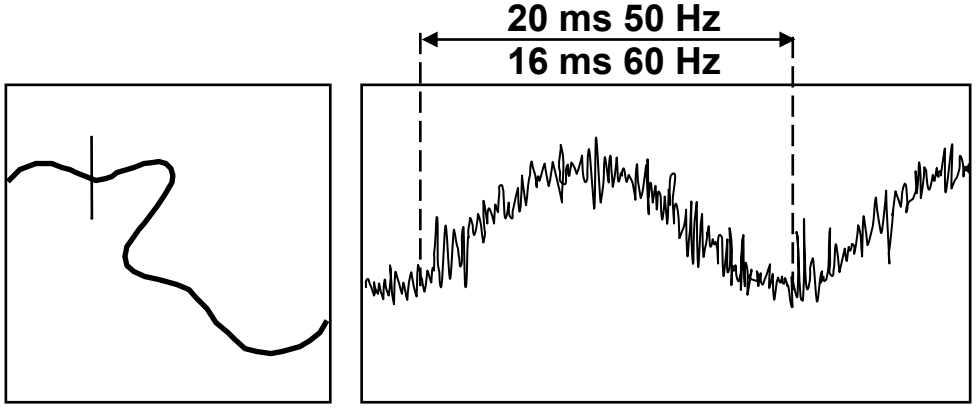
Some Gels can start up skin irritations !

$Z_R = Z_A$ Correct $Z_R \neq Z_A$ **50/60 Hz**

Baseline not stabile ?

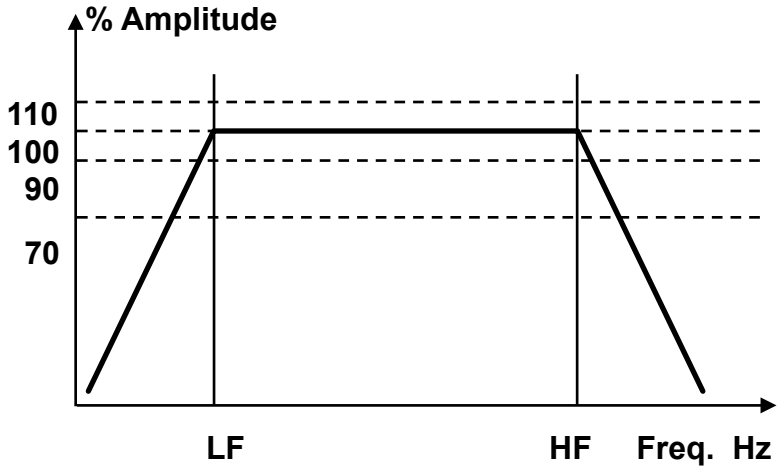
$Z_{Ref} \neq Z_{Act}$

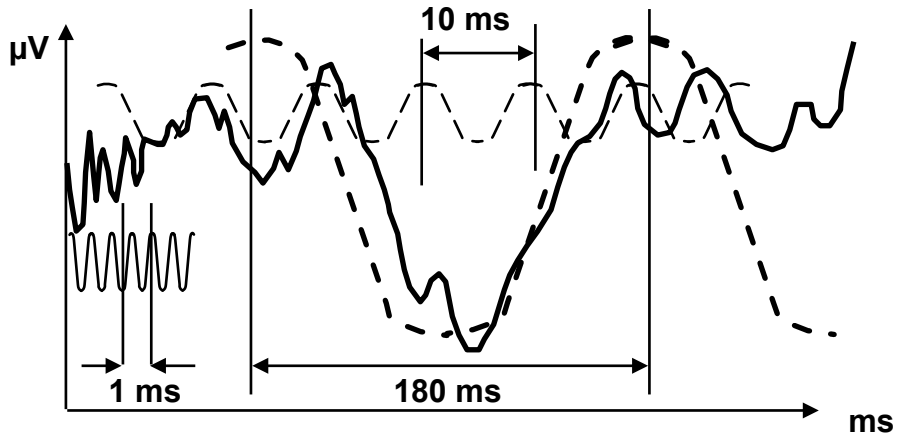
- **Skin contact**
- **Dry electrode**
- **Poor electrode quality**
- **Defective cable**
- **Defective Input Connector**



With Stimulation **Electromyography**

Band Pass and Filters





Amplitude of EMG or EP signal depend of filter adjustment.

A precise adjustment provide a better trace without unsuitable frequencies as :

- **Muscular noise**
- **External interferences**
- **Unsuitable brain activity**
- **etc..**

- **Many frequencies in the *Red* signal**
- **Role of filters isolate suitable frequencies**

In this case 10 and 180 ms
Frequencies 100 Hz and 5.5 Hz

HF ⇨ minimum 100 x 2 = 200 Hz

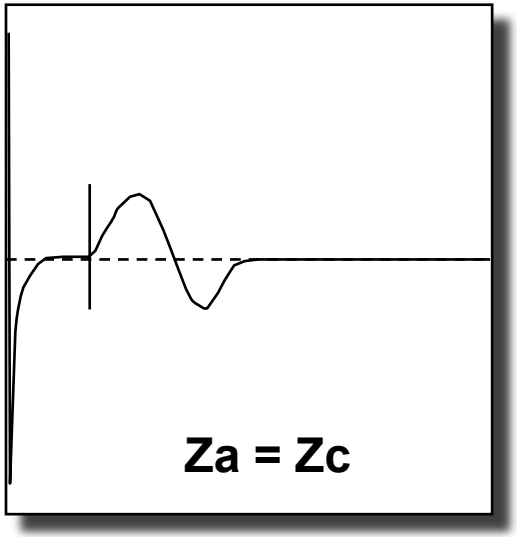
FB ⇨ maximum 5.5 / 2 = 3 Hz

Routine Setup *in Practice*

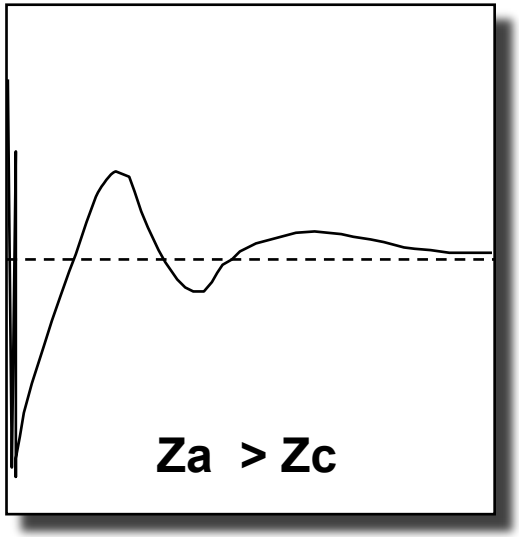
Electrode	EMG				NC	Evoked Potentials EP Needles or Surface				
	CN-MN	Special	Special		Surface	SEP		AEP A1-A2		VEP O1-O2-Oz
Tests	MUP IP T/A	SF	Macro SF	Macro Canula	SNC MNC F- H Blink Decrem^{t}	Cortex	Others	AEP	P300	
High FQ [KHz]	10 200	10	10	2	2	1	2	2	0,1	
Low FQ [Hz]	or More 10	or More 500	or More 500	5	20	0,5	20	50	0,2	0,5
Sweep ms/Div	10 - 20	1 - 2	1	10	See Applications	10	5/10	1	100	30

Stimulation Artifact *balanced Impedances*

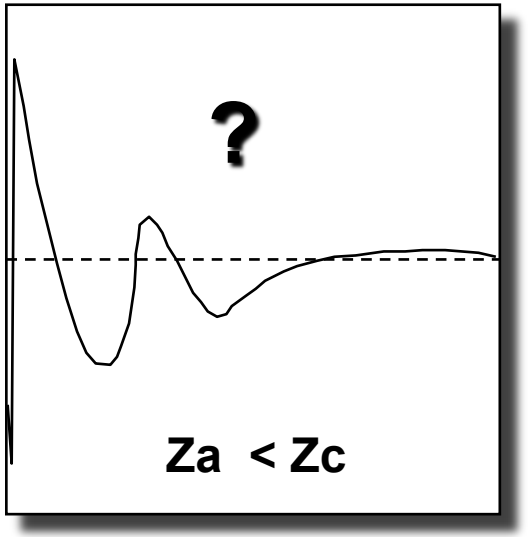
Correct



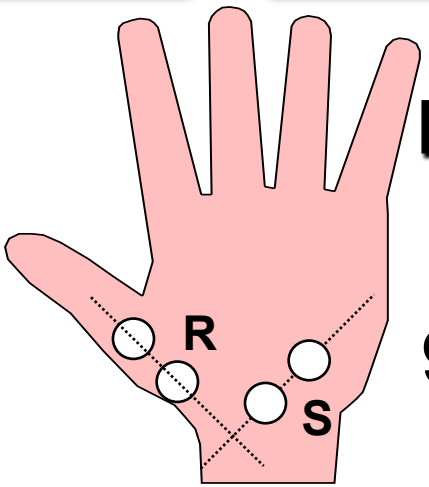
No Latency



Uncertain Latency



Unbalanced impedance between Zanode and Zcathode give positive or negative variation of stimulus artifact !



Proximity Technic

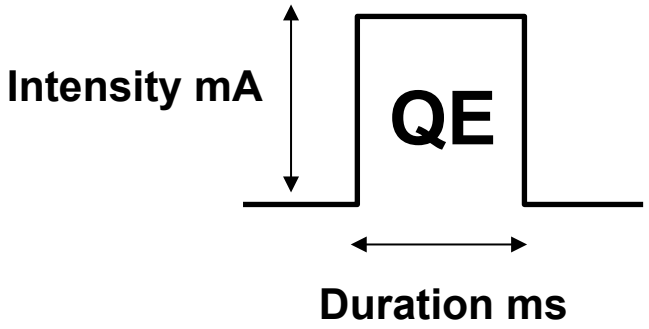
90° angle

Intensity & Duration *Stimulation*

Stimulation is defined by Intensity and Duration :
Quantity of Electricity (QE)

You get the same QE with :

10 mA / 0,2 ms and 20 mA / 0,1 ms



Reminder :

- Long Duration gives Larger Stimulus Artifact
- Higher Intensity is painful
- Short Duration, Limitation in Max. of QE (depth nerves - Fat patient)
- It's better (for patient) to reduce the number of stimuli

Averager *Principle*

Extract a revealed potential buried in an activity 1000 times greater or more.

Two methods:

Sum-Mean

$$\frac{1+2+n}{n}$$

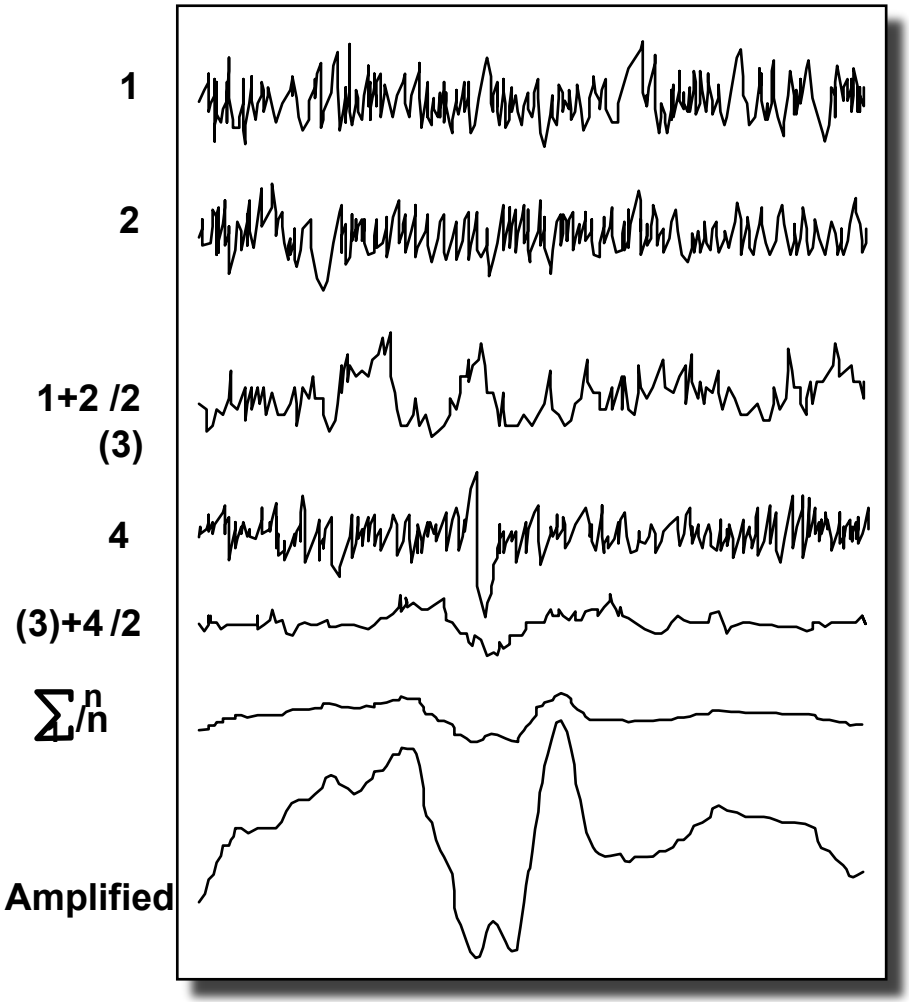
n is set before to start
Wait n reached

Normalized

$$\frac{\frac{1+2}{2}+3}{\frac{2}{2}}+n$$

Possibility to stop averager at any time.
n is an actual value

KEYPOINT



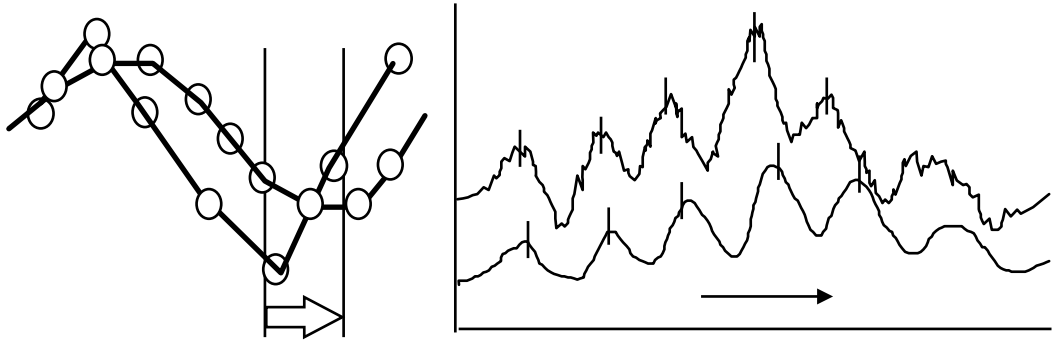
Smoothing Technics

Post-Calculation

Mean Value of 3 points
Then Interpolation of points

More smoothing =

- **Latency displacement**
- **Amplitude decreasing**



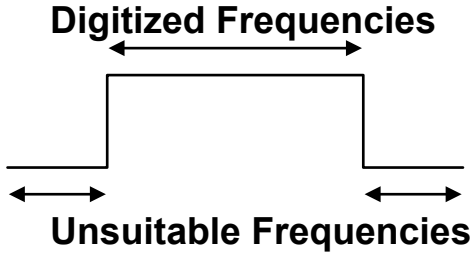
KEYPOINT

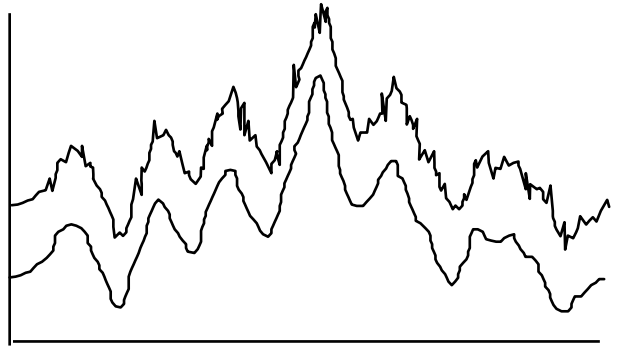
Post-Digitized

Re-Digitized Signal
with new pass-band

More smoothing =

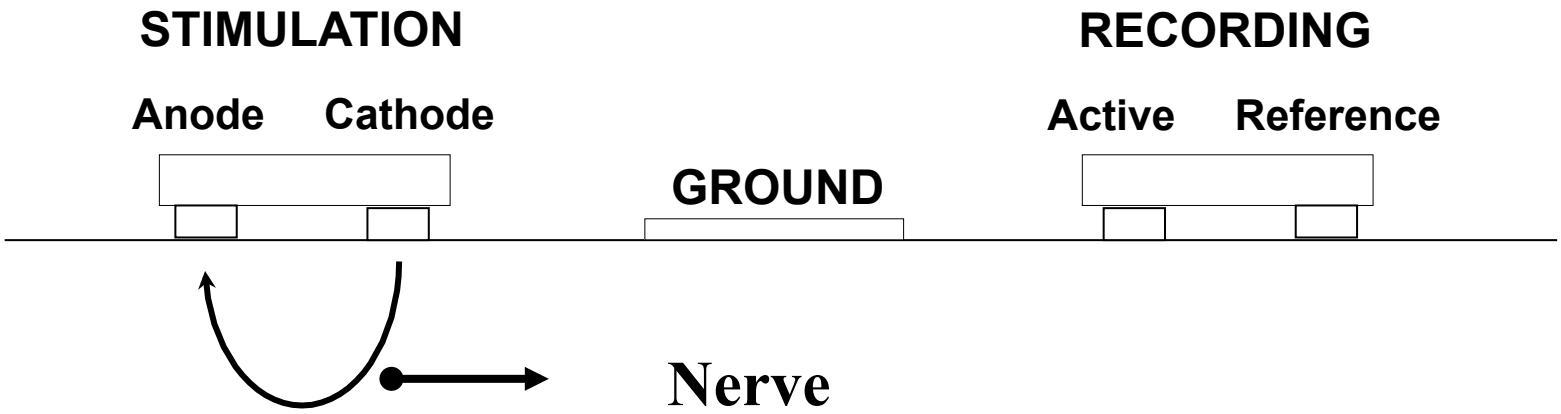
- **Amplitude decreasing**





Ground *Stimulation & Recording Rule*

As Possible, Ground must be placed between Stim. & Rec.



BLACK TO BLACK

Stimulation Polarity : NEGATIVE

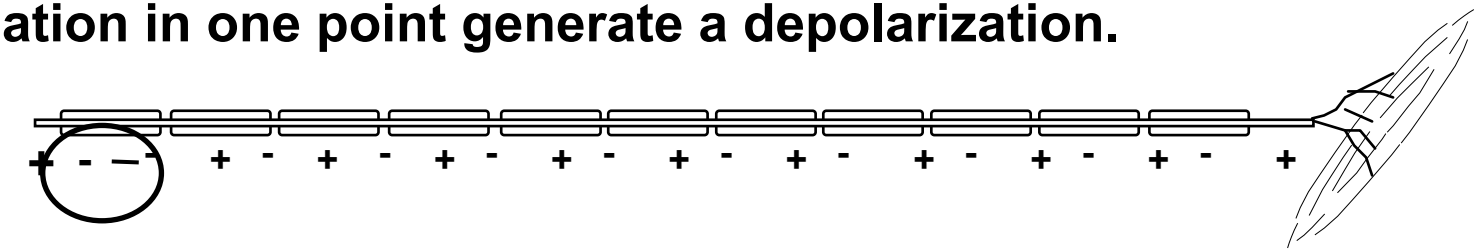
NERVE CONDUCTION

MNC - SNC - F.WAVES - INCHING

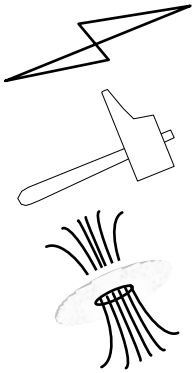
Stimulation

Nerve is a Chain of Polarized Cells (Myelin Action)

Stimulation in one point generate a depolarization.



A Nerve could be Depolarized by :

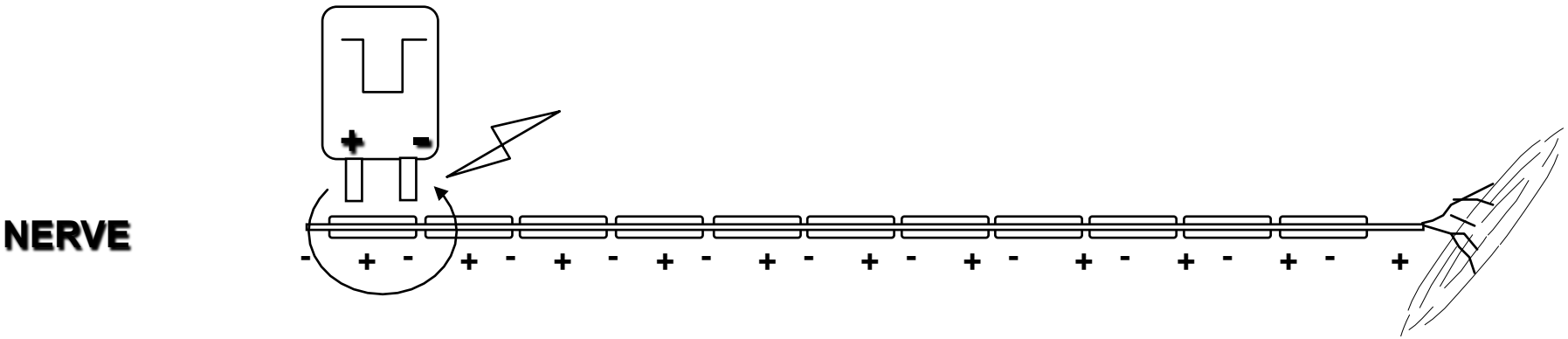


Electrical Choke

Mechanical Compression

Magnetic Field

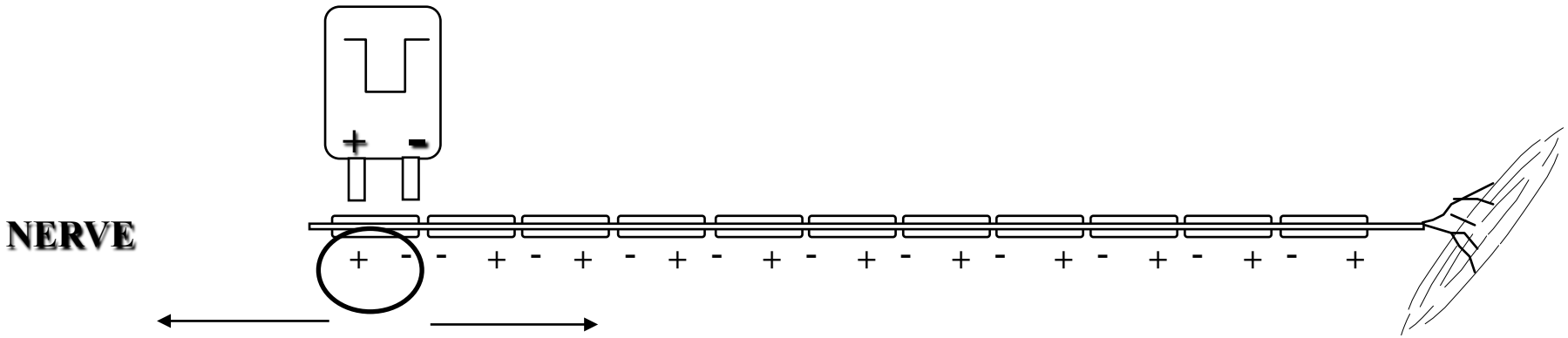
Current Stimulation

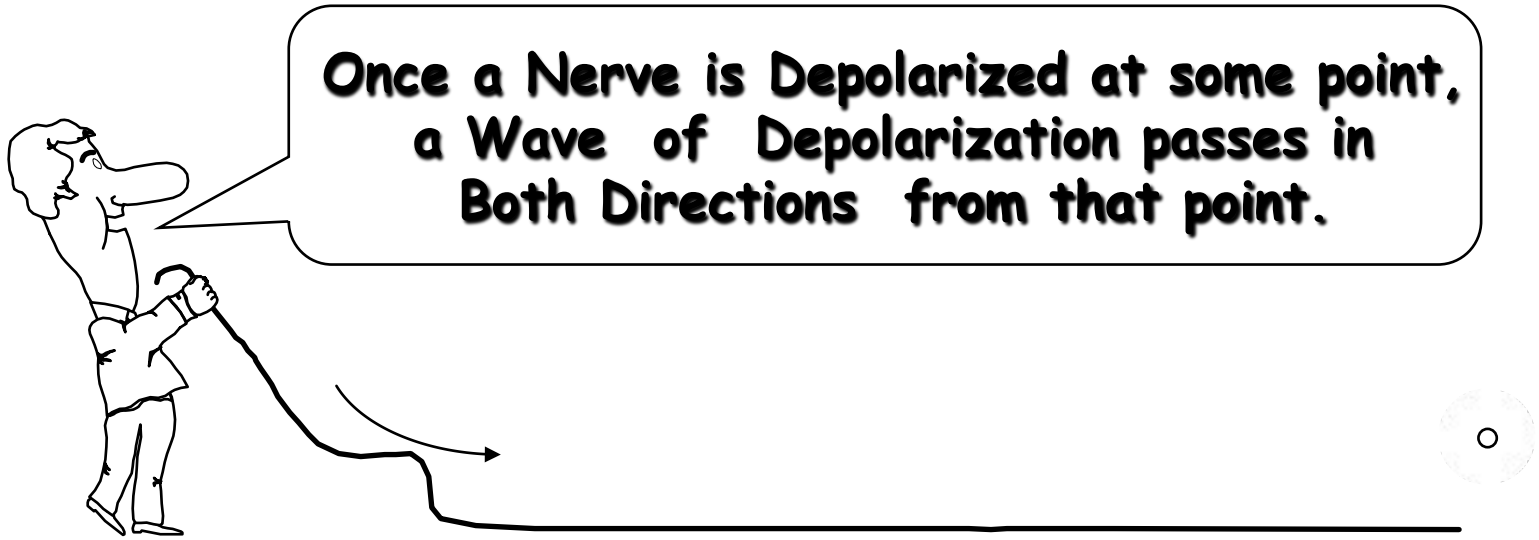


Supramaximal Stimuli

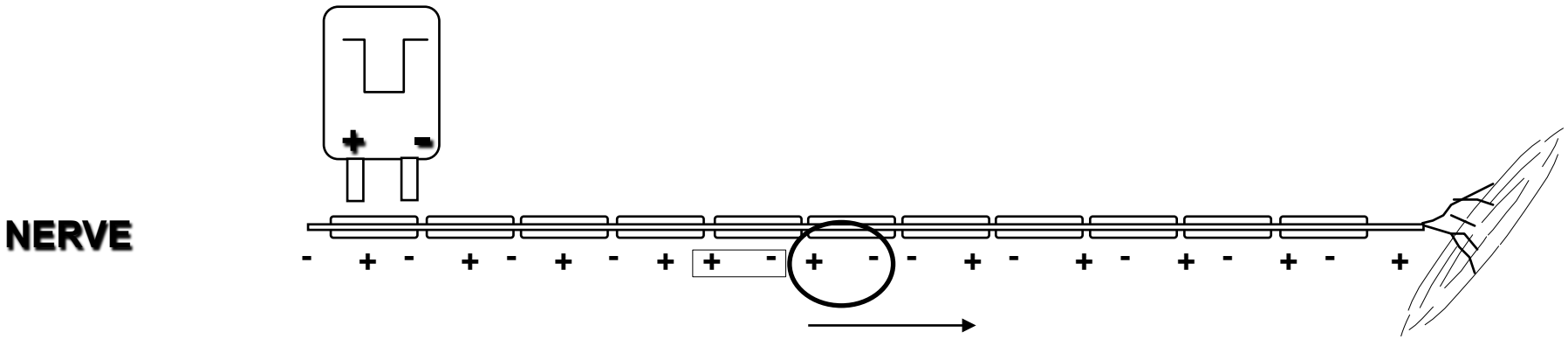
Mini. 3 Times Sensory Threshold

Depolarization





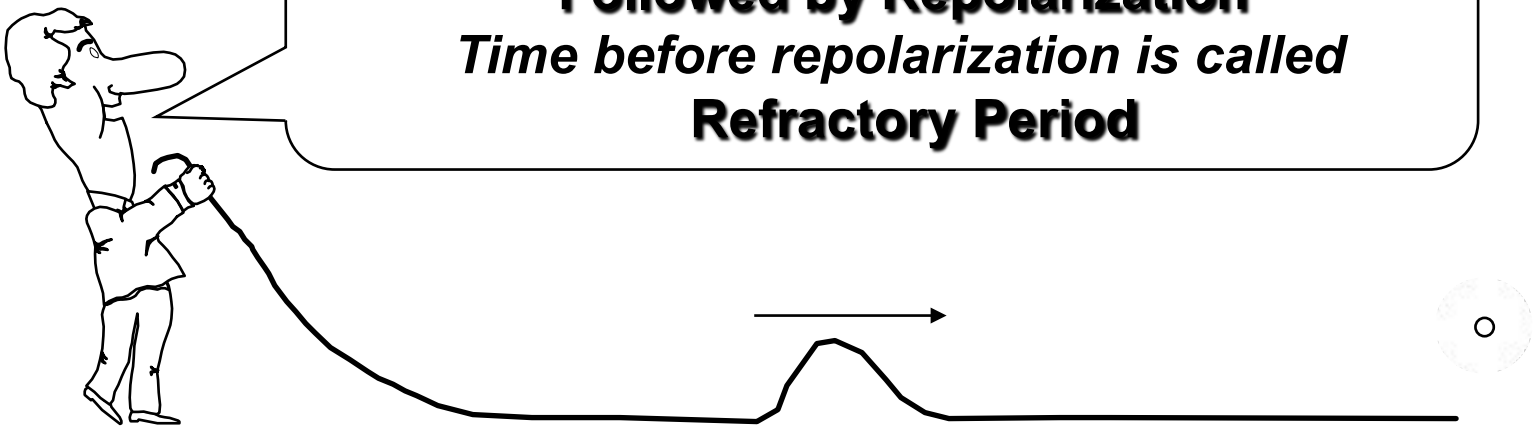
Propagation - Refractory Period



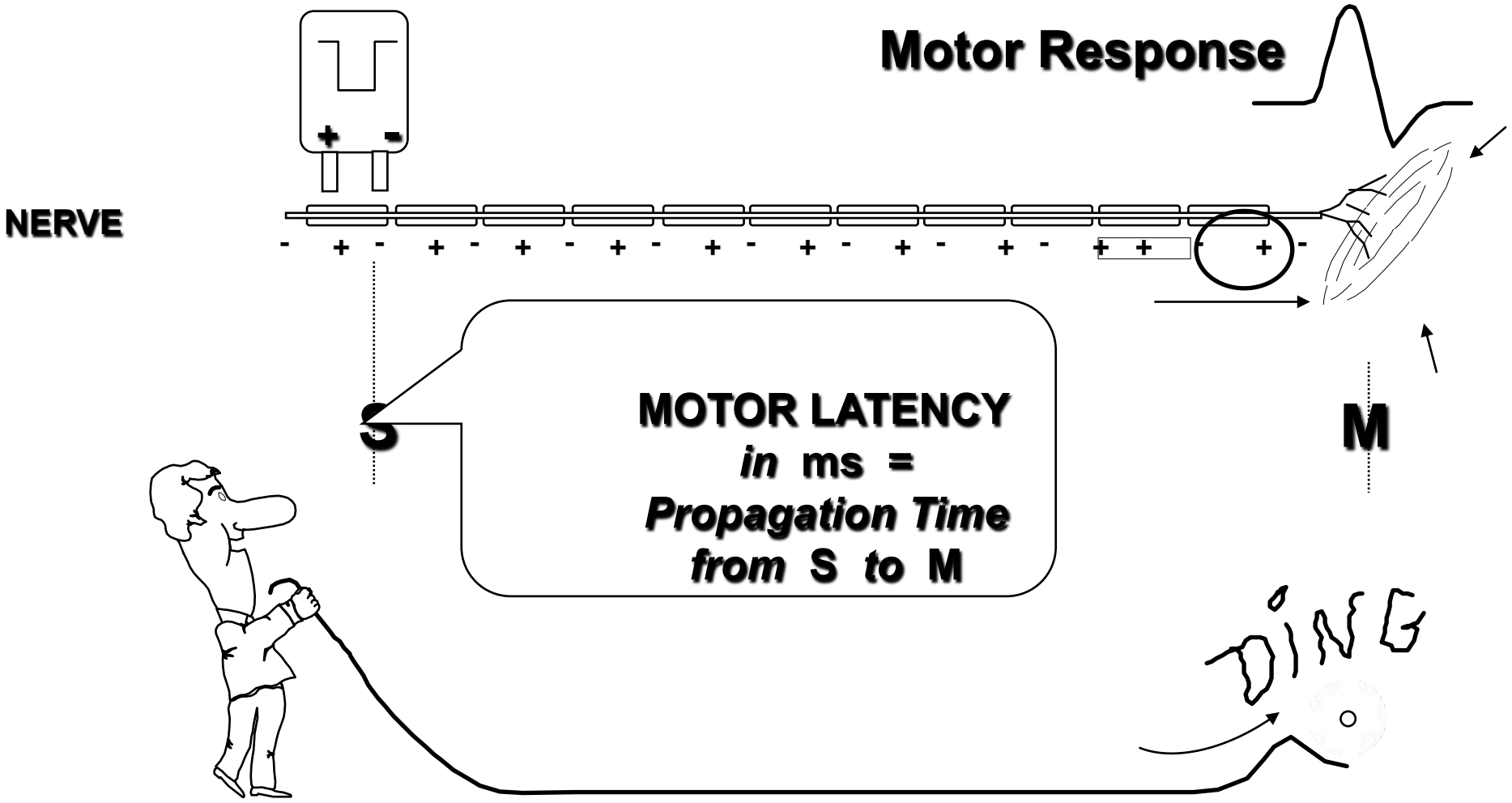
Propagation by Succesive Depolarizations Followed by Repolarization

Time before repolarization is called

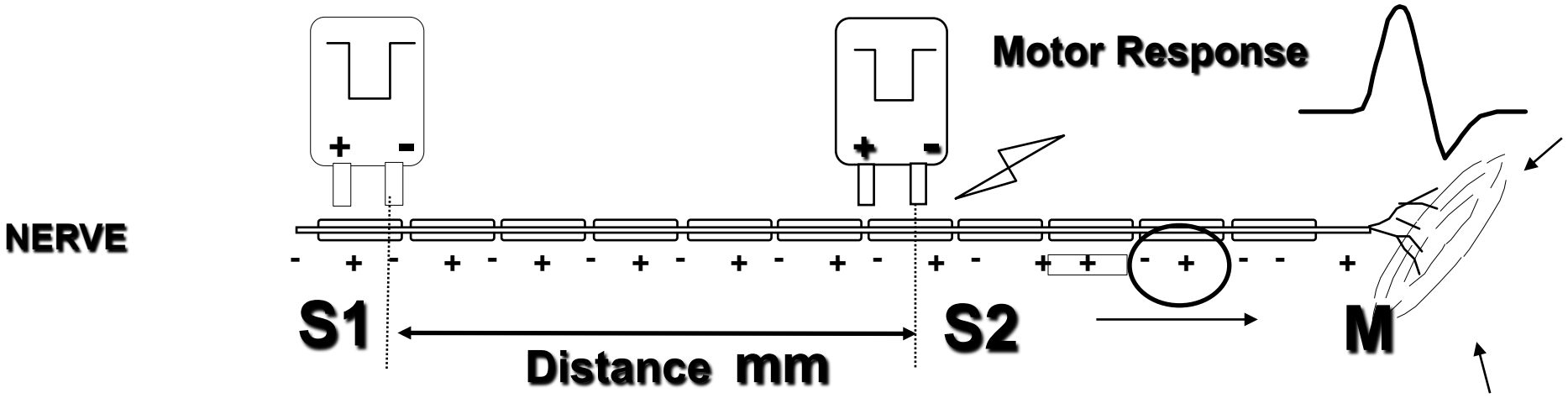
Refractory Period



Motor Latency



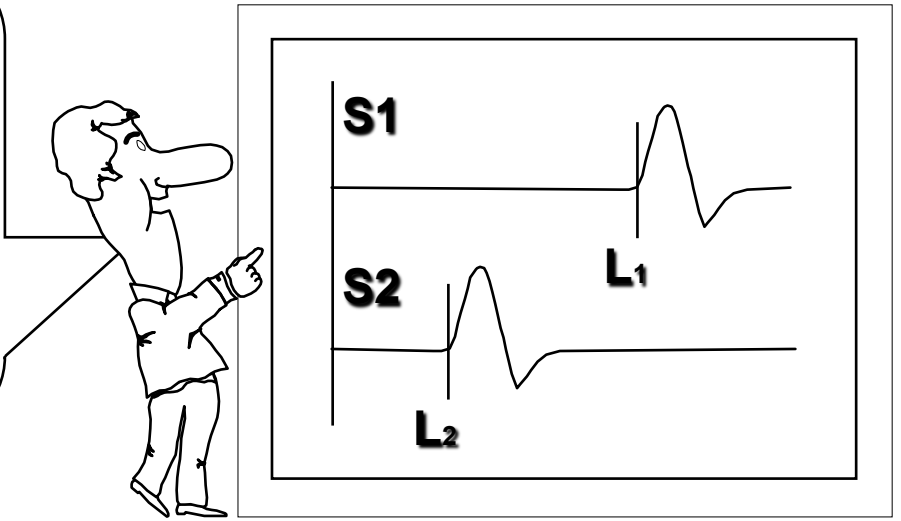
Conduction Velocity



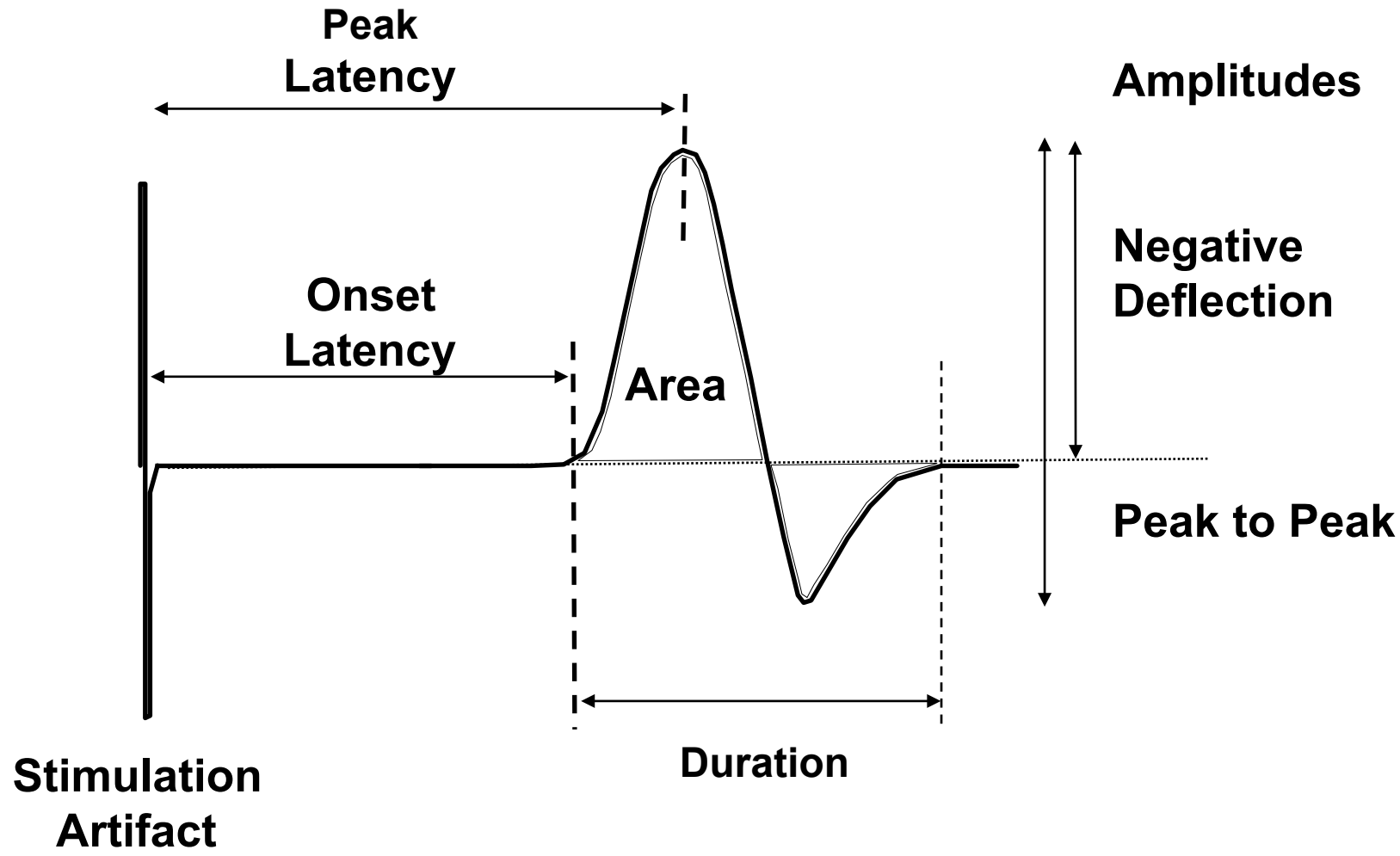
VELOCITY in m/s

$$\frac{\text{Distance}}{\text{Latency S1 - Latency S2}}$$

Normal Value : 45 to 65 m/s
Depend. of : Nerve - Age - T°

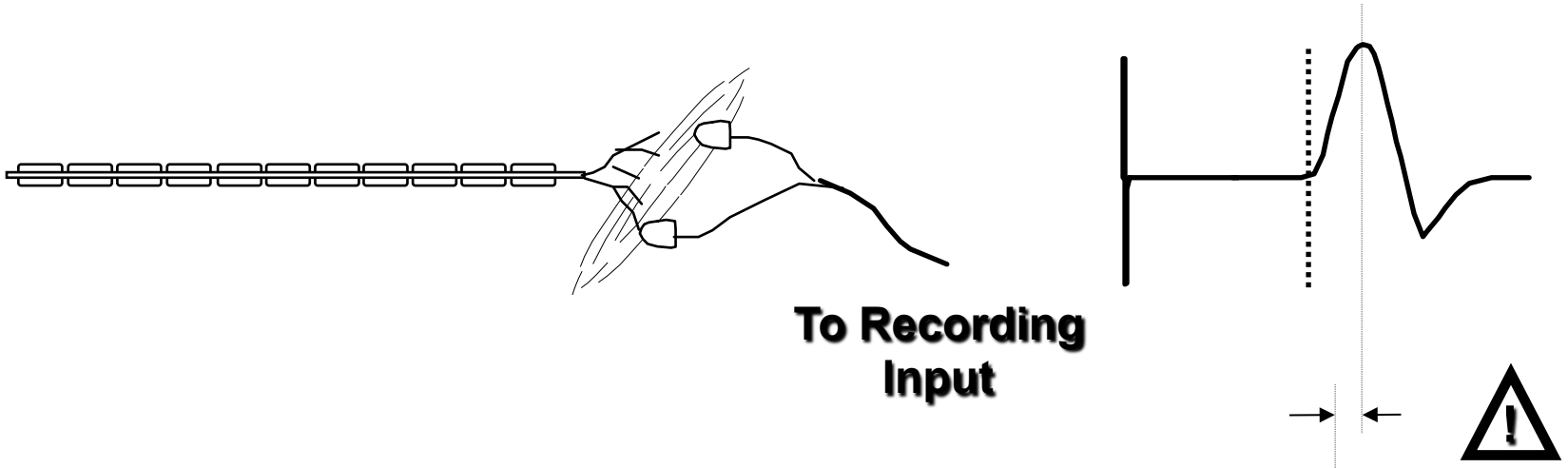


Motor Response

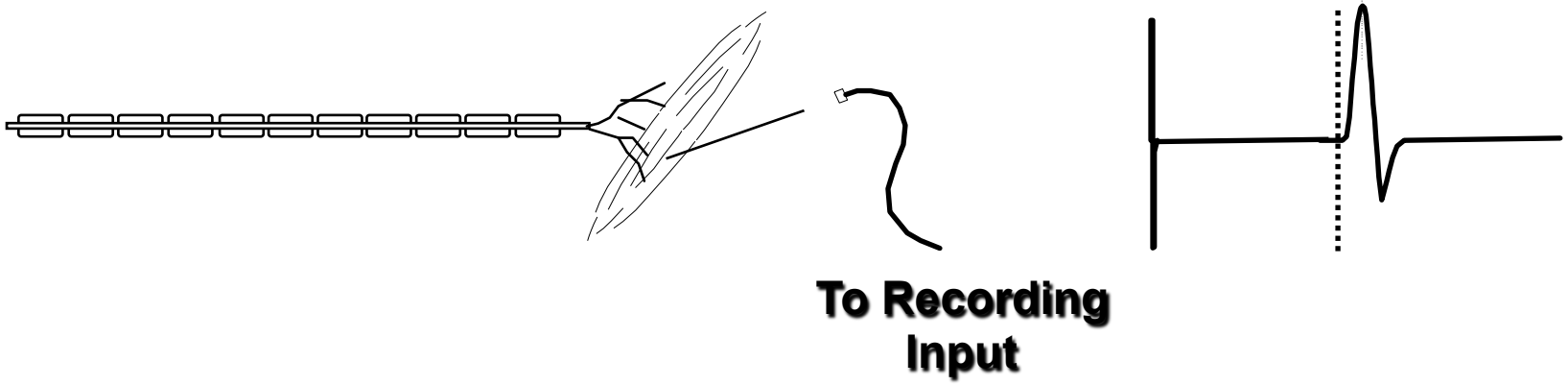


Recording

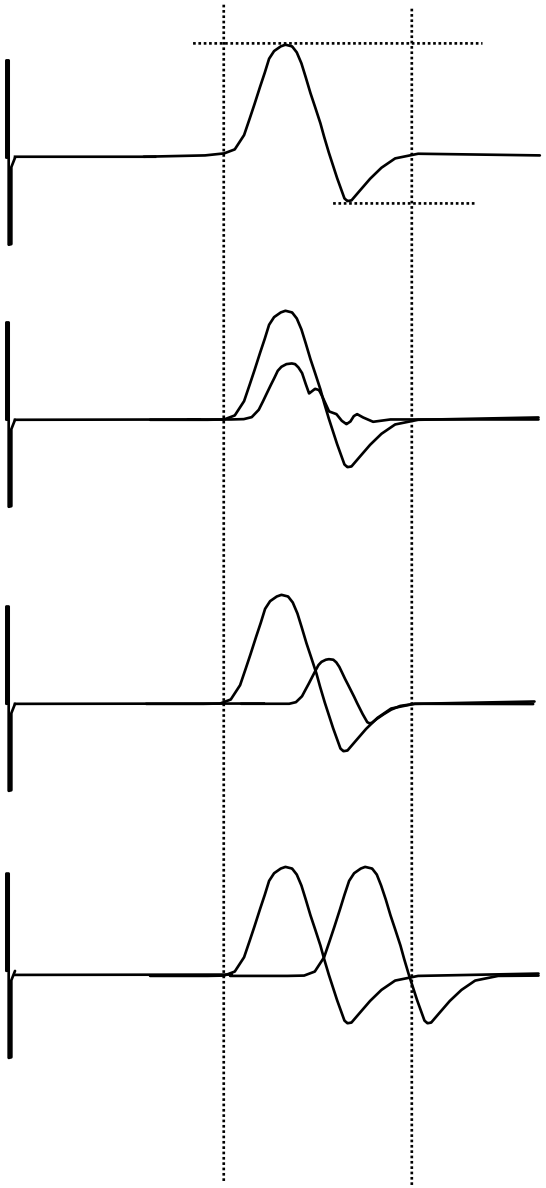
SURFACE ELECTRODES



NEEDLE ELECTRODE



Pathologic Responses

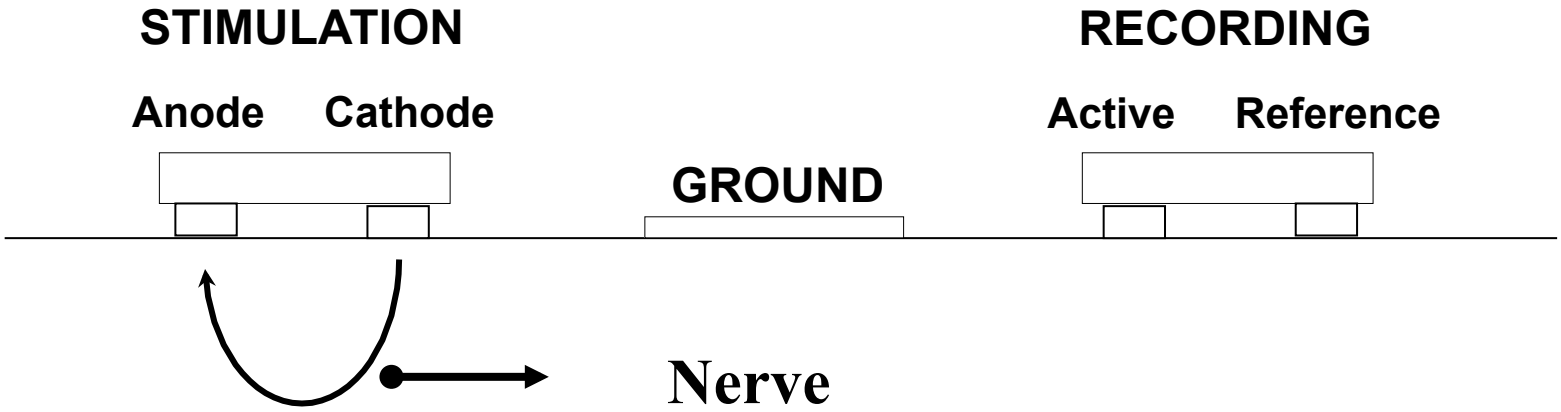


	Amplitude	Duration	Latency
Normal	**Nl**	**Nl**	**Nl**
Axonal Degeneration	↓	↓	**Nl**+/- ↑
Conduction Block *Severe Demyelination*	↓	↓	**Nl**+/- ↑
Focal Slowing *Myelin Damaged*	**Nl**	**Nl**	↑

Nl = Normal

Stimulation & Recording *RULE*

As Possible, Ground must be placed between Stim. & Rec.



BLACK TO BLACK

Stimulation Polarity : NEGATIVE

Motor & Sensory *General Remarks*

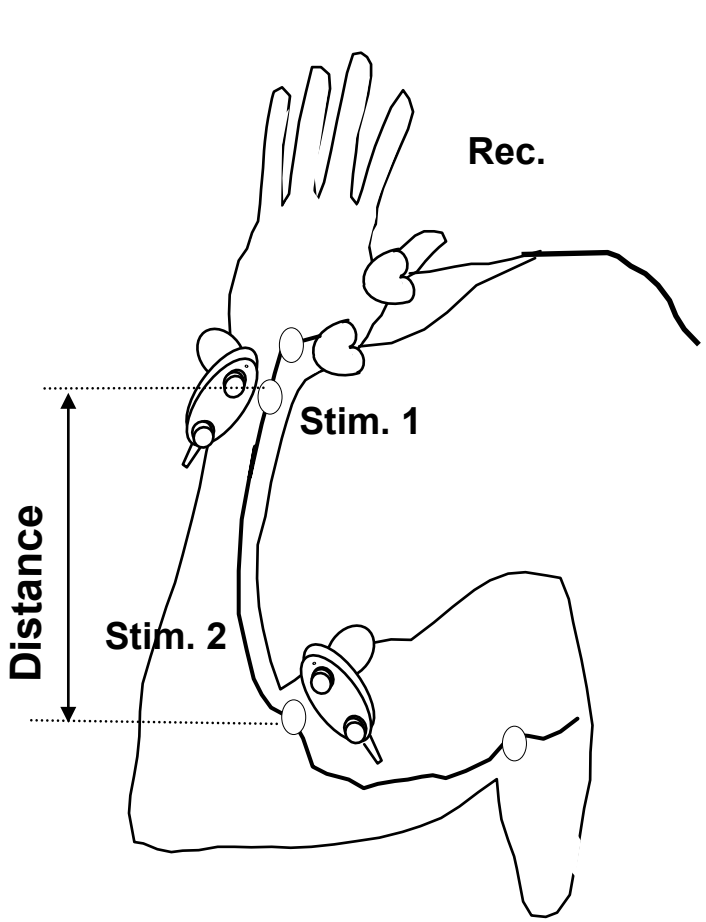
MOTOR

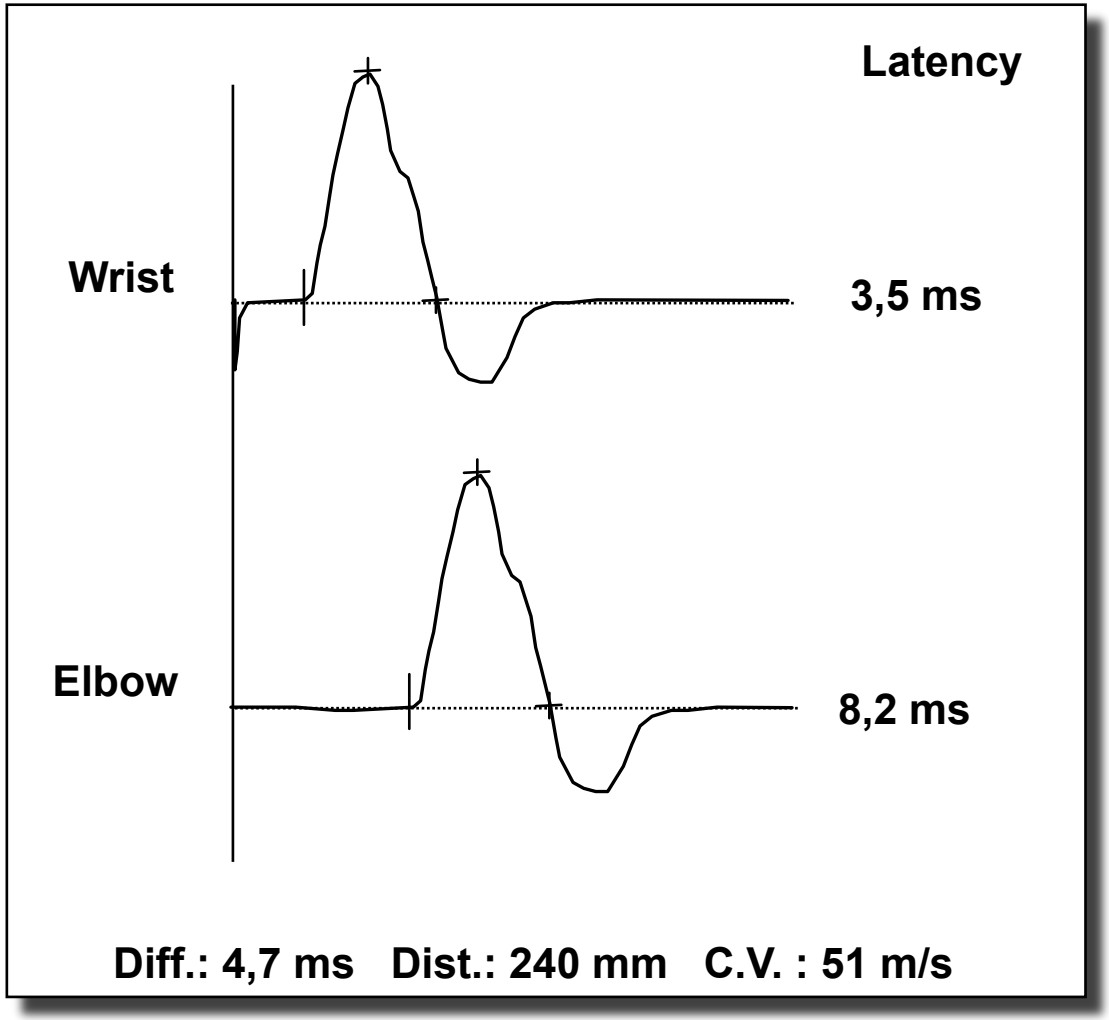
- **Amplitude minimum 1 mV - Direct response**
- **Form normally biphasic**
- **Duration 1 to 3 ms - Latency depend of stimulation site**
- **Stimulation Current depend nerve and site, 15 - 30 mA**

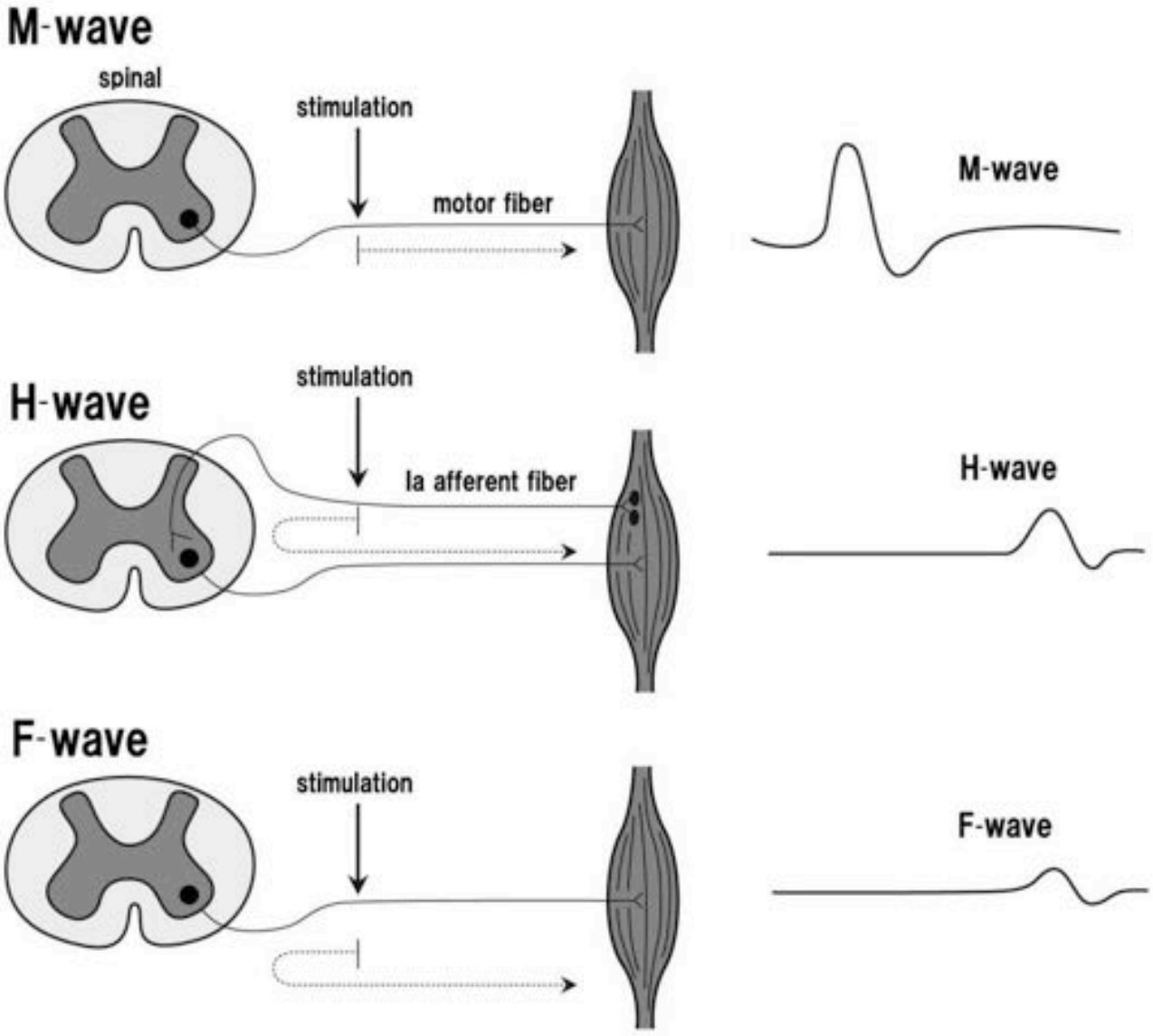
SENSORY

- **Amplitude 5 µV to 35 µV**
- **Indirect response - Averager needed**
- **Direct response for high amplitude potentials**
- **Form normally biphasic**
- **Duration 1 to 3 ms - Latency depend of stimulation site**
- **Stimulation Current depend nerve and site, 5 - 15 mA**

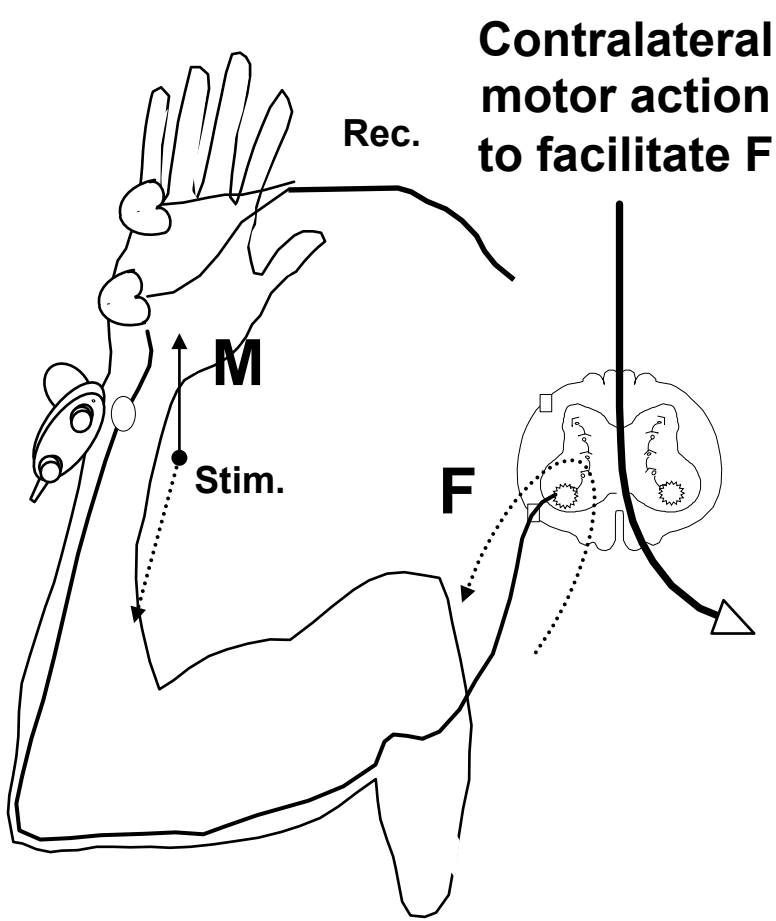
Motor Conduction *Median Nerve*

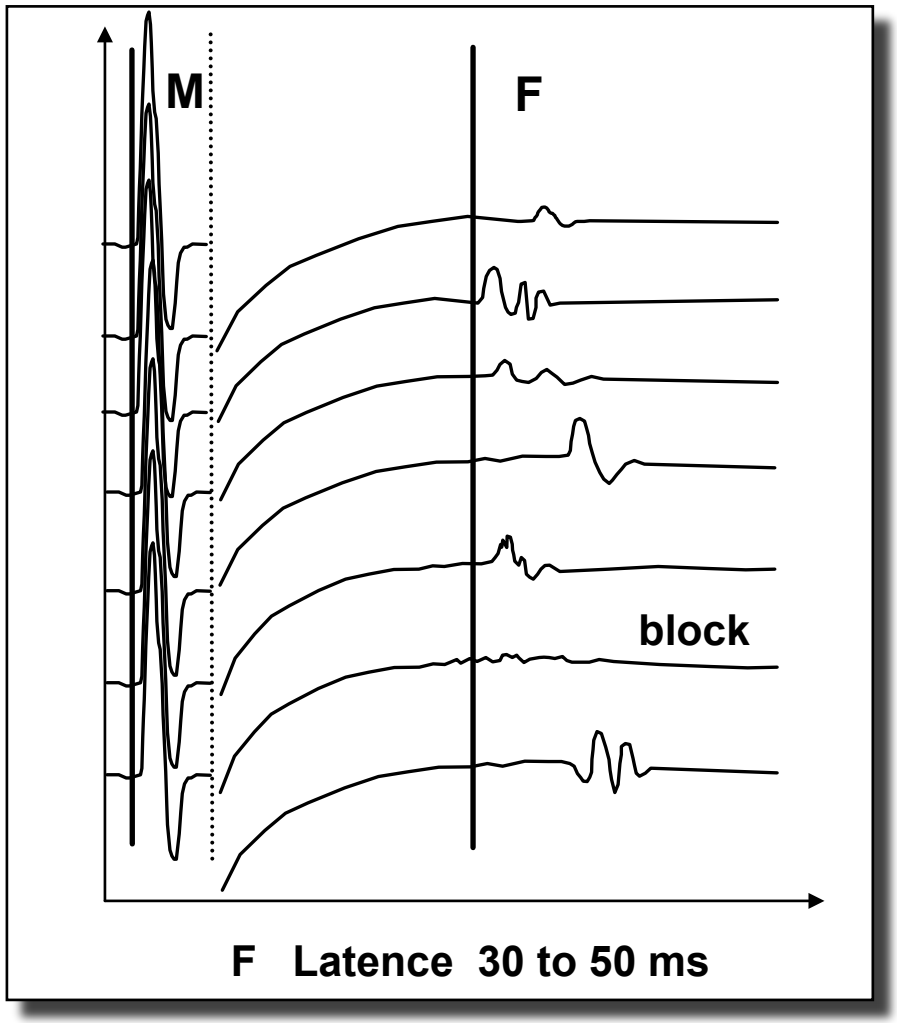




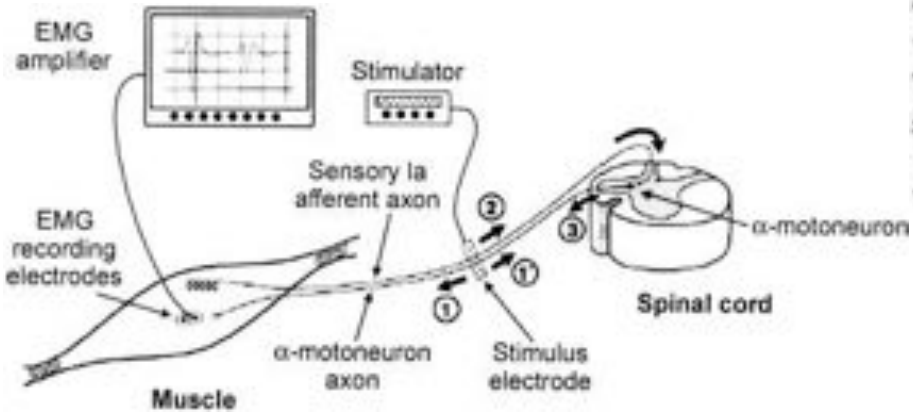

M-wave
spinal
stimulation
motor fiber
M-wave
H-wave
stimulation
Ia afferent fiber
H-wave
F-wave
stimulation
F-wave

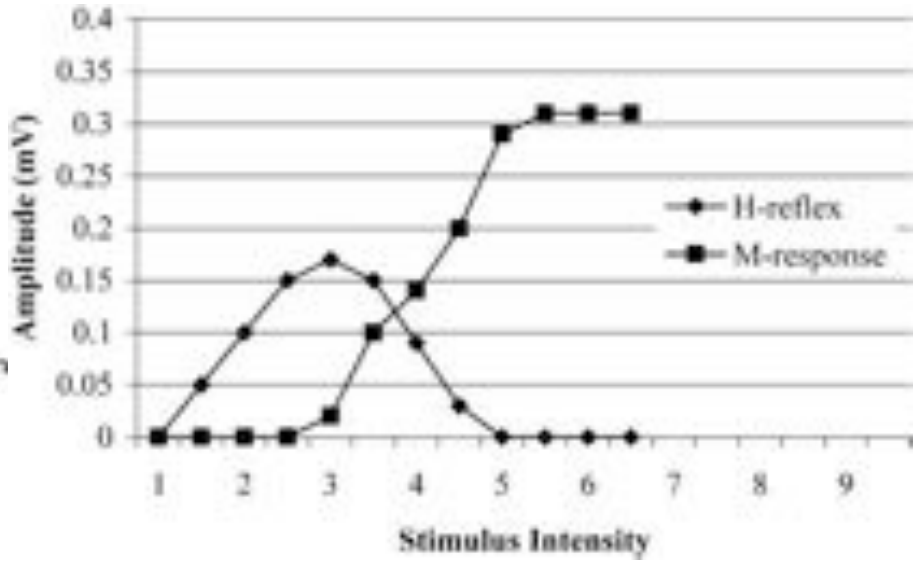
F-Waves *Ulnaris Nerve*





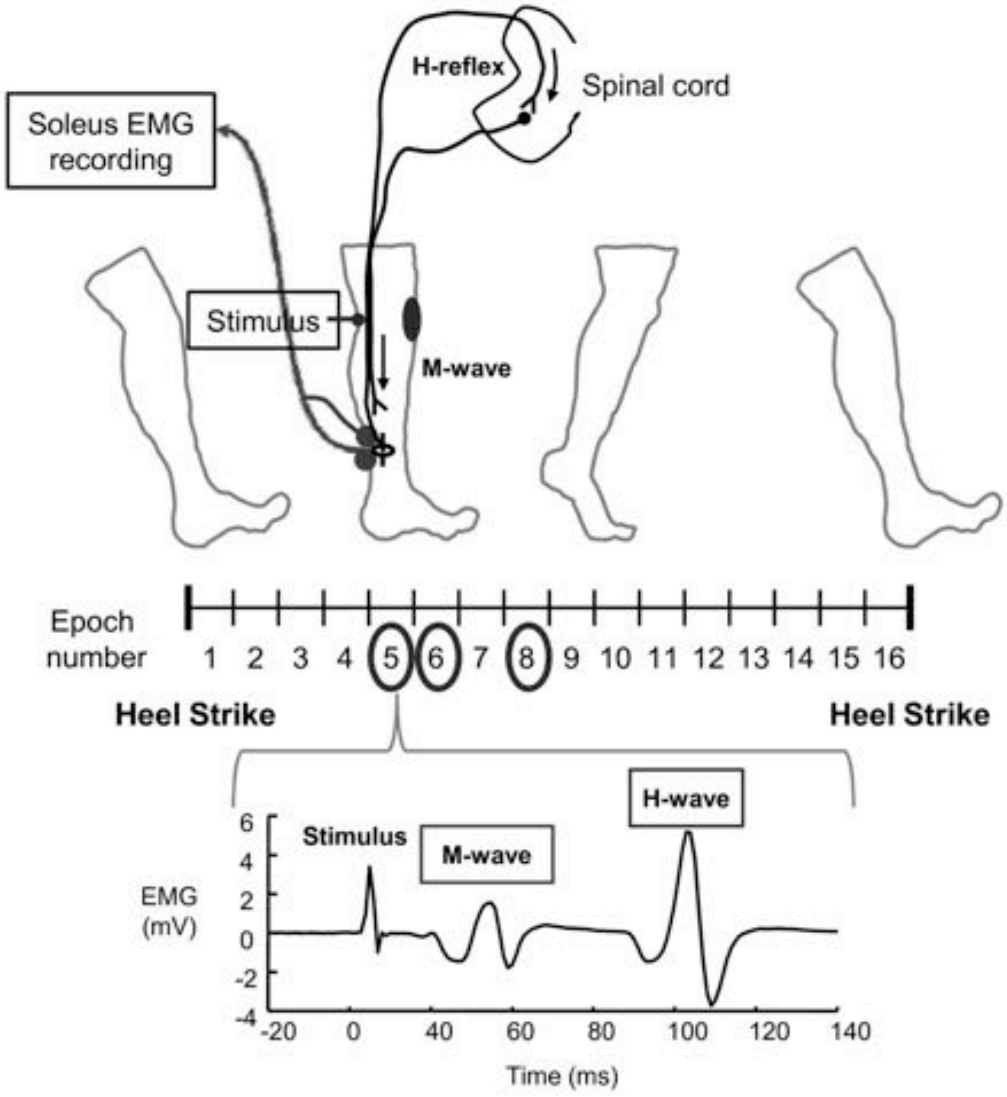
Originally described by Paul Hoffmann in 1910,[1] and later given his name,[2] the Hoffmann reflex (H-reflex) is an electrically induced reflex analogous to the mechanically induced spinal stretch reflex. The primary difference between the H-reflex and the spinal stretch reflex is that the H-reflex bypasses the muscle spindle[3] and, therefore, is a valuable tool in assessing modulation of monosynaptic reflex activity in the spinal cord. The H-reflex is an estimate of alpha motoneuron (αMN) excitability when presynaptic inhibition[4] and intrinsic excitability[5] of the αMNs remain constant. This measurement can be used to assess the response of the nervous system to various neurologic conditions,[6,7] musculoskeletal injuries,[8–14] application of therapeutic modalities,[15–17] pain,[18] exercise training,[19–22] and performance of motor tasks.[5,23–26]

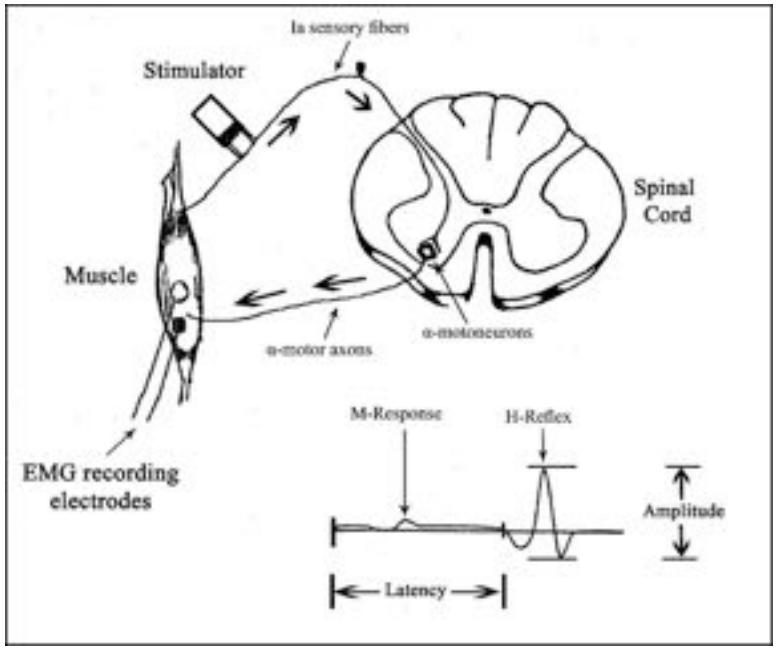


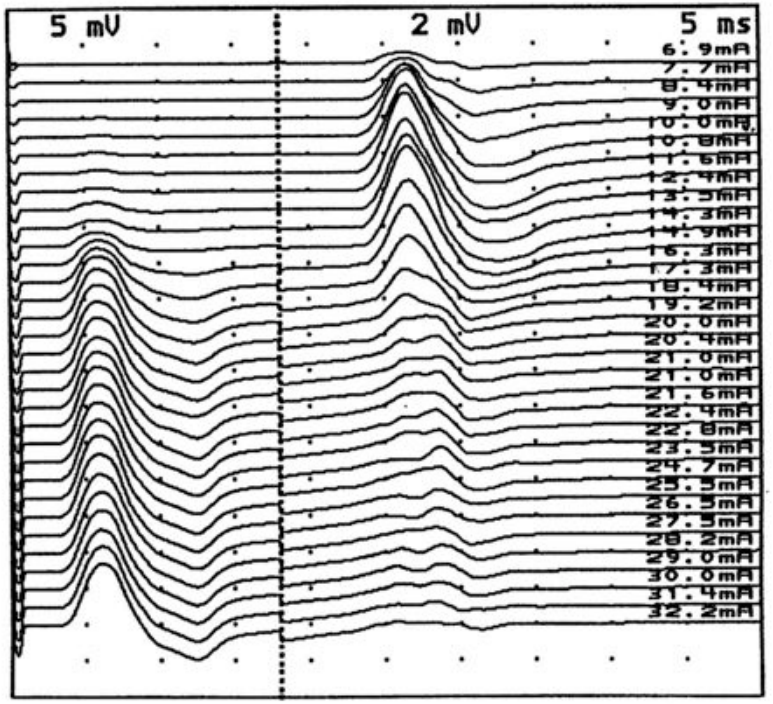


http://www.ncbi.nlm.nih.gov/pmc/articles/PMC522151/

Recruitment curve. The stimulus intensity is set at 0 and gradually increased until maximum Hoffmann reflex amplitude and maximum muscle response amplitude are achieved.







Hmax/Mmax ratio

Although there is considerable variability of HM ratio, soleus HM ratio is normally less than 0.7 (Delwaide, 1984).

J. Neurol. Neurosurg. Psychiat., 1966, **29**, 201

Ratio of maximum H reflex to maximum M response as a measure of spasticity

W. B. MATTHEWS

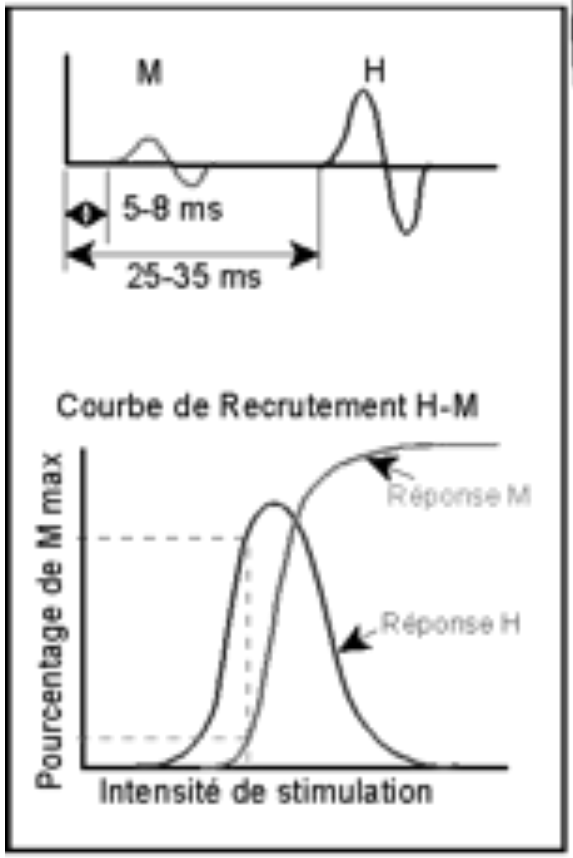
From the Derbyshire Royal Infirmary

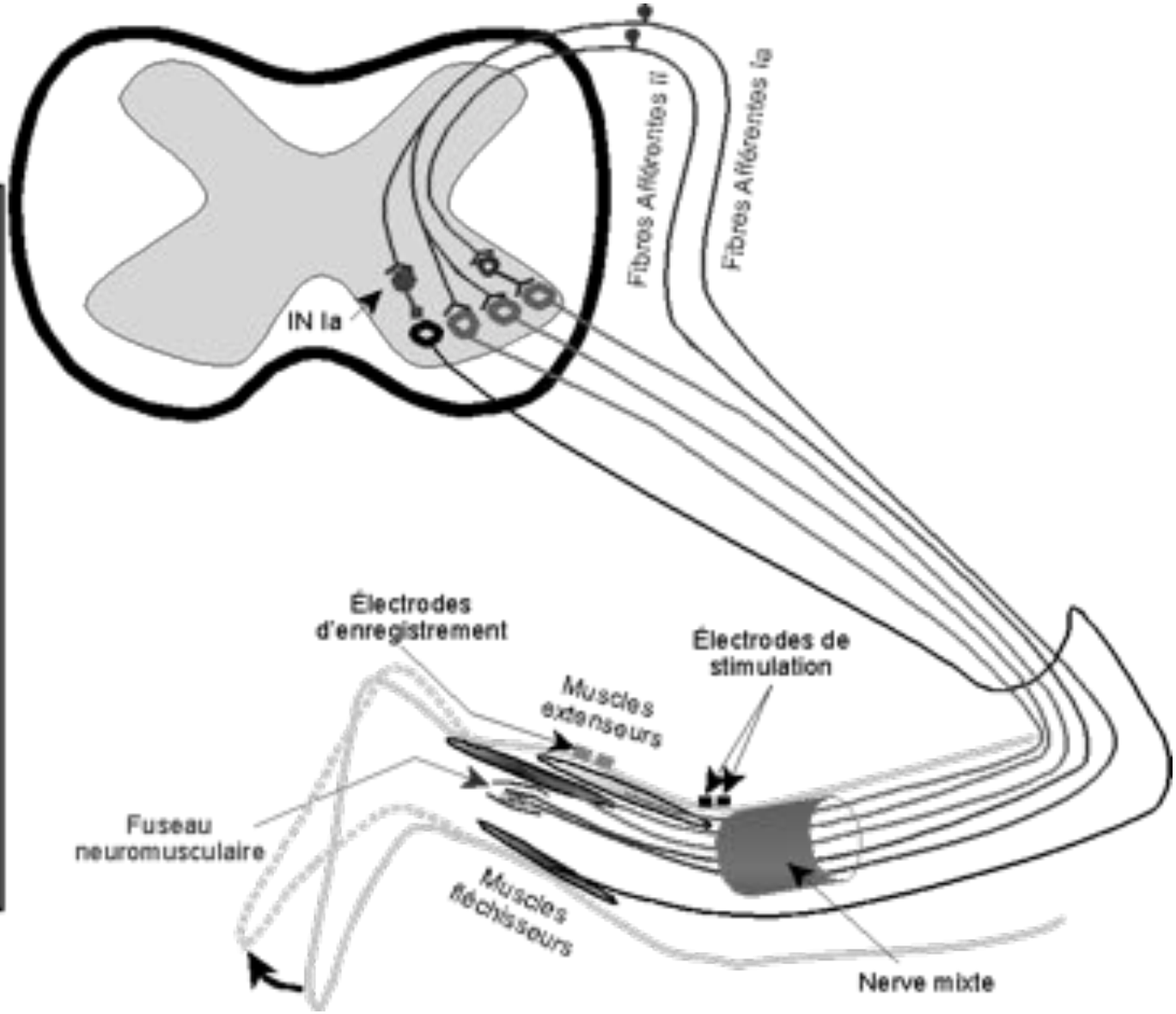
TABLE I

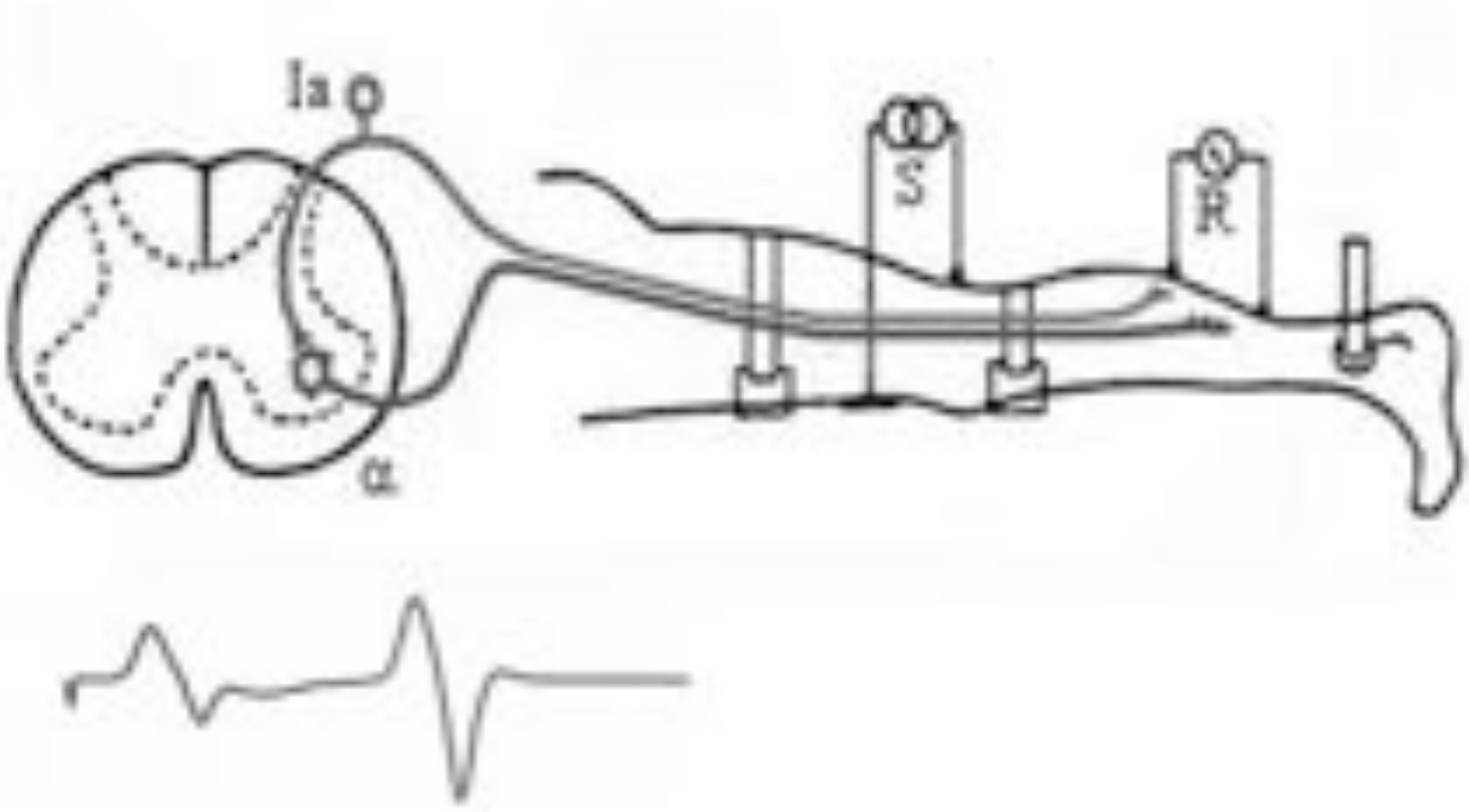
H/M RATIO BEFORE AND AFTER REDUCTION OF SPASTICITY BY THE INTRAVENOUS INJECTION OF CHLORPROETHAZINE OR DIAZEPAM

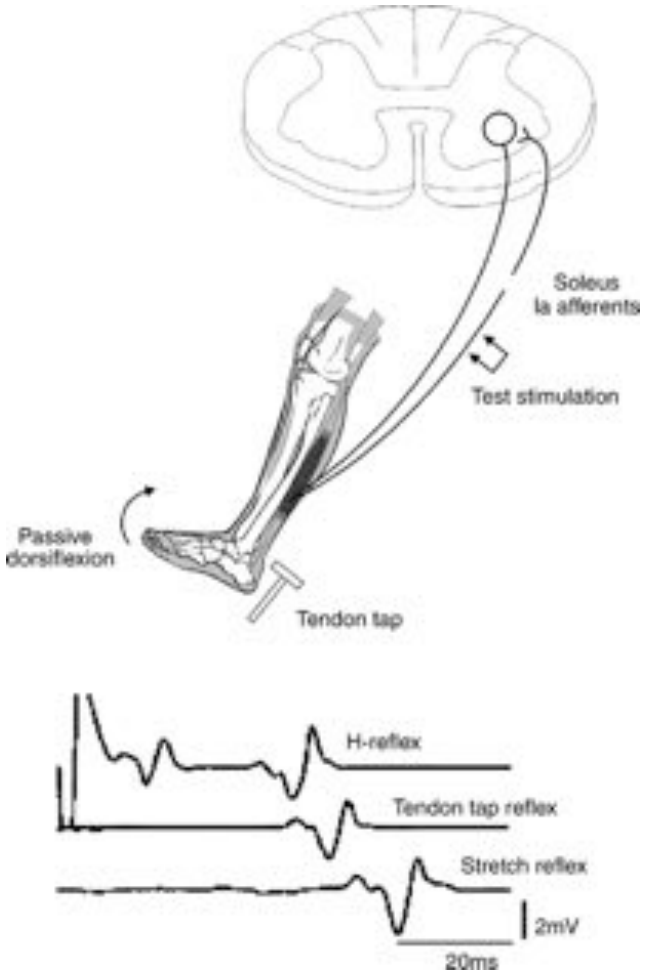
Drug	*Before*	*After*
Chlorproethazine	0·39	0·17
Chlorproethazine	0·67	0·41
Chlorproethazine	0·36	0·36
Chlorproethazine	0·67	0·67
Diazepam	0·26	0·16
Diazepam	0·32	0·27
Diazepam	0·22	0·22
Diazepam	0·37	0·32
Diazepam	0·24	0·24
Diazepam	0·19	0·17
Mean	0·35	0·30

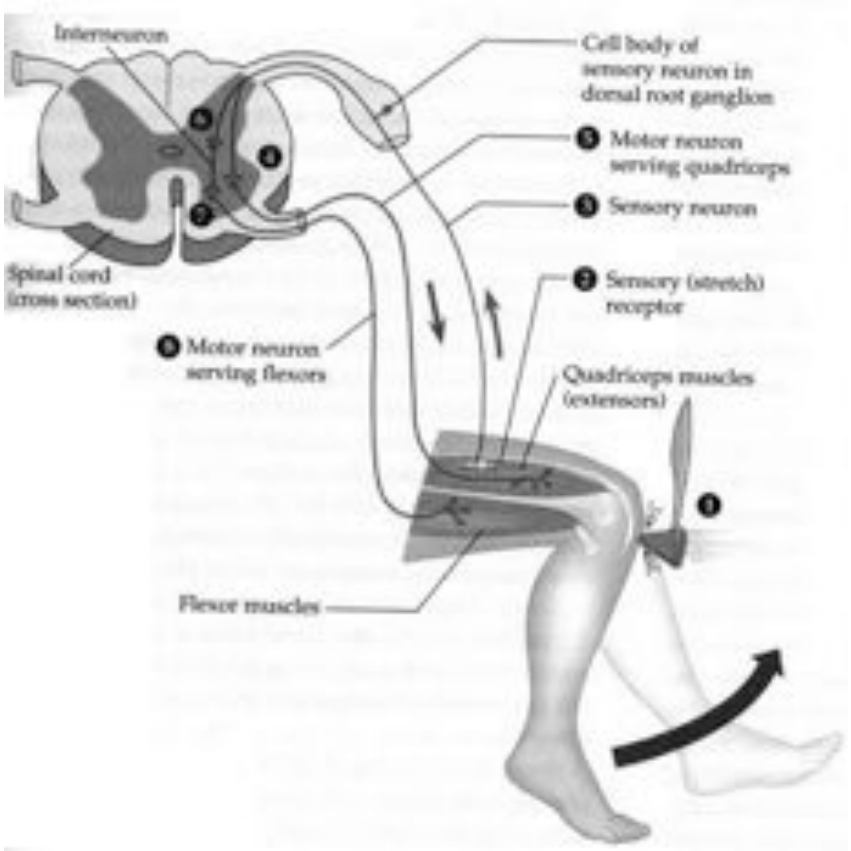
3


M
H
5-8 ms
25-35 ms
Courbe de Recrutement H-M
Pourcentage de M max
Réponse M
Réponse H
Intensité de stimulation

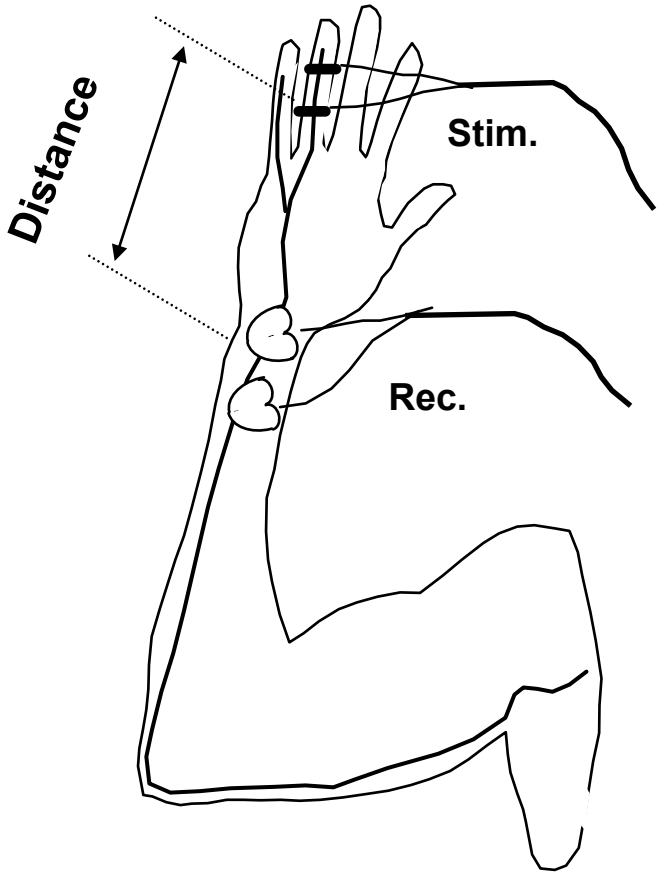

IN Ia
Fibres Afférentes II
Fibres Afférentes Ia
Électrodes d'enregistrement
Électrodes de stimulation
Muscles extenseurs
Fuseau neuromusculaire
Muscles fléchisseurs
Nerve mixte

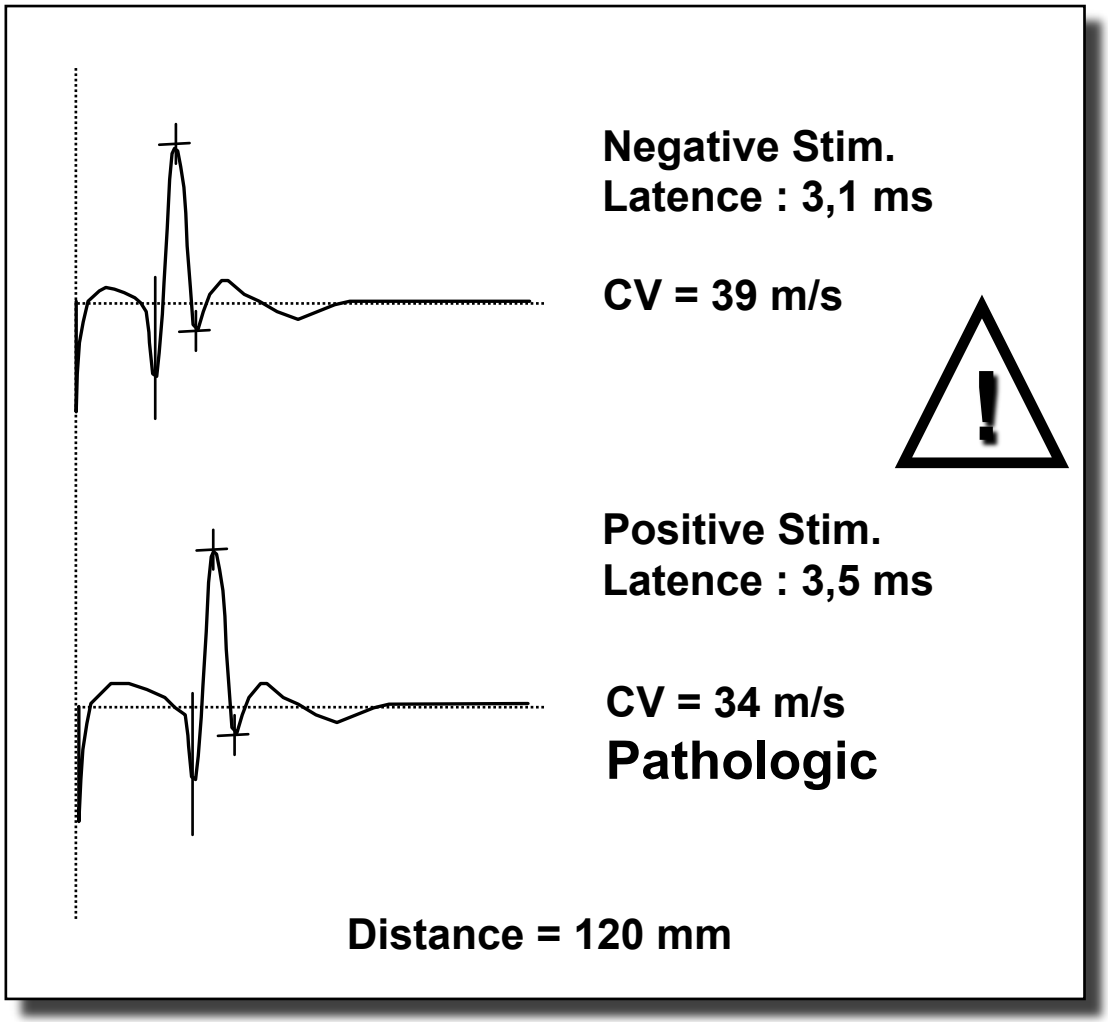

Ia
α
S
R


Soleus
Ia afferents
Test stimulation
Passive
dorsiflexion
Tendon tap
H-reflex
Tendon tap reflex
Stretch reflex
2mV
20ms


Interneuron
Cell body of
sensory neuron in
dorsal root ganglion
Motor neuron
serving quadriceps
Sensory neuron
Spinal cord
(cross section)
Sensory (stretch)
receptor
Motor neuron
serving flexors
Quadriceps muscles
(extensors)
Flexor muscles

Sensory Conduction *Ulnaris Nerve*

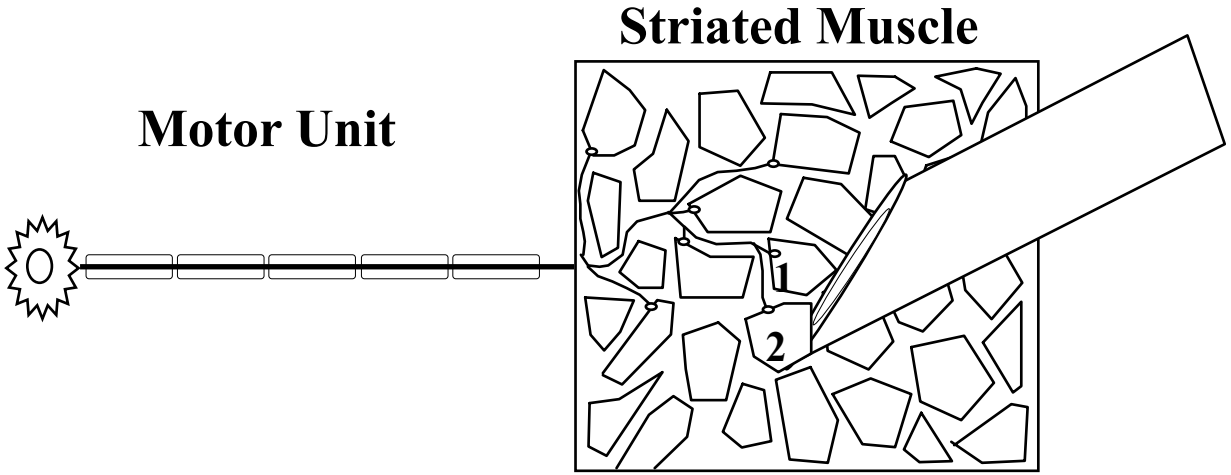


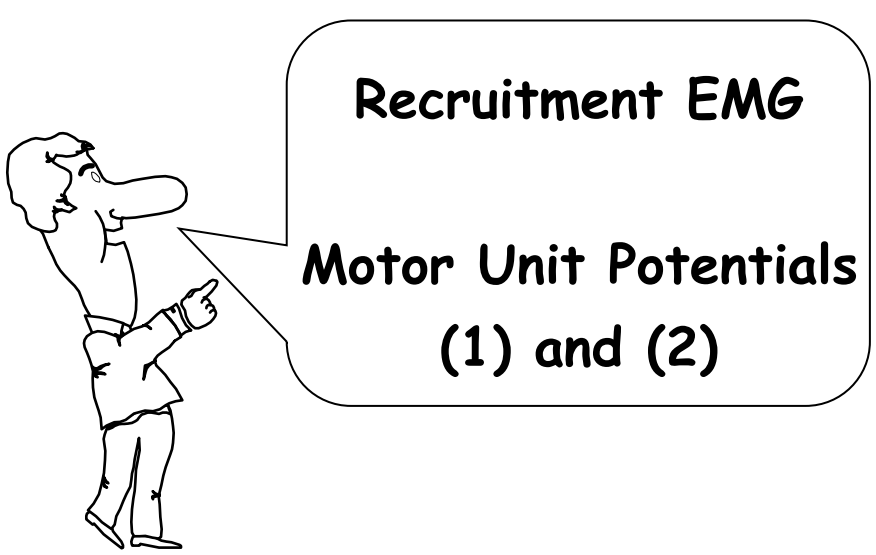


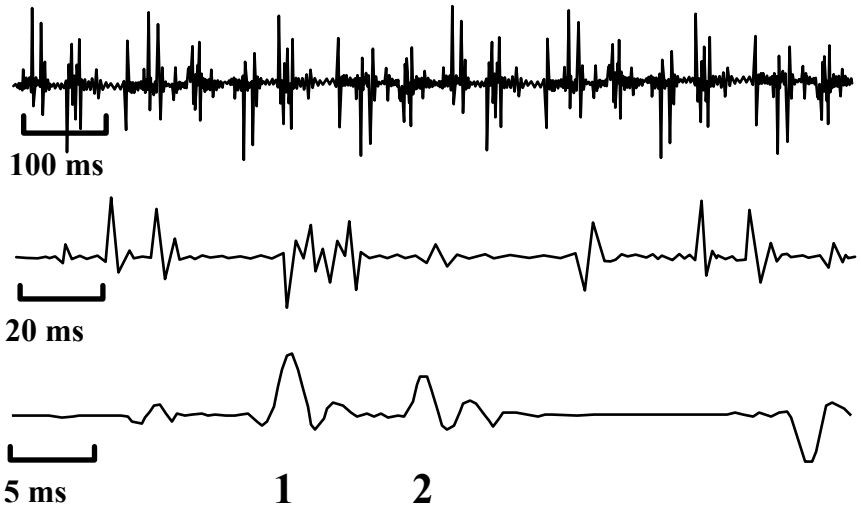
ELECTROMYOGRAPHY

EMG - T/A - MUP - DECREMENT - SFU - MACRO

Electromyography

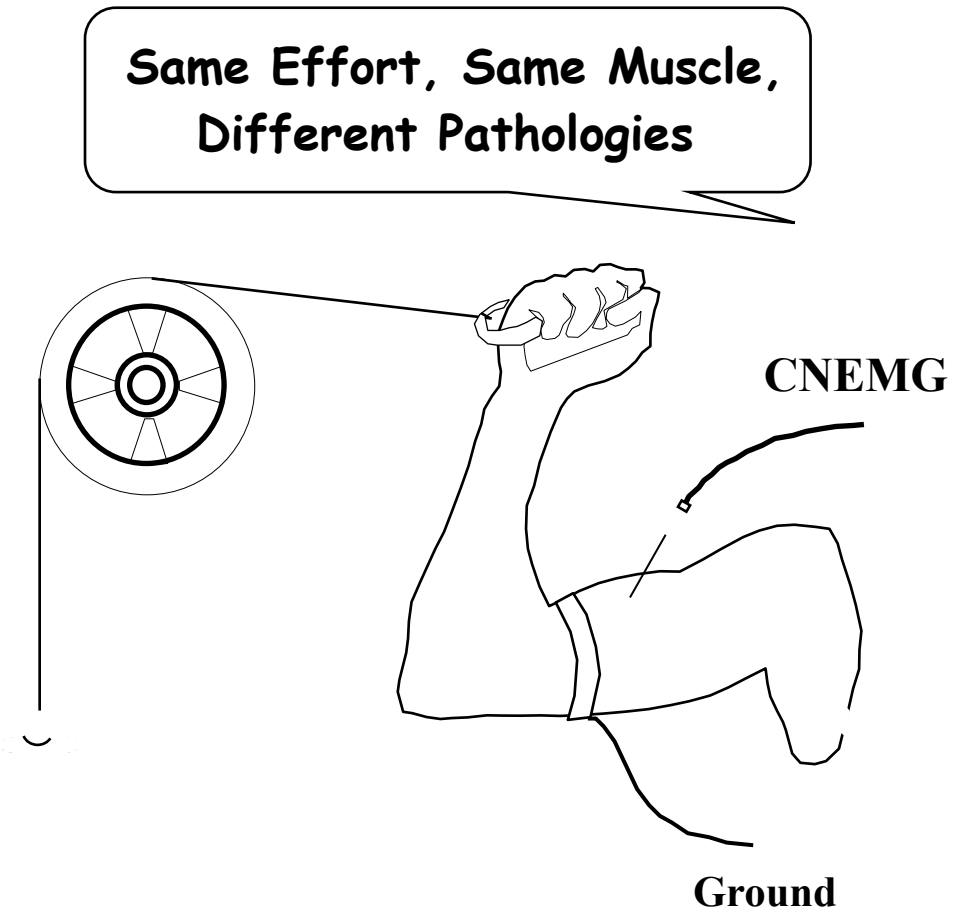


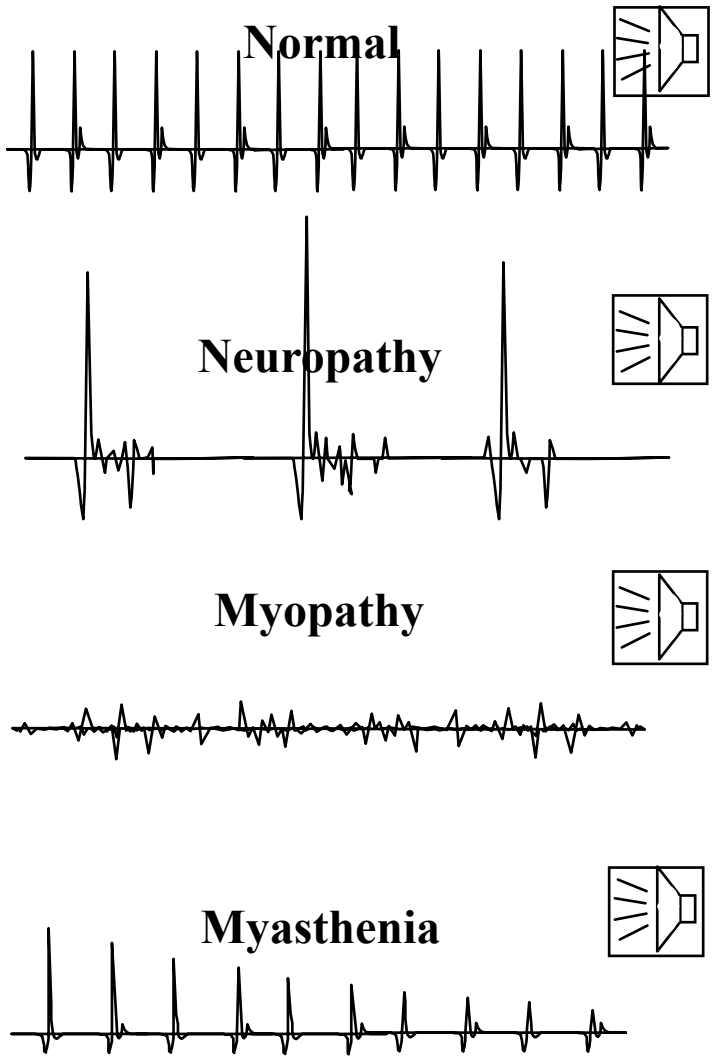




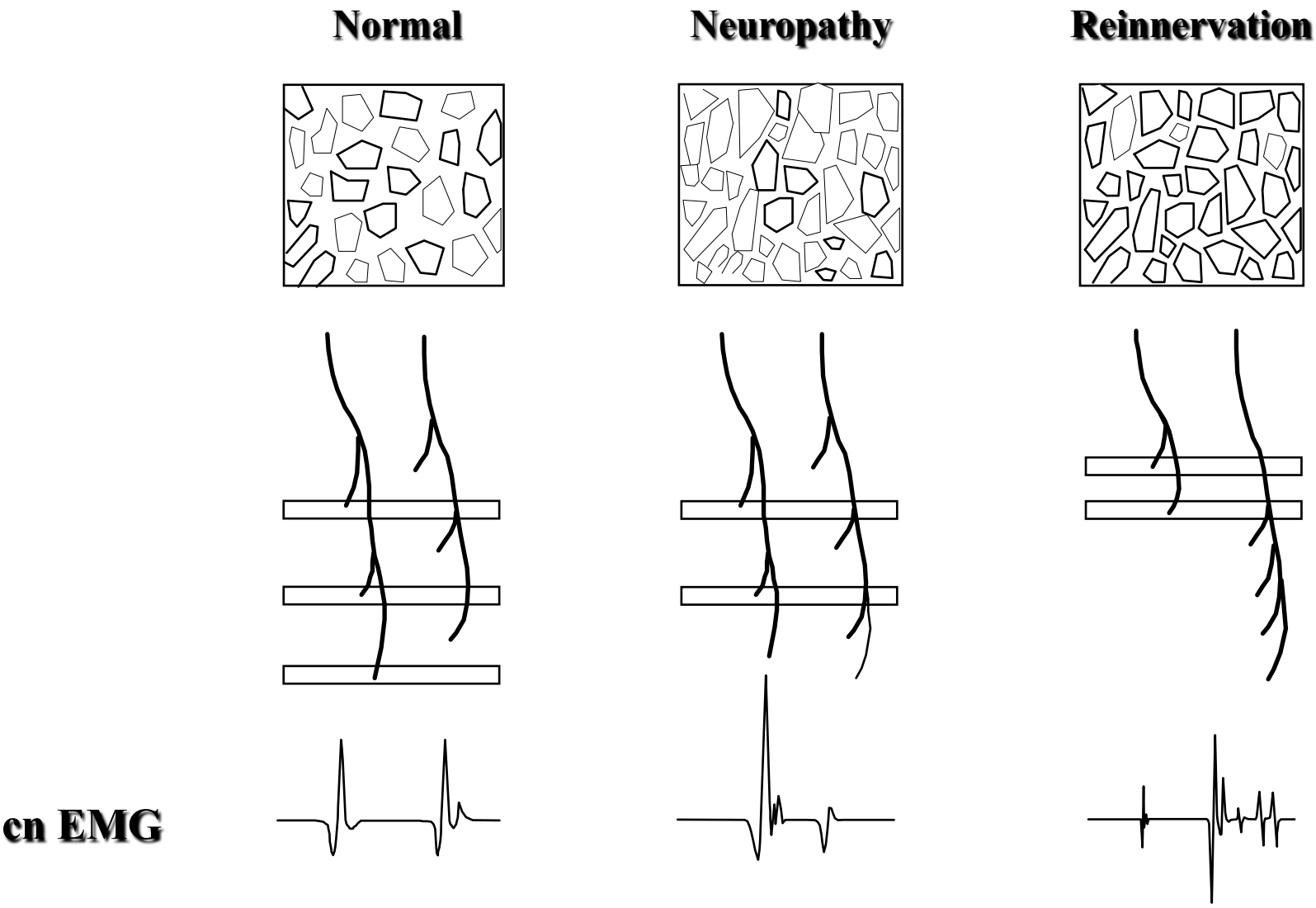
Pathologies in Muscle

STOP



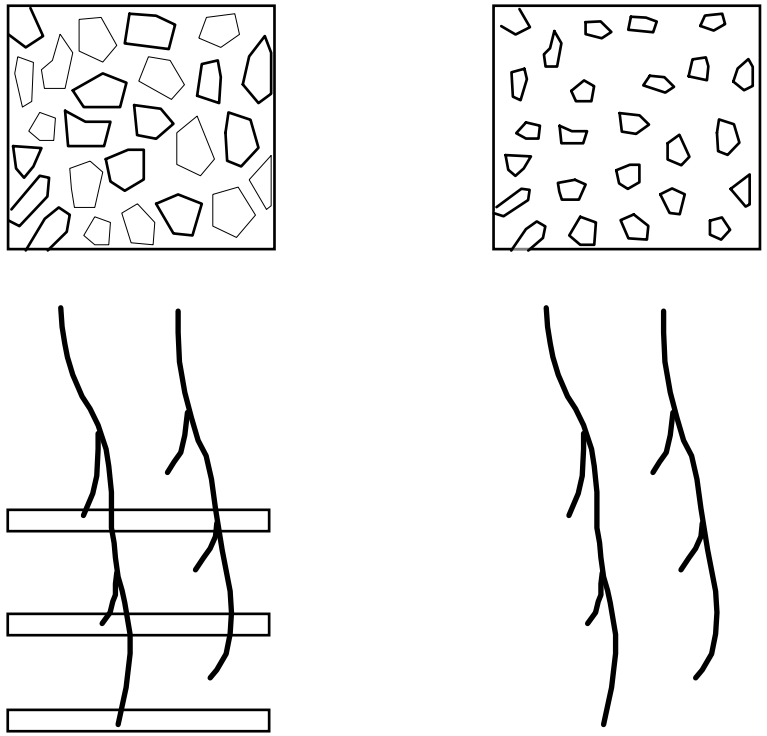


Neuropathy - Reinnervation



Myopathy

Normal **Myopathy**



Cells Degeneration

Smaller Fibers

More Tissue

Motor Conduction :

Latency OK

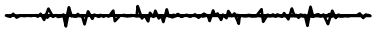
Low Amplitude

cn EMG

Duchenne Myopathy

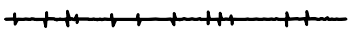
Pathologies *(Classification)*

CENTRAL WEAKNESS
Spinal Cord - Brain



Pron. Myopathy

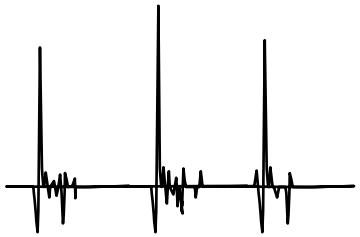
NORMAL



Complete Denerv.

MYOPATHY
Muscle Fibers

++



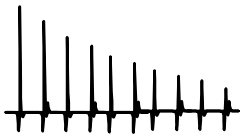
NEUROPATHY
Axon - Myelin or both

Loss of MU

+

Partial Denerv.

Mod. Neuro.



MYASTHENY
Neuromuscular Junction

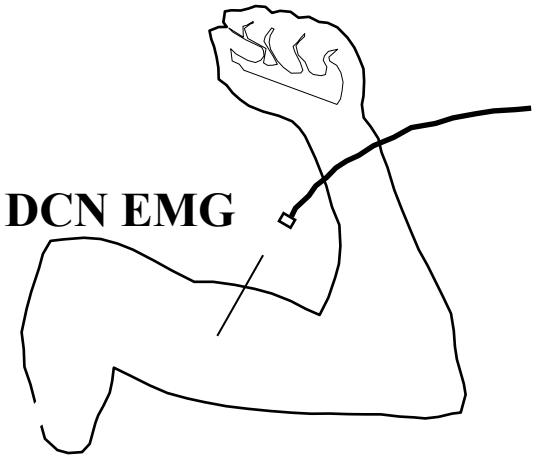
EMG - Recruitment

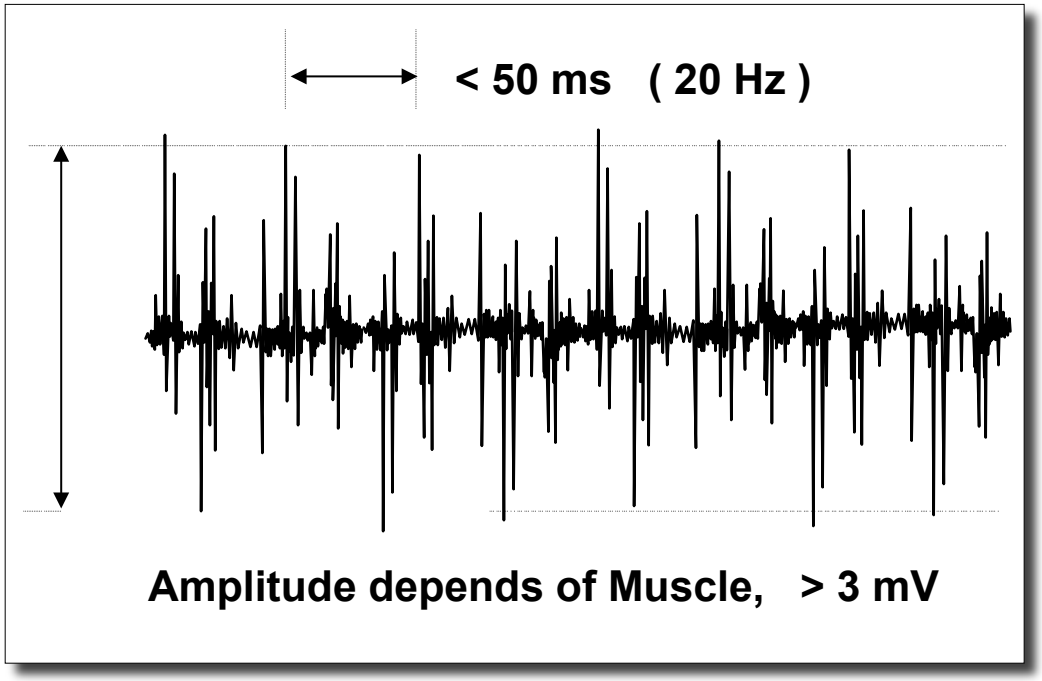
STOP

EMG Needles :

- **Disposable Concentric**
- **Disposable Monopolar**

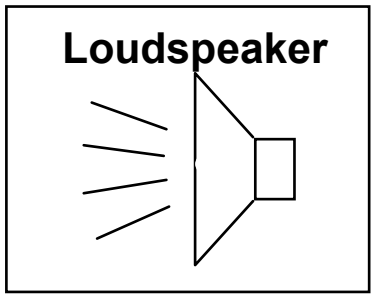
MAXIMUM EFFORT





Auditory control of :

- **Resting Silence**
- **Focused in the muscle**
- **Frequency Firing**



Motor Unit Potential (MUP)

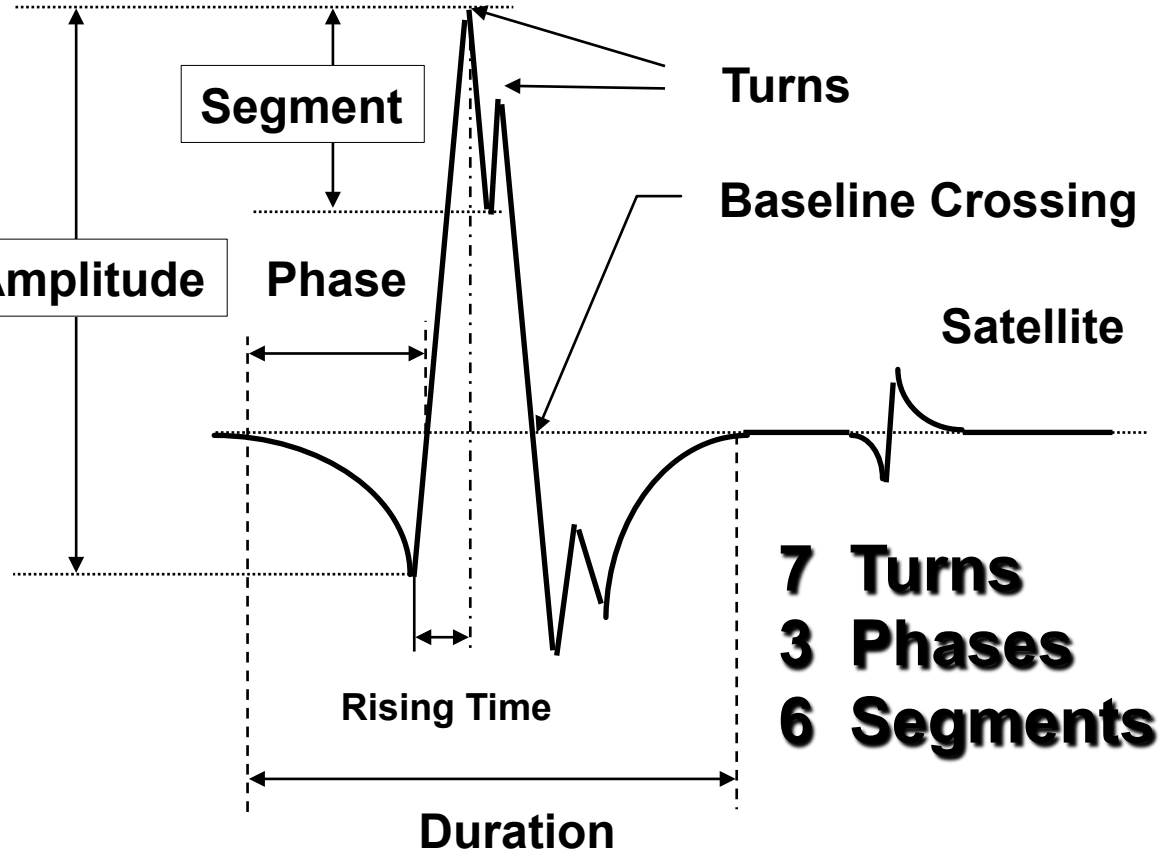
Single Potential, Phases ⩽ 3
Polyphasic Potential, Phases > 3

Group of Muscle Fibers

generate MUPs.

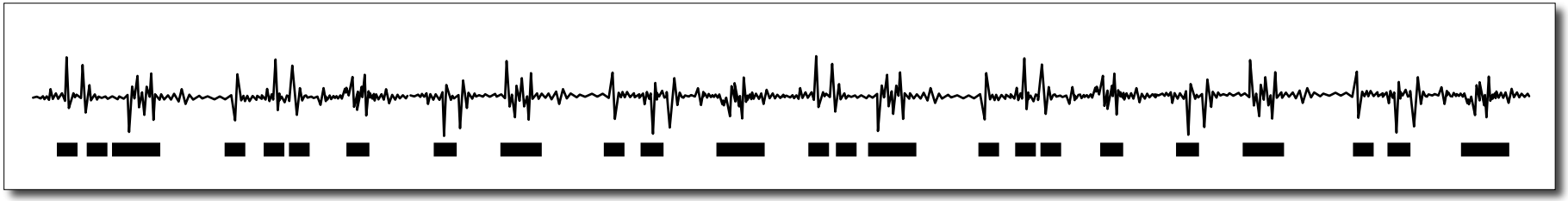
Different Fibers

different MUPs.

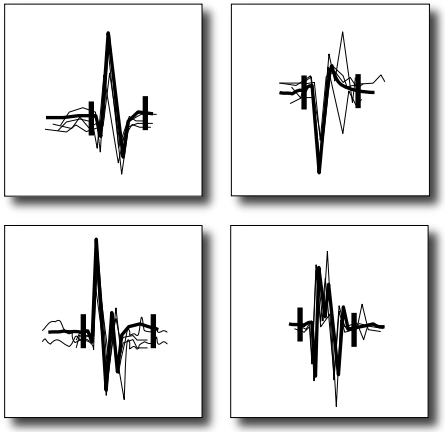


M U P *Analysis*

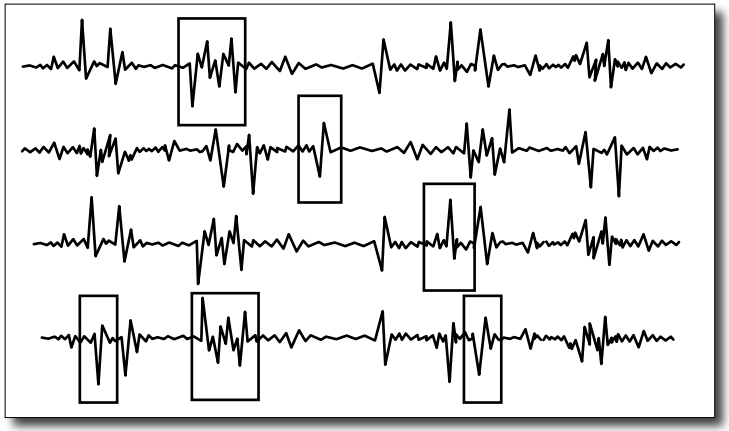
STOP



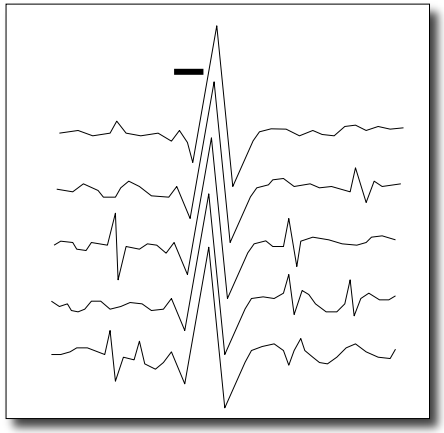
Multi-MUP - Averaging



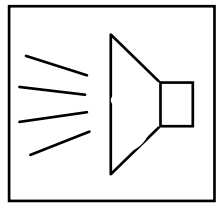
Manual Selection



Single - Triggering

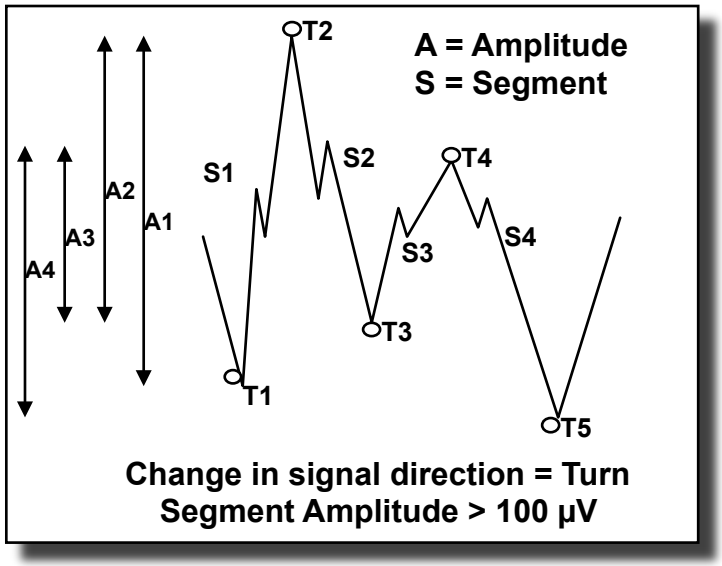


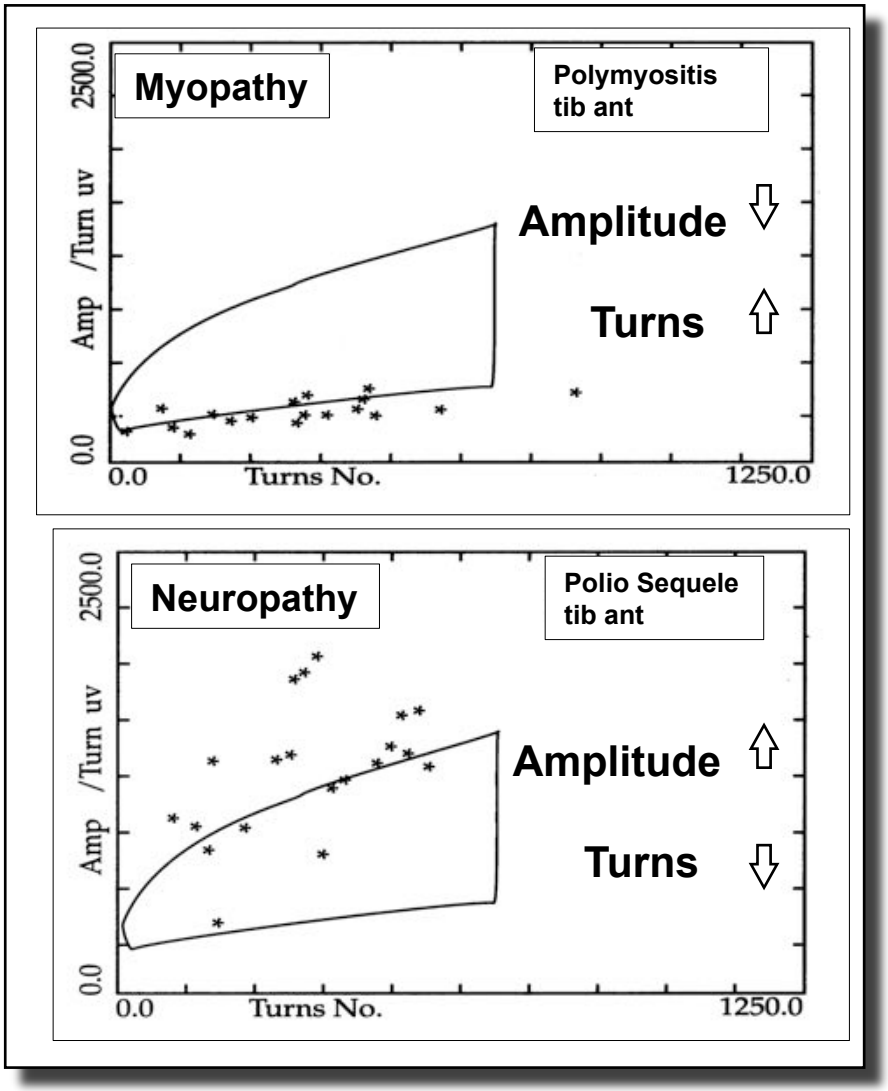
- **Moderate Contraction**
- **Simple/Polyphasic Potentials Ratio**
- **Amplitude**
- **Duration**



Turns/Amplitude

- 1 seconde EMG signal
- Concentric or Monopolar Needle
- Few sites in same muscle
- 20 measurments at diff. force
- Number of Turns > 100 µV
- Mean Amplitude of Turns





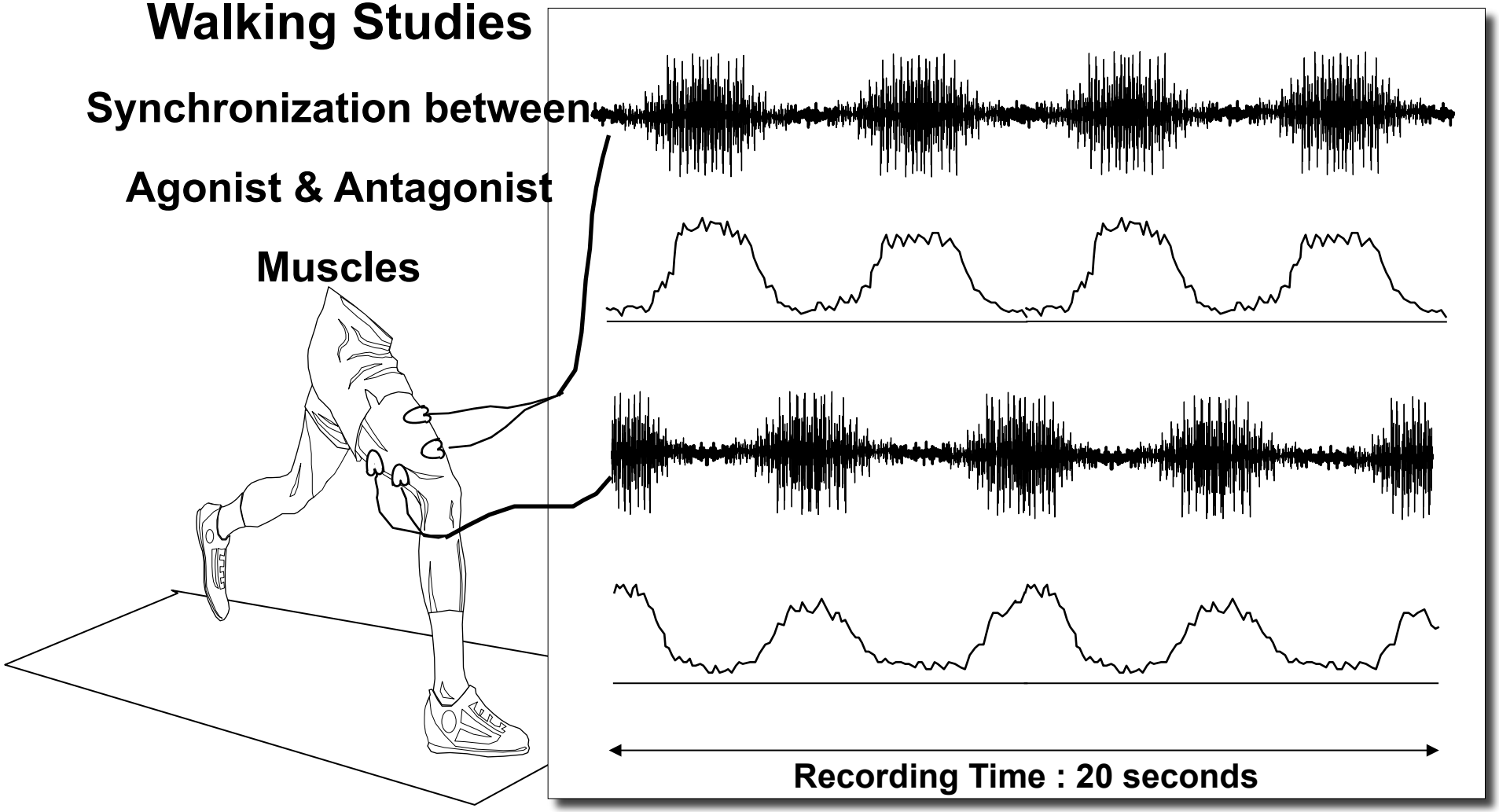
Multi-Channel EMG Oscilloscope Program

Walking Studies

Synchronization between

Agonist & Antagonist

Muscles



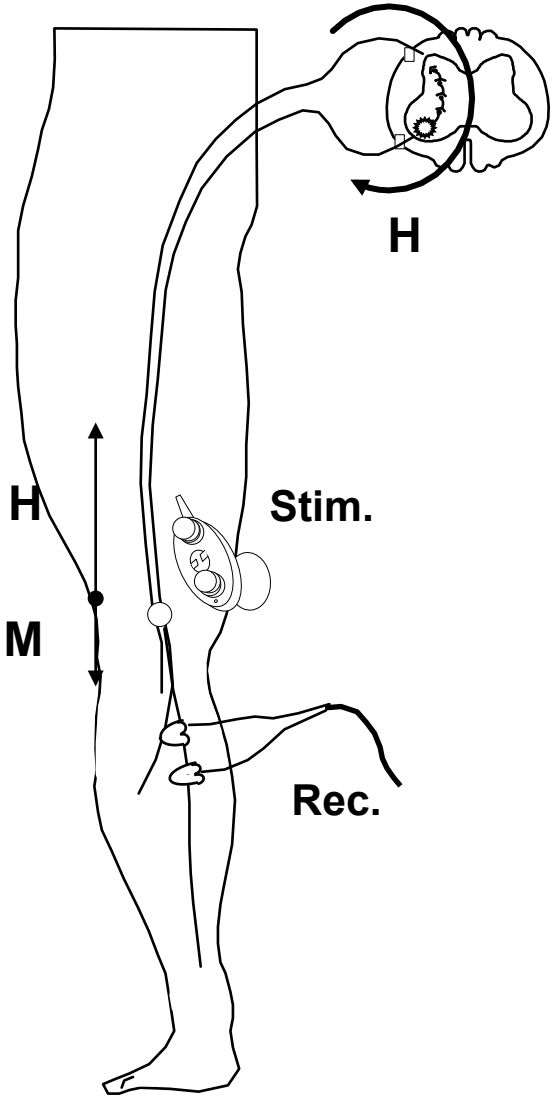
REFLEXES

H - BLINK - T - BCR

H - Reflex

Tibial Nerve - Root S1

Polyneuropathies
Radiculopathies

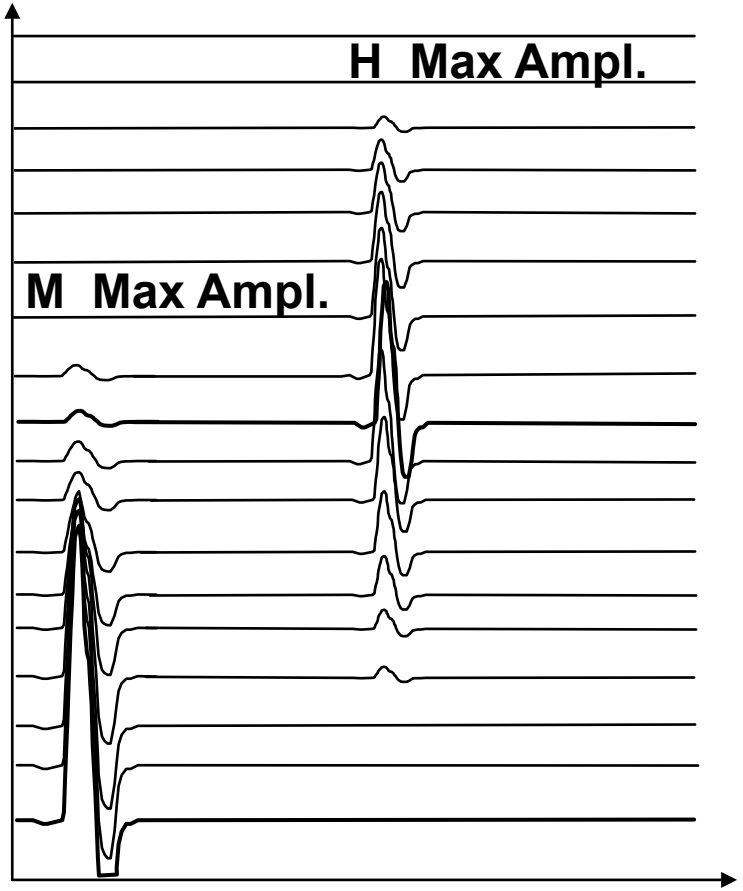


Stimulation

Dur. 1 ms

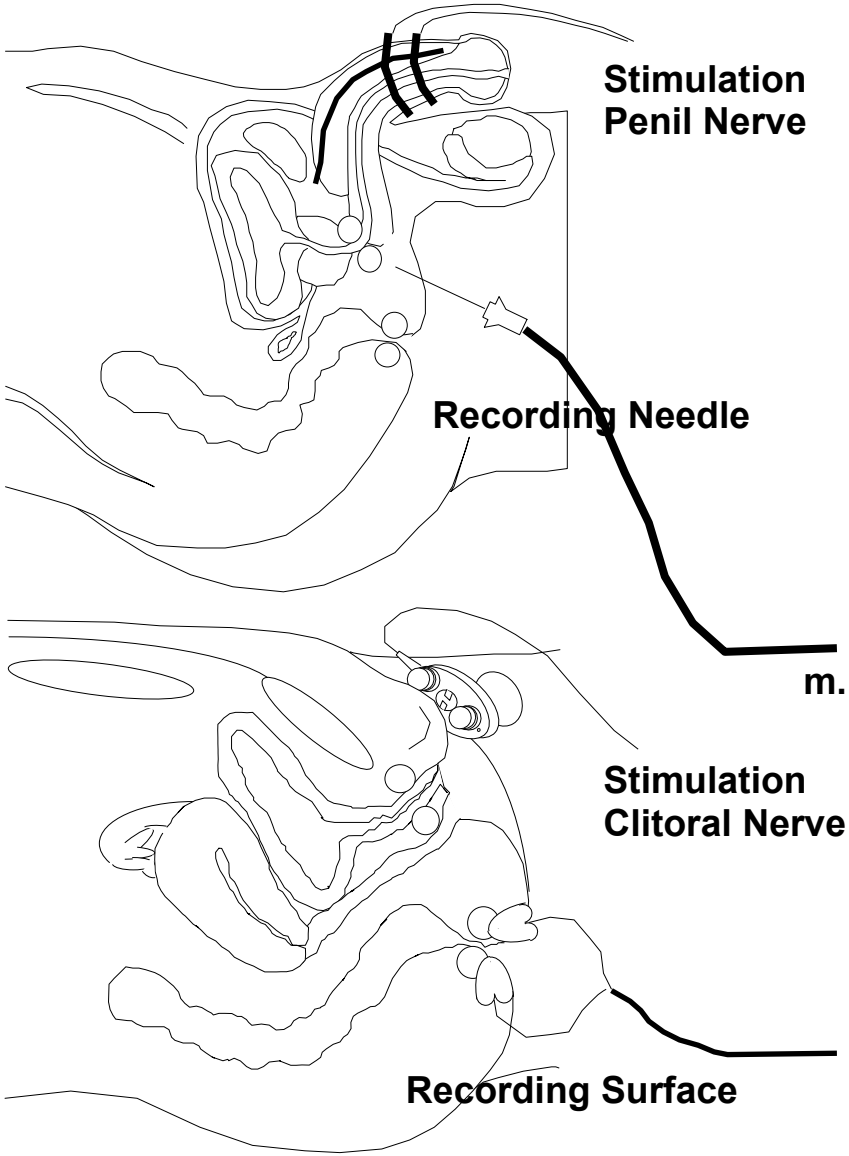
Int. from 0 mA to M Max.

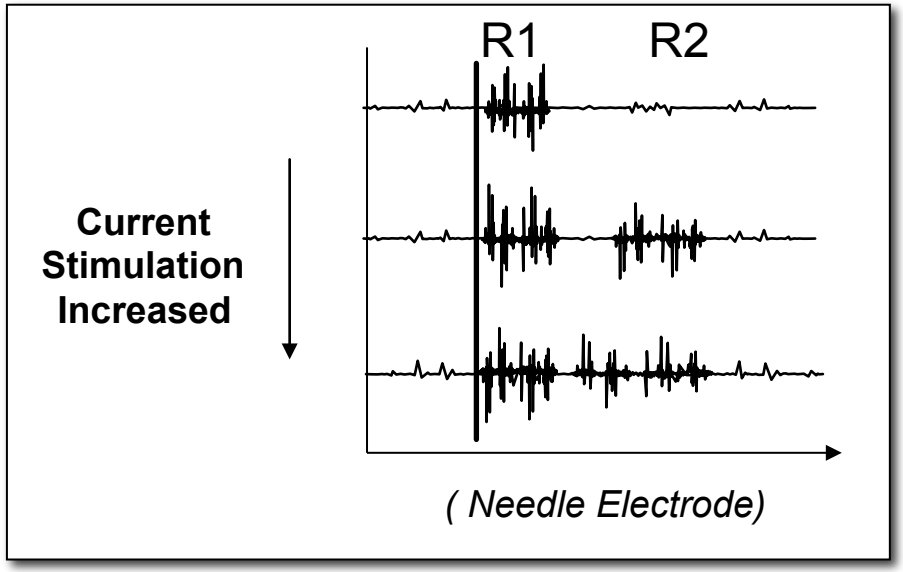
Increment step 0,2 mA



Latencies **M : 10 ms** **H: 30 ms depend height**

Bulbocavernous Reflex



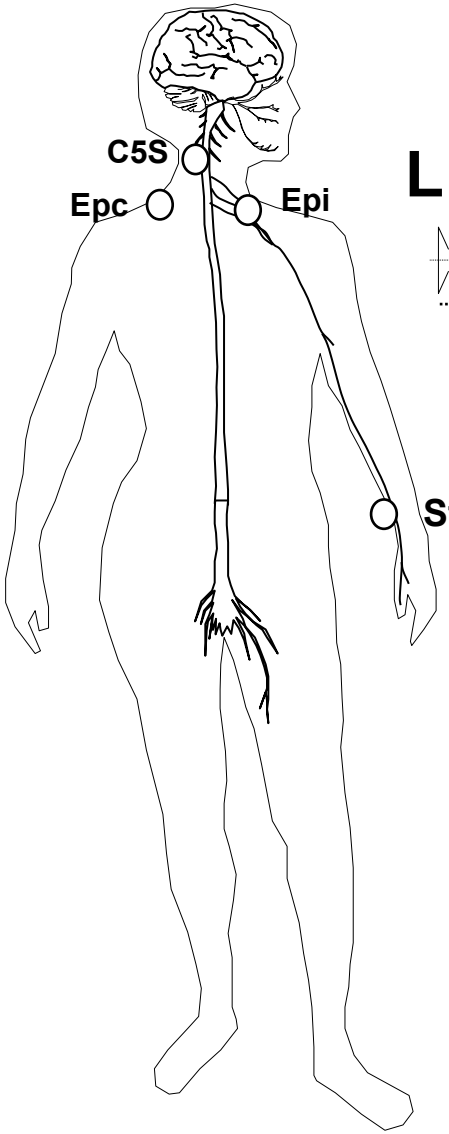


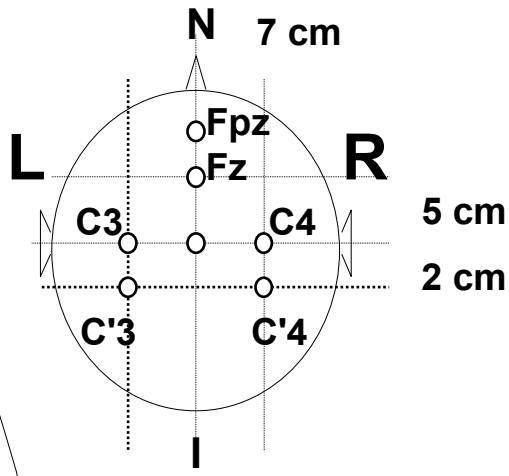
Recording Reflex
Latency R1
typ. 33 ms

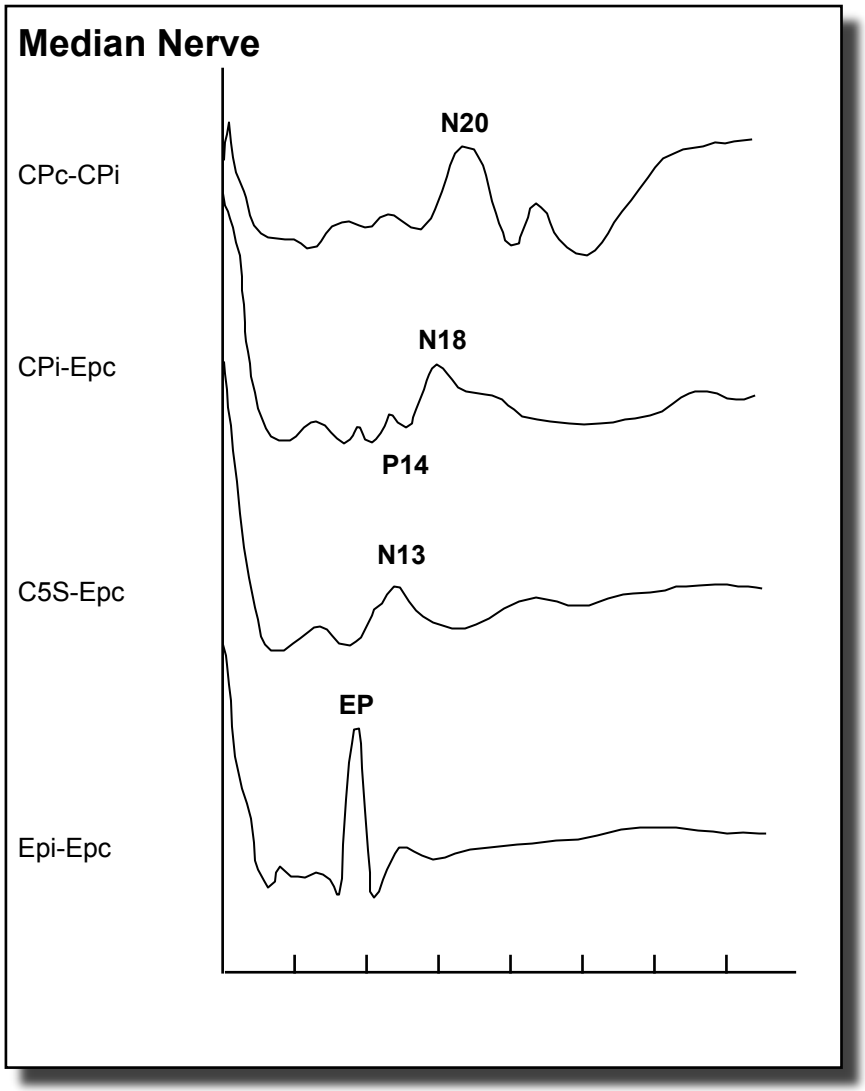
EVOKED POTENTIALS

SEP - VEP - BAEP - AEP - P300 - MEP - IOM

Somatosensory E.P. *Upper Extremities*

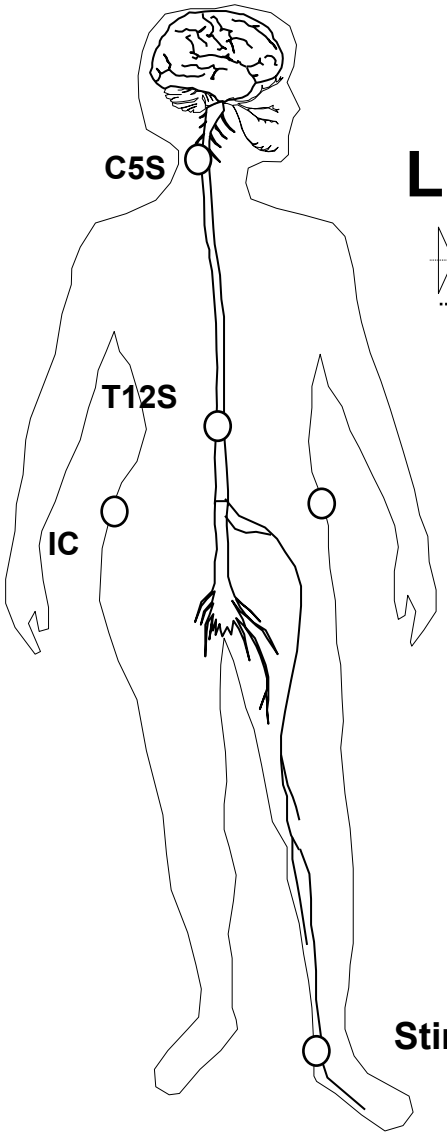


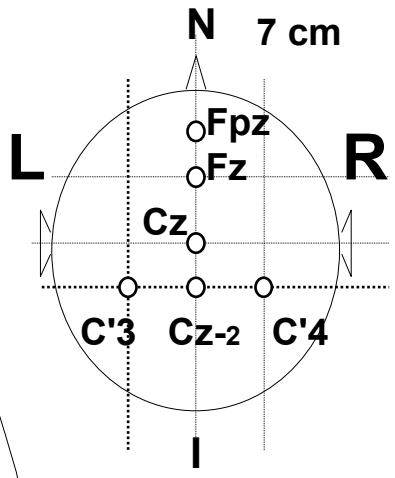


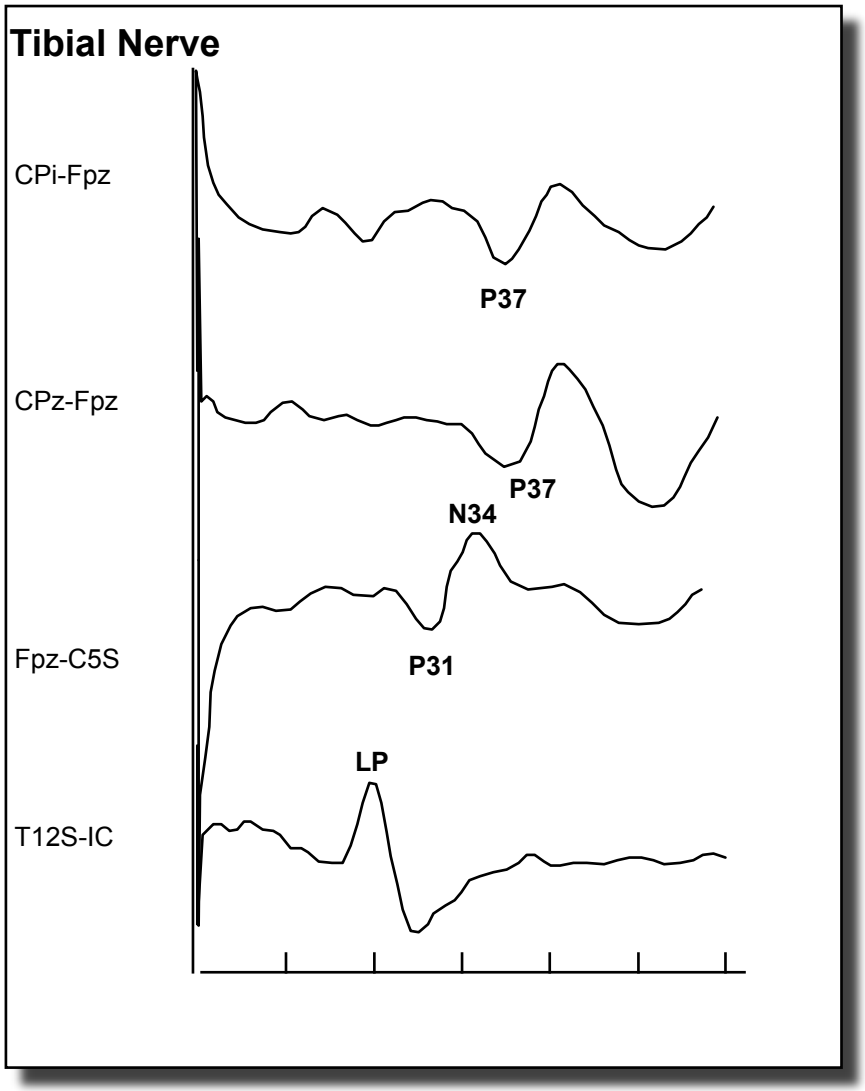


- Rectal stimulation / bladder

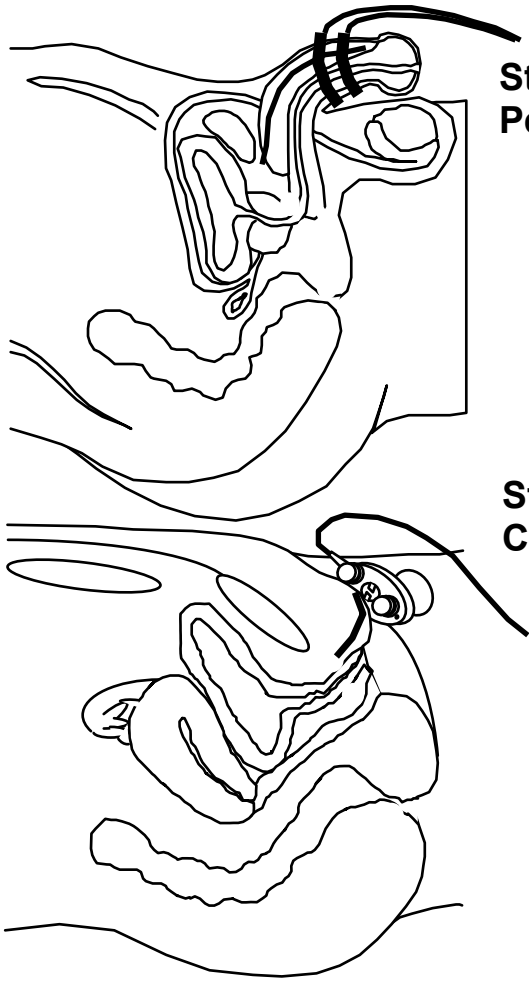
Somatosensory E.P. *Lower Extremities*





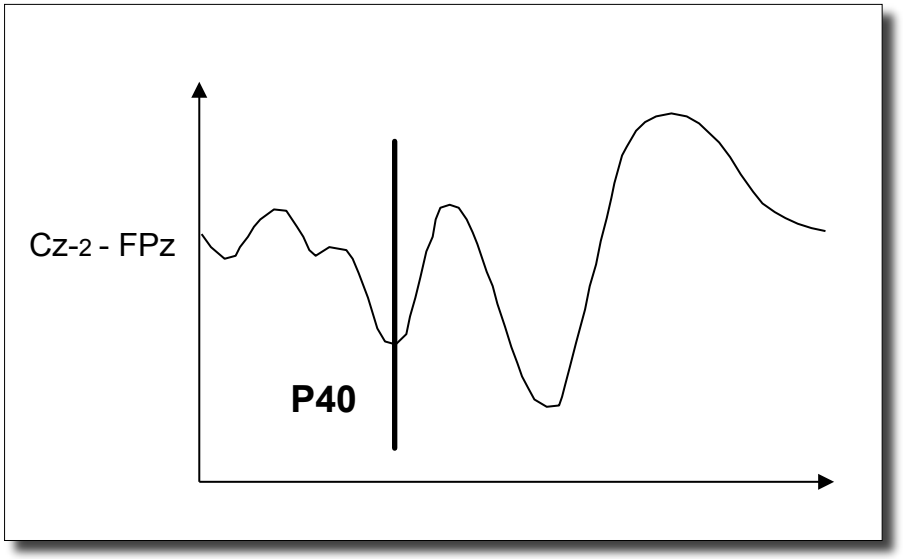


SEP - *Pudendal Nerve*

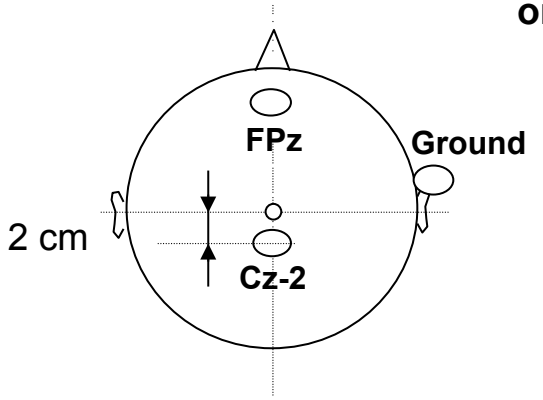


Stimulation Penil Nerve

Stimulation Clitoral Nerve

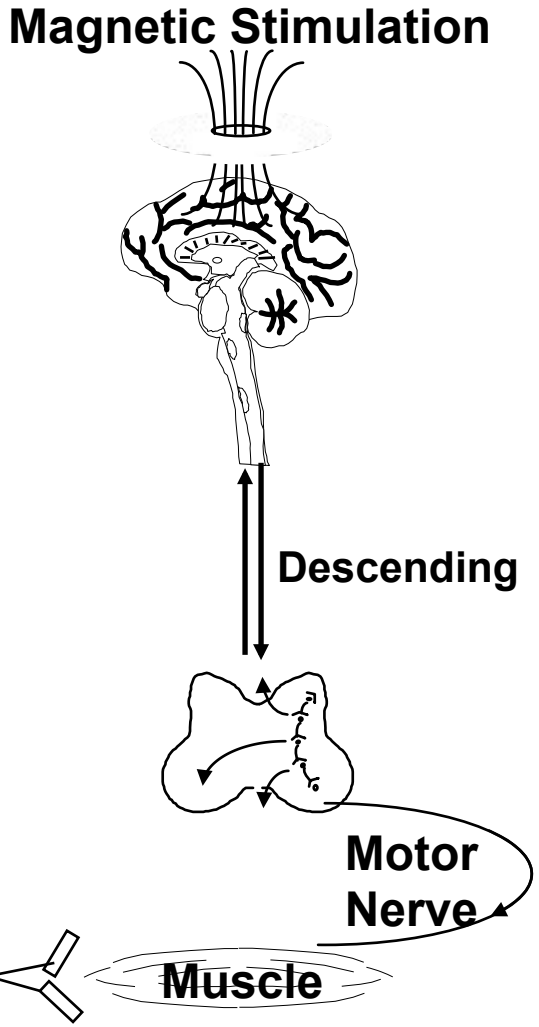


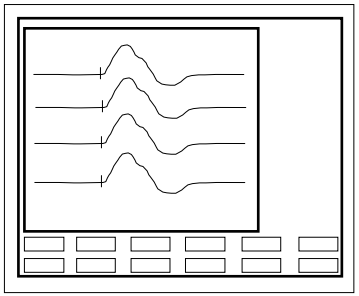
Record on Scalp with Scalp Needle or Surface Electrode
Averaging : 200



Latency P40
typ. 39 ms
(nl < 44 ms)

Motor E.P.





Trigger

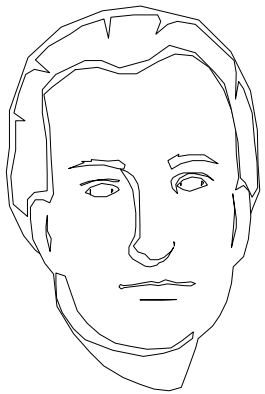
Record

Keypoint

AUTONOMIC

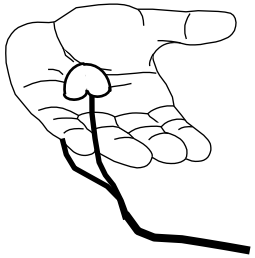
SSR - R:R INTERVALES - PELVIC

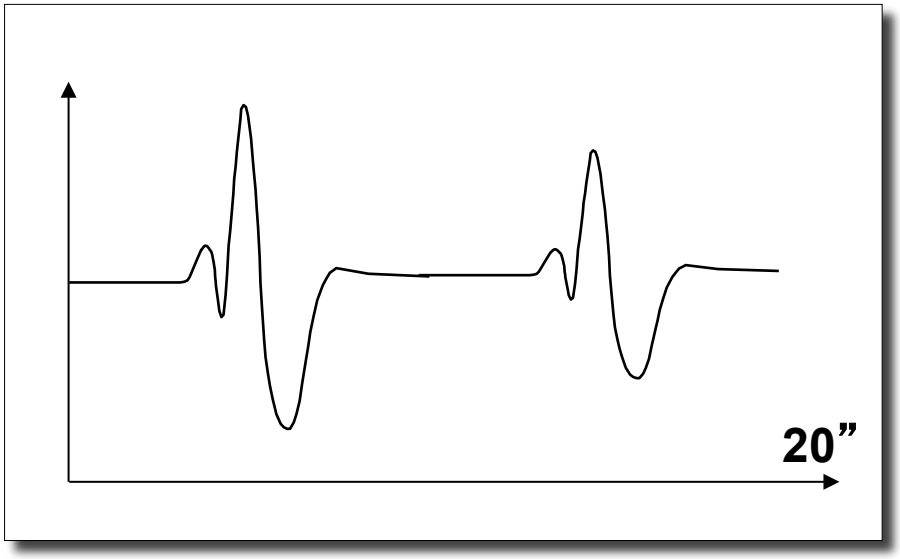
Sympathetic Skin Response *Autonomic*



Stim.

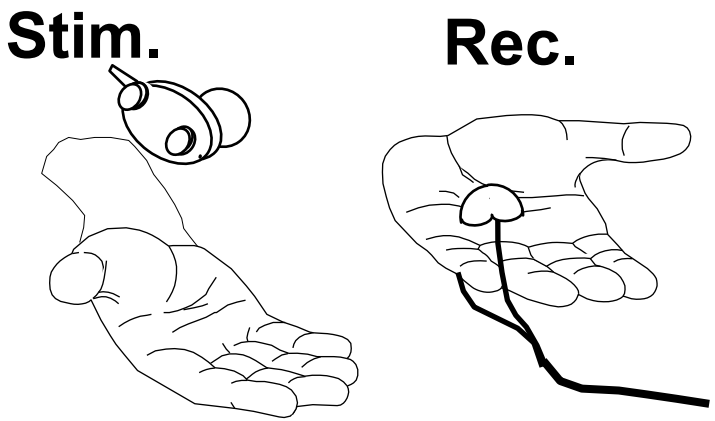
Rec.

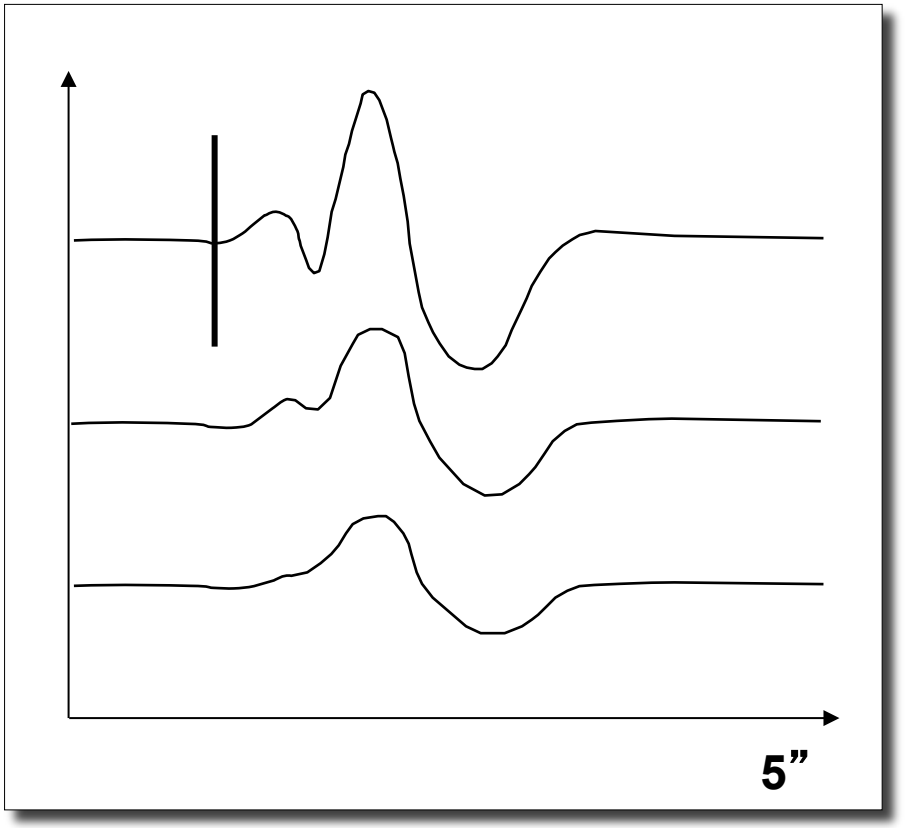




Free Running : Oscilloscope Program

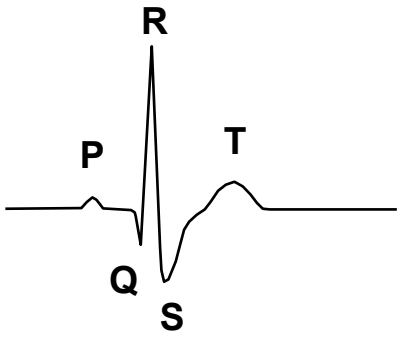
Sympathetic Skin Response *Autonomic*

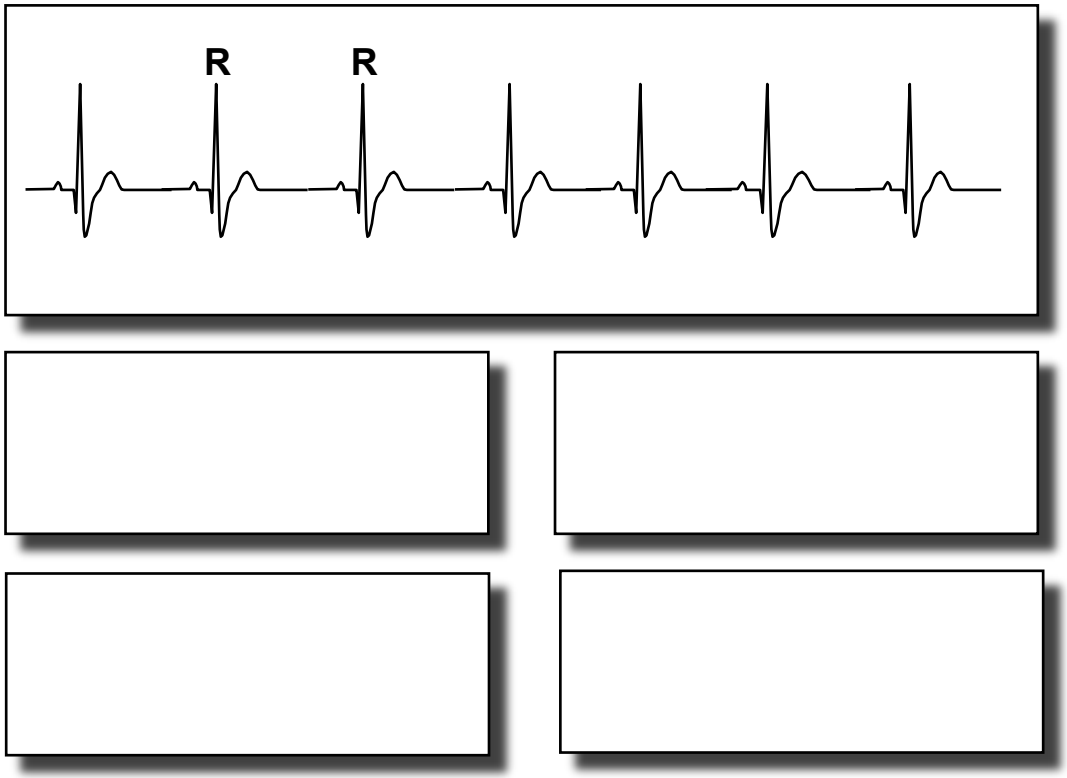




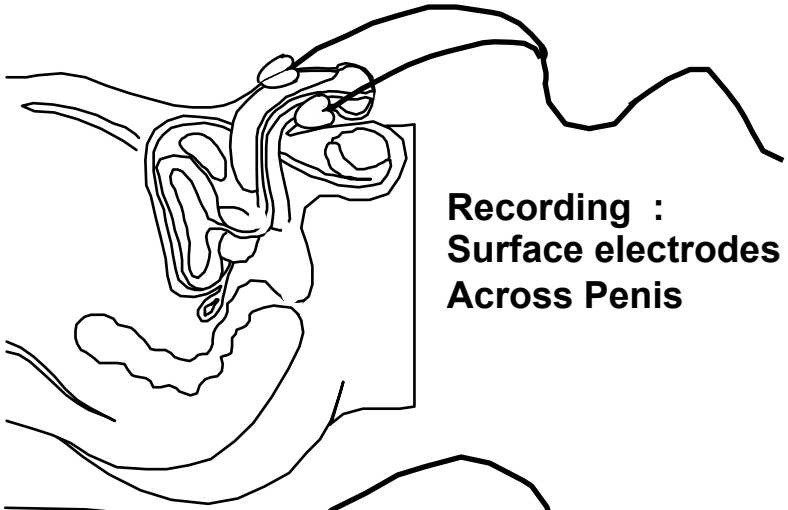
Synchronized Recording : Program SSR

R - R Interval *Autonomic Heart Rate*

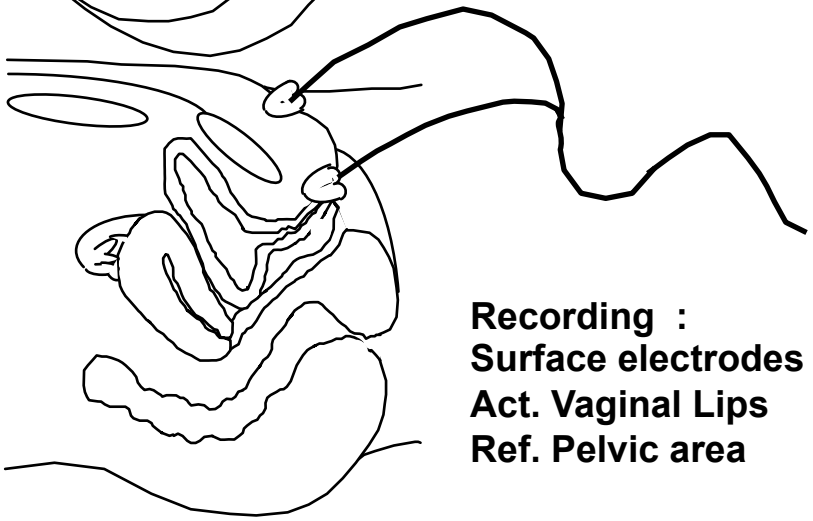




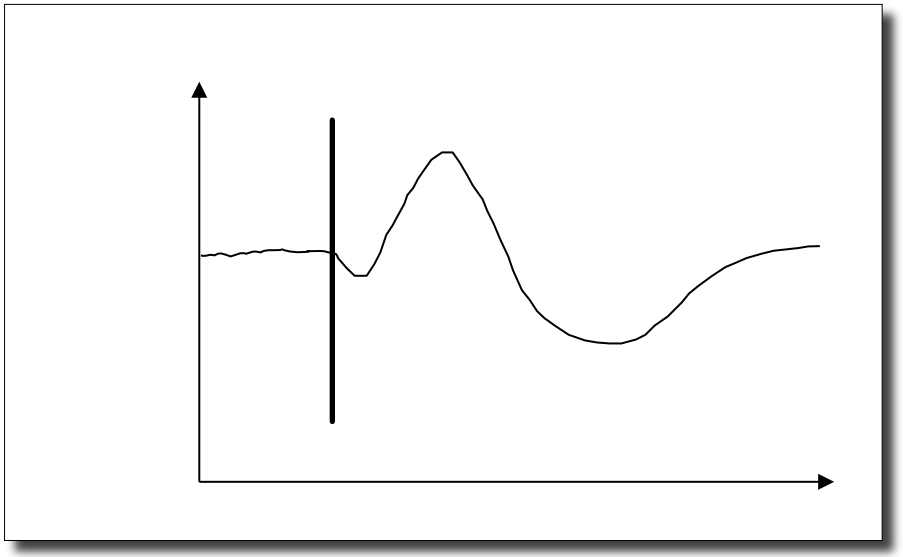
Pelvic SSR *Sexology Studies*



Recording :
Surface electrodes
Across Penis

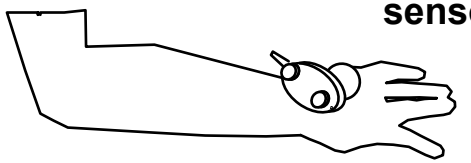


Recording :
Surface electrodes
Act. Vaginal Lips
Ref. Pelvic area

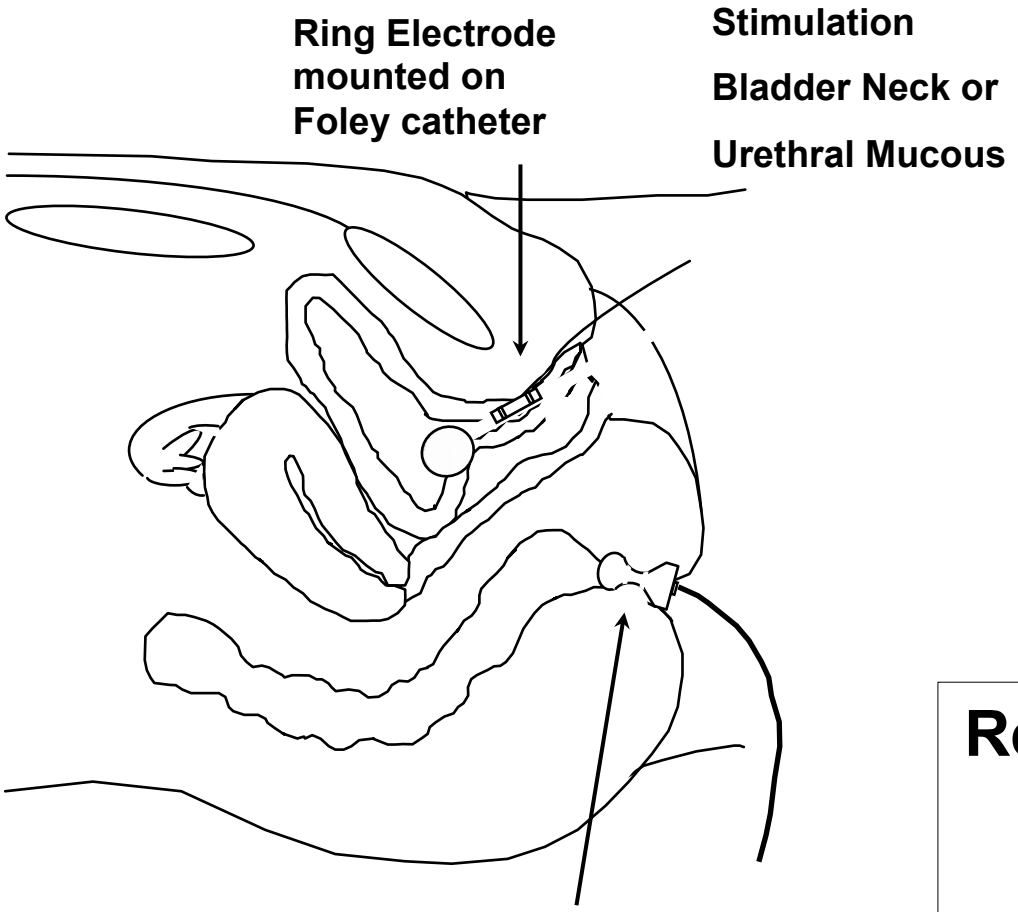


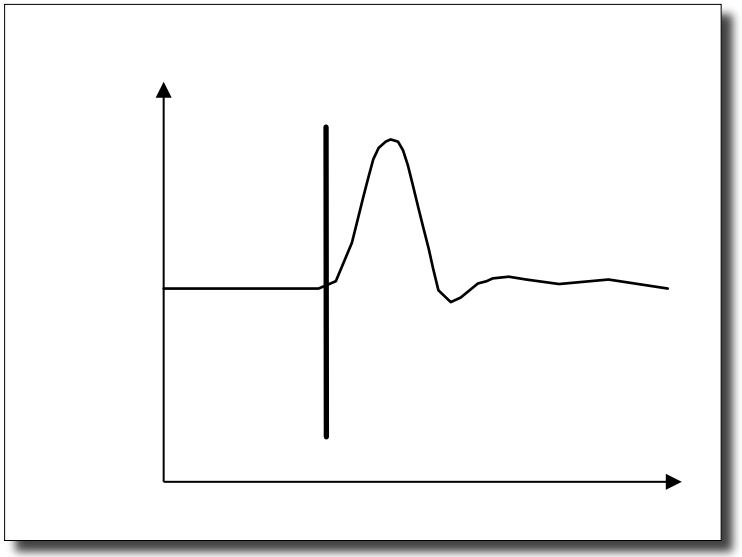
Typ. Lat. 1,5 s
Amplitude : 2 - 3 mV

Stimulation Median nerve, Intensity 3 times sensory threshold.



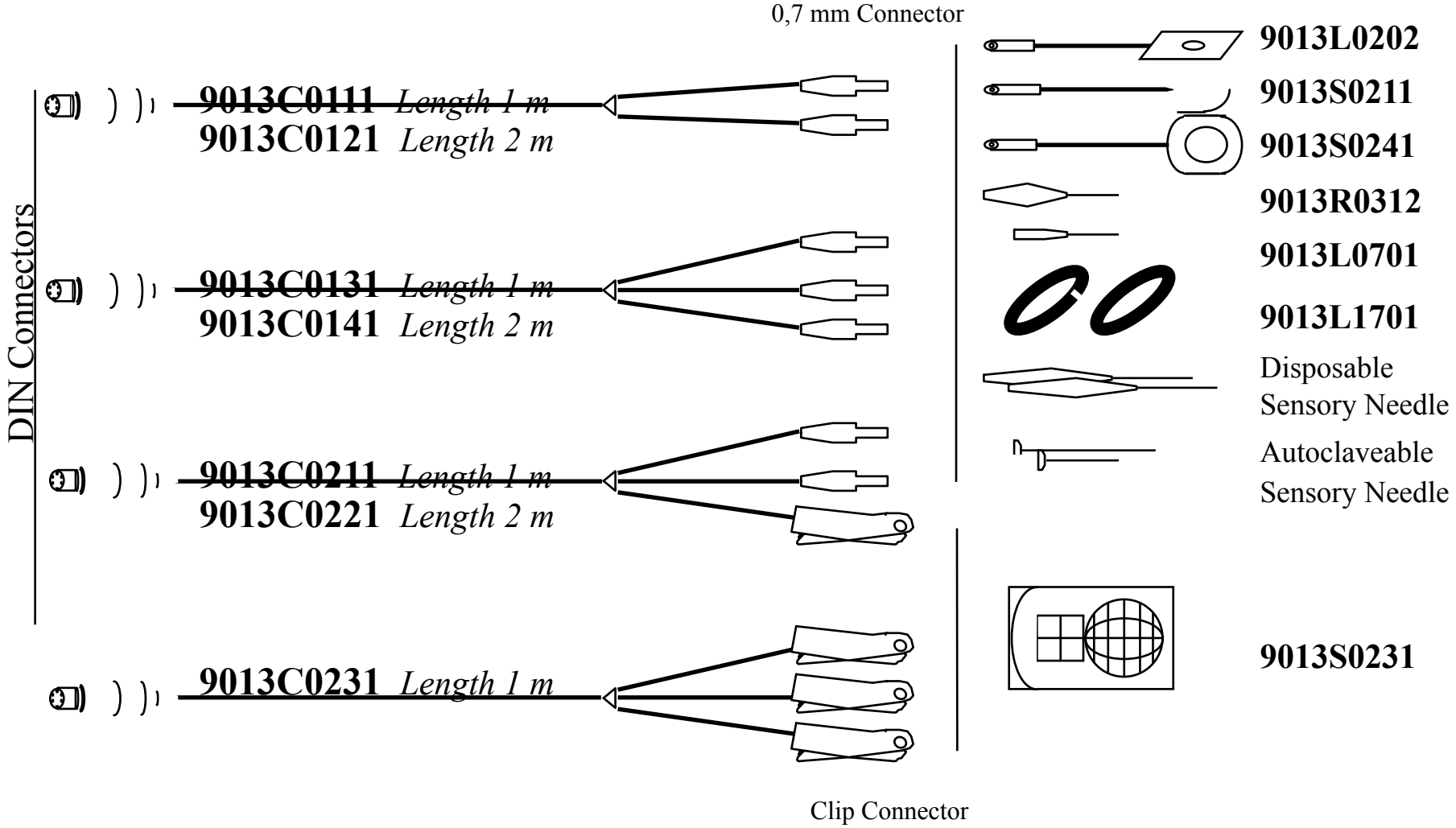
Autonomic Pelvic Responses *Sphincters*

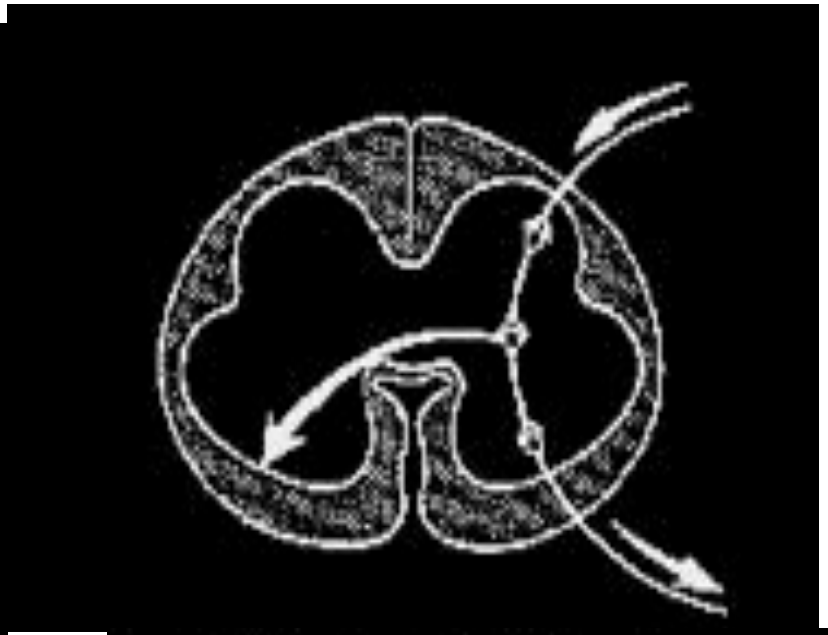


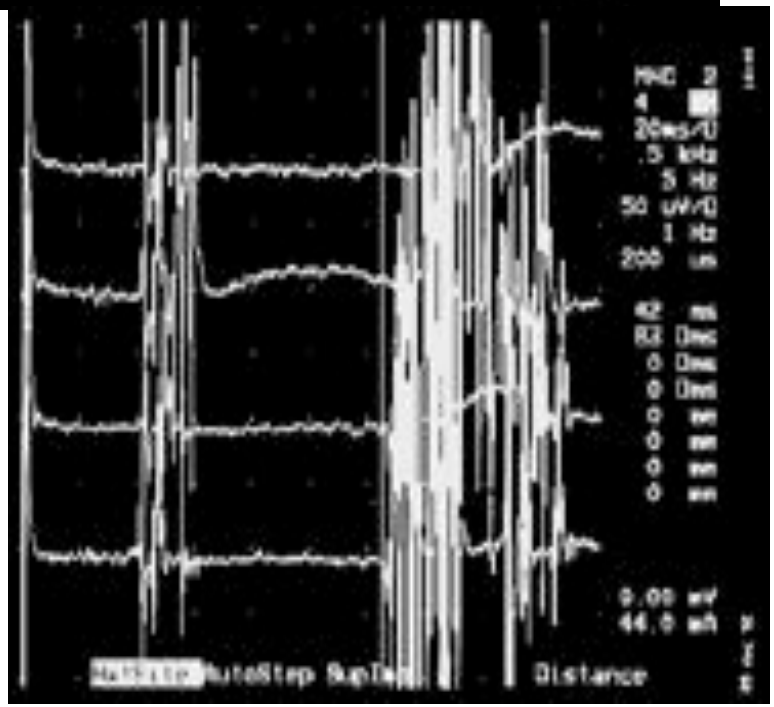


Recording Junction Reflex
Averaging : 50 to 200
Typ. Lat. 55 - 70 ms

Hush™ Cables *and* Electrodes






Distance

Latences du réflexe bulbo-caverneux mécaniquement induit

Technique

- **stimulation : mécanique nerf pudendal marteau électronique (région clitoridienne ou gland)**

- **recueil : électrode aiguille dans muscle bulbo-caverneux droit et gauche**

Latences du réflexe bulbo-caverneux mécaniquement induit

- 20 patients : 13 hommes, 7 femmes
- âge moyen : 50,9 ans (DS : 16,8)

- absence pathologie neurologique
- troubles périneaux : pollakiurie, algies périnéales

Latences du réflexe bulbo-caverneux mécaniquement induit

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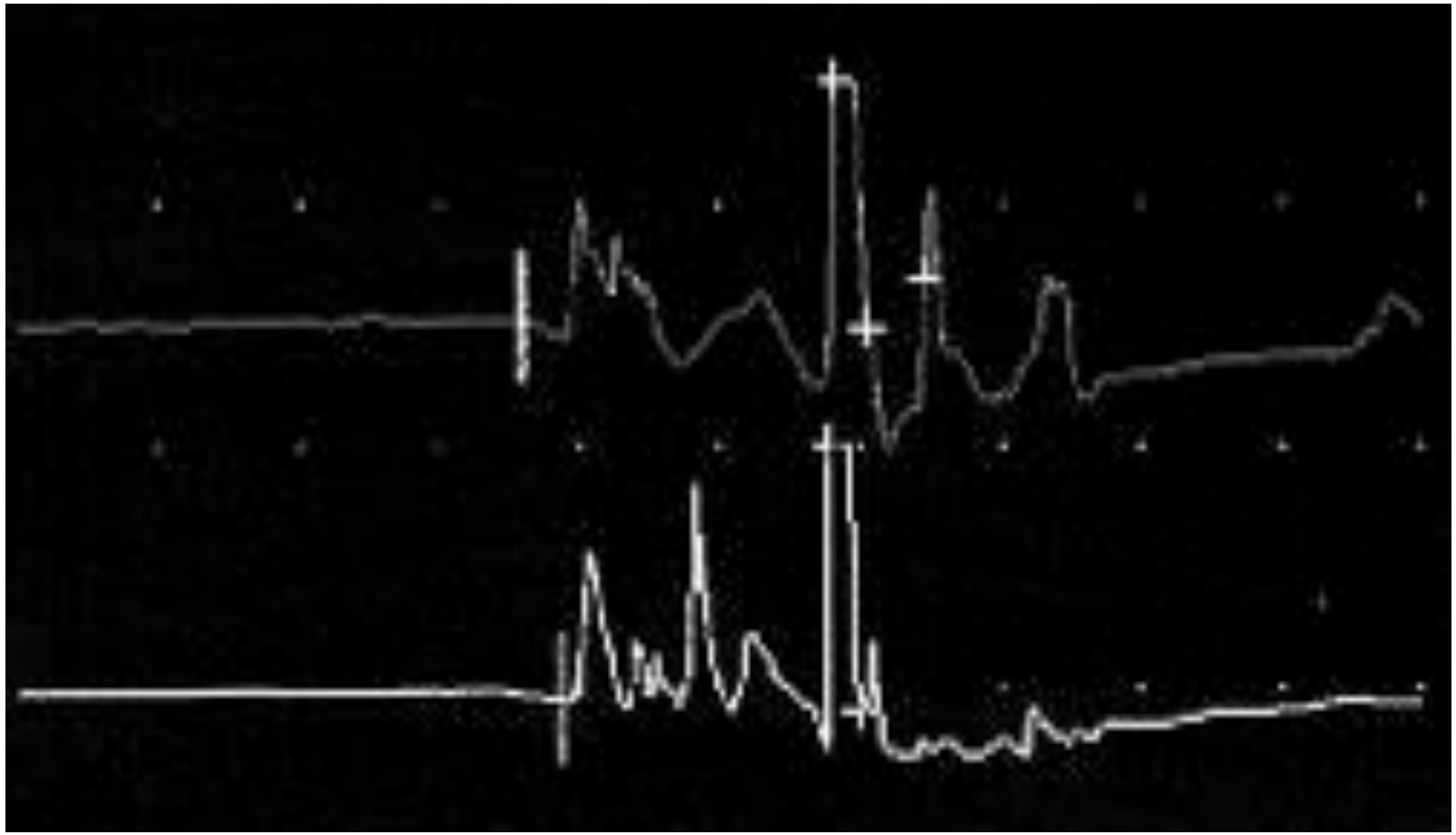
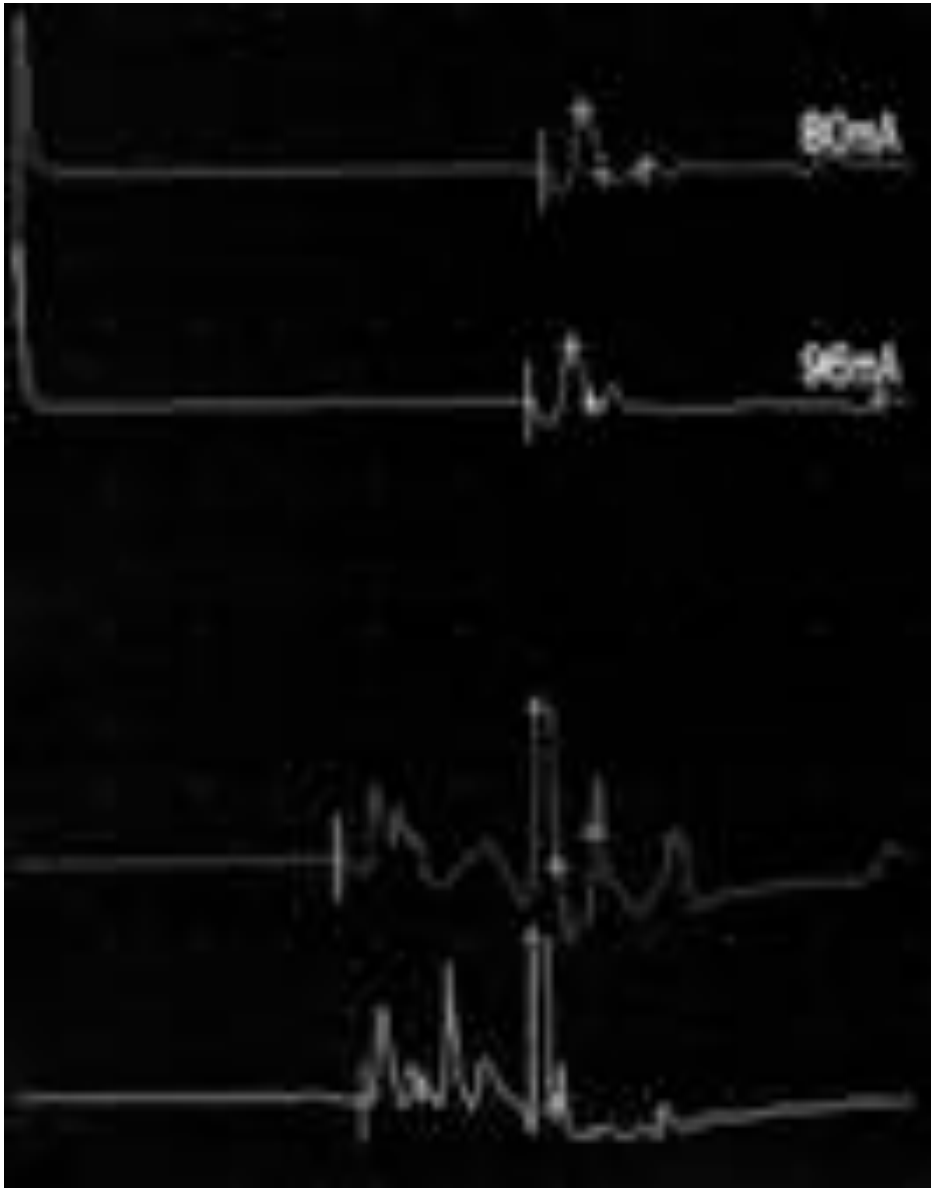
mesure des latences :

- **droite et gauche**
- **5 stimulations électriques de chaque côté**
- **2 stimulations mécaniques de chaque côté**
- **valeur retenue : la plus courte latence pour chacune des stimulations**




80mA
96mA

Latences du réflexe bulbo-caverneux mécaniquement induit

	Droit	Gauche
LRBC électrique	33 ms (SD : 4,2)	33,3 ms (SD : 3,1)
LRBC mécanique	31,5 ms (SD : 4,1)	31,3 ms (SD : 4,5)

Latences du réflexe bulbo-caverneux mécaniquement induit

- **bonne reproductibilité de la mesure latence LRBC mécanique (p : 0,0001) (ANOVA)**

- **valeurs normales : latences maximales (à 2 DS)**

  - **40,3 ms à gauche**
  - **39,7 ms à droite**
  - **écart maximal inter-latence : 6 ms**

Latences du réflexe bulbo-caverneux mécaniquement induit

- **LRBC mécaniquement induit : résultats similaires à la technique classique par stimulation électrique**

- **méthode facile, reproductible et mieux tolérée**

ETUDE ELECTROPHYSIOLOGIQUE DE LA PERCUSSION SUS-PUBIENNE

•

rééducation des neuro-vessies pour déclencher une contraction vésicale

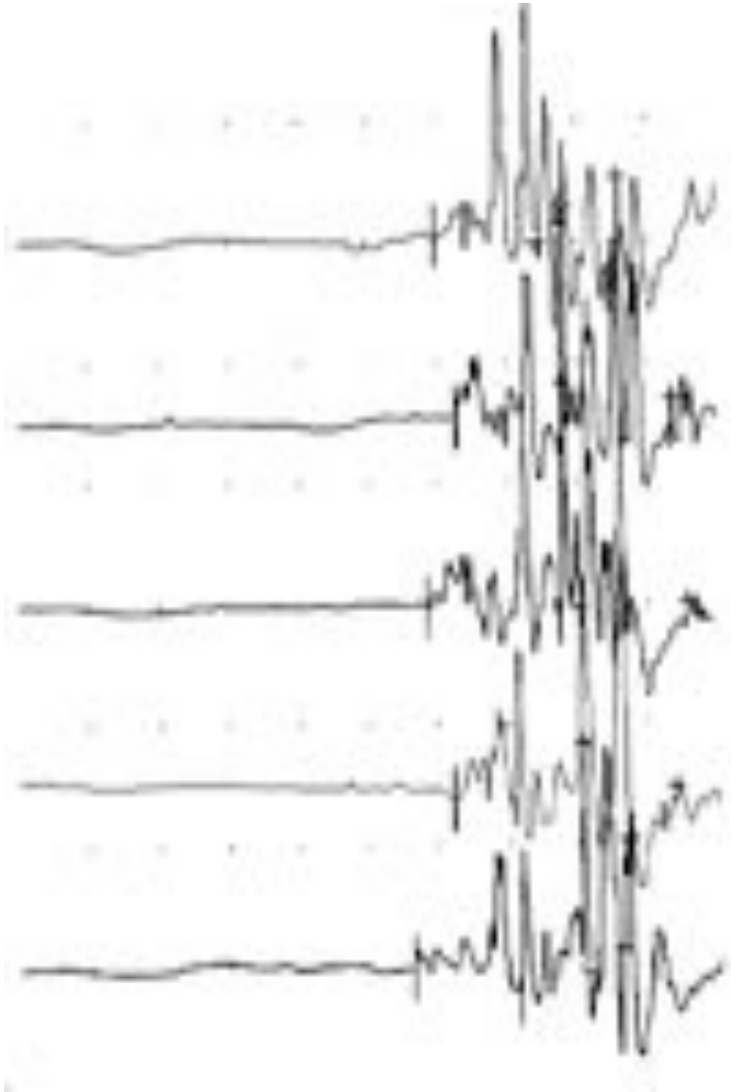
• réflexe intégré au niveau sacré ; pas toujours efficace pour assurer vidange complète si dyssynergie vésico-sphinctérienne

ETUDE ELECTROPHYSIOLOGIQUE DE LA PERCUSSION SUS-PUBIENNE : matériel et méthode

- 21 patients neurologiquement sains
- 14 femmes (10 IUE/ 4IUimp) 7 hommes (7/7 signes irritatifs)
- age moyen 51 ans (SD=14,2)

- stimulation mécanique supra pubienne par marteau électronique
- stimulation électrique du nerf sensitif afferent (NDV, N. clitoris)
- recueil à l ’aiguille dans le muscle bulbo-caverneux gauche

ETUDE ELECTROPHYSIOLOGIQUE DE LA PERCUSSION SUS-PUBIENNE : résultats



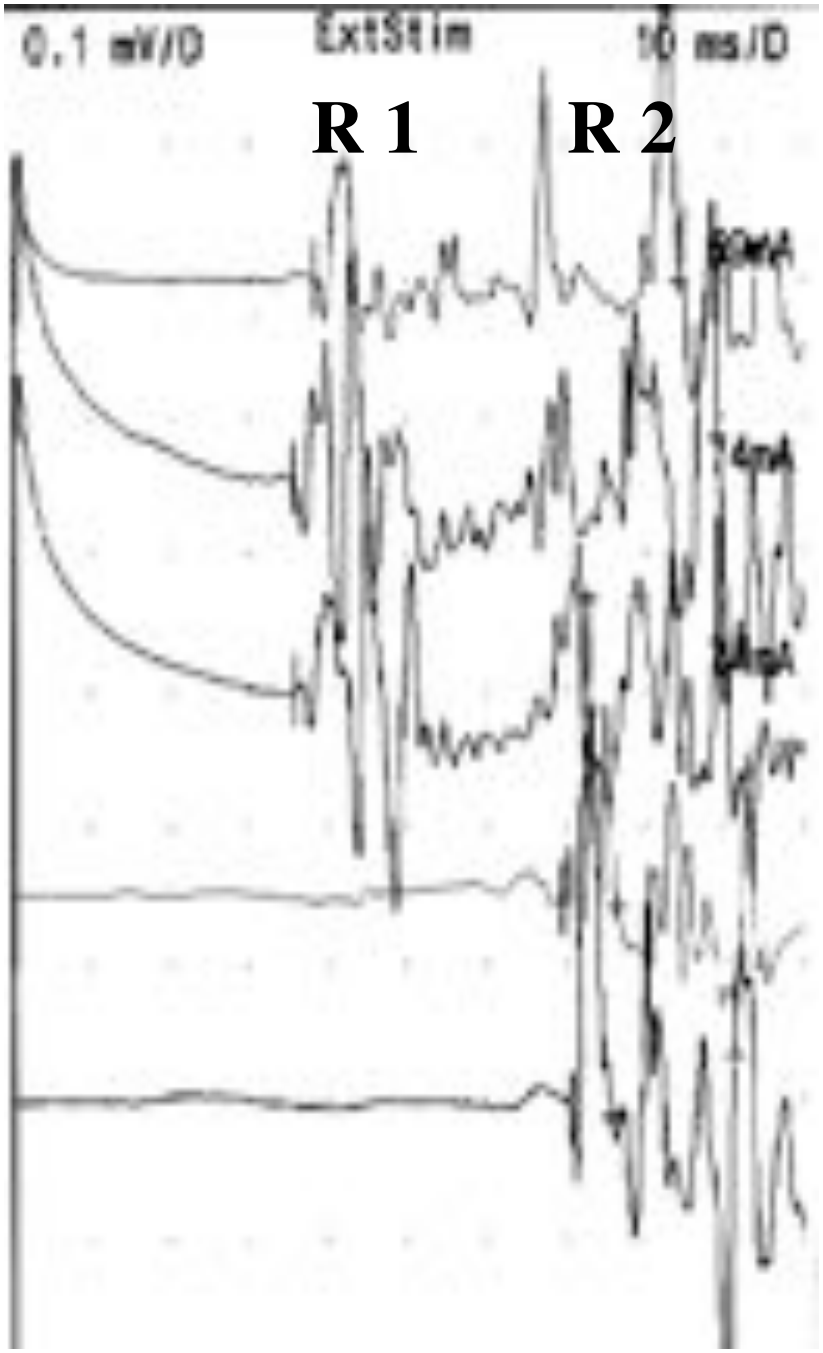
- **réponse électromyographique vérifiée par 2 fois stable et reproductible (analyse de variance avec p< 0,0001)**

- **latence moyenne de 67,5 ms (SD=14,7)**

ETUDE ELECTROPHYSIOLOGIQUE DE LA PERCUSSION SUS-PUBIENNE

Réflexe polysynaptique :

- **latence courte les différentiant d'une contraction volontaire**
- **jitter**
- **habituation**
- **caractère polyphasique**
- **latence proche de la réponse R2 polysynaptique du réflexe bulbo-caverneux électrique**



Réflexe bulbo-caverneux électrique

Réflexe pubo-caverneux mécanique

Réflexe Pubo-Caverneux

- efferent : nerf pudendal; afférent : nerf pelvien ?
- récepteur stimulé probablement intravésical

- chez l'homme spinal, ce réflexe entre très certainement en compétition avec le réflexe proprioceptif cutanéo ou vésico- détrusorien (déclenchement de la contraction vésicale par percussion sus pubienne) et représente probablement ainsi un équivalent de dyssynergie vésico-sphinctérienne

- chez le sujet normal, il s'agit d'un réflexe de continence, permettant une contraction périnéale réflexe à un stimulus susceptible d'engendrer une hyperpression abdominale