

Evaluation of CPT Measures

Neuval[®] Windows Software Database Overview

The screenshot shows the 'Neuval Main Menu' window titled 'NEUVAL CPT DATABASE - MAIN MENU'. The interface features a central menu of options connected by a curved line, each with a corresponding icon: 'Record a new CPT exam' (calendar with checkmark), 'Record a new R-CPT exam' (calendar with 'R' and checkmark), 'Look up exam record' (magnifying glass), 'Change or delete exam record' (document with pencil), 'Look up a patient ID' (magnifying glass over a document), 'Add a new patient ID to the database' (document with plus sign), and 'Change or delete a patient ID record' (document with minus sign). A central button displays 'Neuval i2100 2.9.1.126'. At the bottom, there is an 'Advanced Mode' button, 'Help' and 'Close' buttons, and a status bar showing the database path 'D:\Neurotron\Neuval i2100\Data\Neuval.GDB' and registration status 'Registered: *** Unregistered *** - Days Remaining: 29'.

Neuval Main Menu

NEUVAL CPT DATABASE - MAIN MENU

Record a new CPT exam

Record a new R-CPT exam

Look up exam record

Change or delete exam record

Neuval i2100 2.9.1.126

Look up a patient ID

Add a new patient ID to the database

Change or delete a patient ID record

Advanced Mode

Help Close

Database: <D:\Neurotron\Neuval i2100\Data\Neuval.GDB>

Registered: ***** Unregistered *** - Days Remaining: 29**

Evaluation of CPT Measures

The Neuval® software program range analysis evaluates and grades the CPT measures. Any measure falling above or below the upper and lower limits of normal indicates hypoesthesia or hyperesthesia, respectively. Abnormal CPT's are graded in severity based on their number of standard deviations away from the normative mean (site and frequency specific). An anesthetic response indicates that the patient is anesthetic to the maximum stimulus output of 9.99 mAmperes. The Neuval® software program evaluation paradigm has been described in several publications.

See Appendix H. at the following URL for more information and case studies:

<http://www.neurotron.com/documents/ClinOverDoc.html>

Additional References

Additional information regarding the statistical evaluation of CPT data as well as normative values may be found from the Neurotron, Inc. website <http://www.neurotron.com/downloads.html#infodocs>.

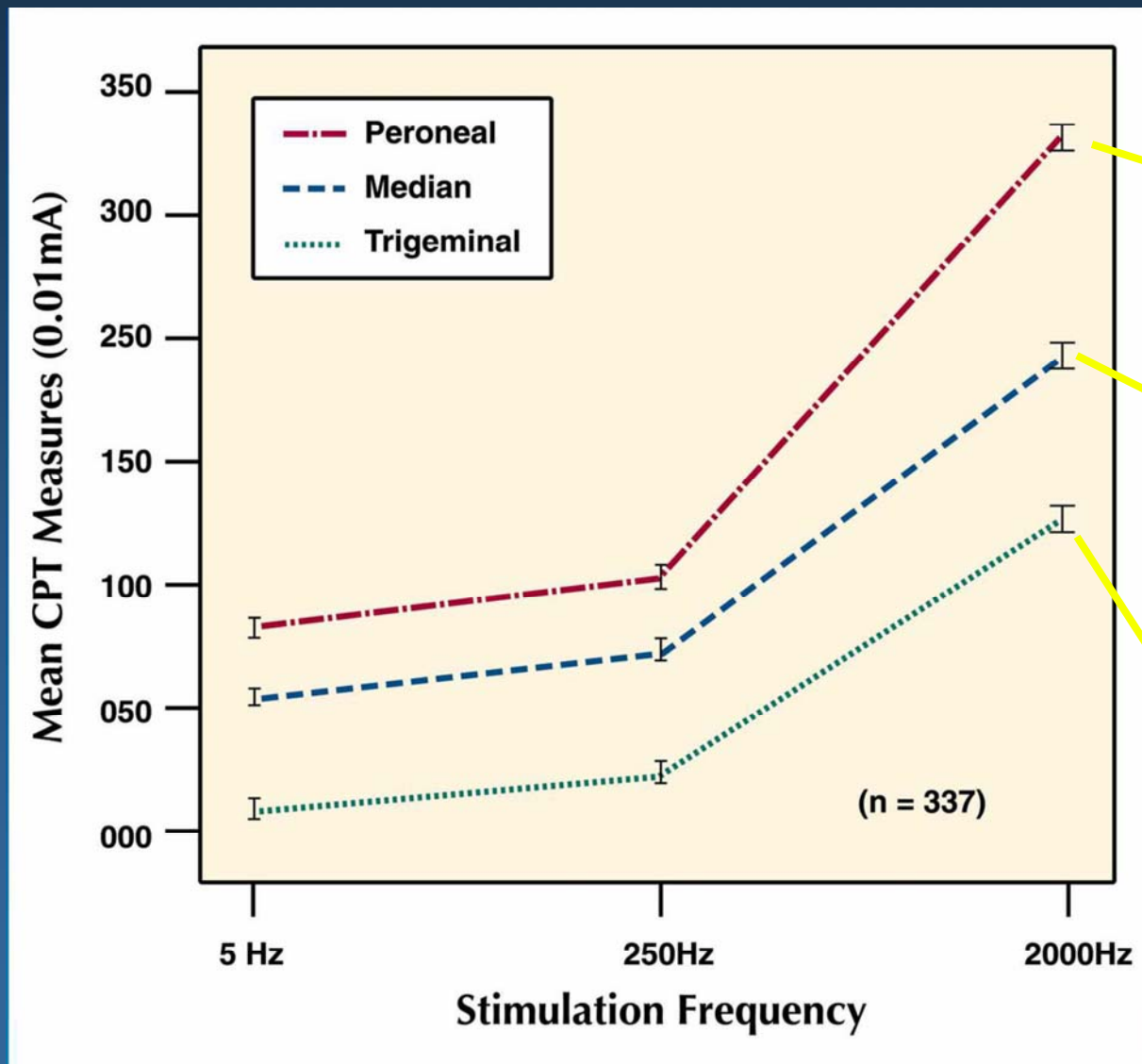
Related publications include:

- Weseley, S.A., Sadler, B., Katims, J.J. Current Perception: Preferred Test for Evaluation of Peripheral Nerve Integrity. Transactions of the American Society of Artificial Internal Organs, Volume 34(3):188-193, 1988.
- Katims, J.J., Rouvelas, P., Sadler, B.T., Weseley, S.A. Current Perception Threshold: Reproducibility and Comparison with Nerve Conduction in Evaluation of Carpal Tunnel Syndrome. Transactions of the American Society of Artificial Internal Organs, Volume 35(3):280-284, 1989.
- Weseley, S.A., Liebowitz, B., Katims, J.J. Neuropathy of Uremia: Evaluation by Nerve Conduction Velocity versus Neurospecific Current Perception Threshold. Nephron, Volume 52:317-322, 1989.
- Katims, J.J., Patil, A.S., Rendell, M., Rouvelas, P., Sadler, B., Weseley, S.A., Bleecker, M.L. Current Perception Threshold Screening for Carpal Tunnel Syndrome. Archives of Environmental Health, Volume 46(4):207-212, 1991.
- Katims, J.J. Electrodiagnostic Functional Sensory Evaluation of the Patient with Pain: A Review of the Neuroselective Current Perception Threshold (CPT) and Pain Tolerance Threshold (PTT). Pain Digest Volume 8(5), 219-230, 1998.
- Ro, L.S., Chen, S.T., Tang, L.M., Hsu, W.C., Chang, H.S., Huang, C.C. Current Perception Threshold Testing in Fabry's Disease. Muscle & Nerve, Volume 22: 1531-1537, 1999.
- Takekuma, K., Ando, F., Niino, N., Shimokata, H. Age and gender differences in skin sensory threshold assessed by current perception in community-dwelling Japanese, Journal of Epidemiology, Volume10(1):S33-S38, 2000.
- Kim, H.S. Kho, Y.K. Kim, S.W. Lee, S.C. Chung. Reliability and Characteristics of Current Perception Thresholds(CPTs) in the Territory of Inferior Orbital and Inferior Alveolar Nerves. Orofacial Pain Clinic. Journal of Orofacial Pain, Volume 14:286-292, 2000.

Neuval[®] Software Overview

- Select test CPT or R-CPT
- Add patient ID Info to database if necessary
- Select Testing Sites
- Enter Test Results
- Print Report

CPT Data: Site vs. Frequency



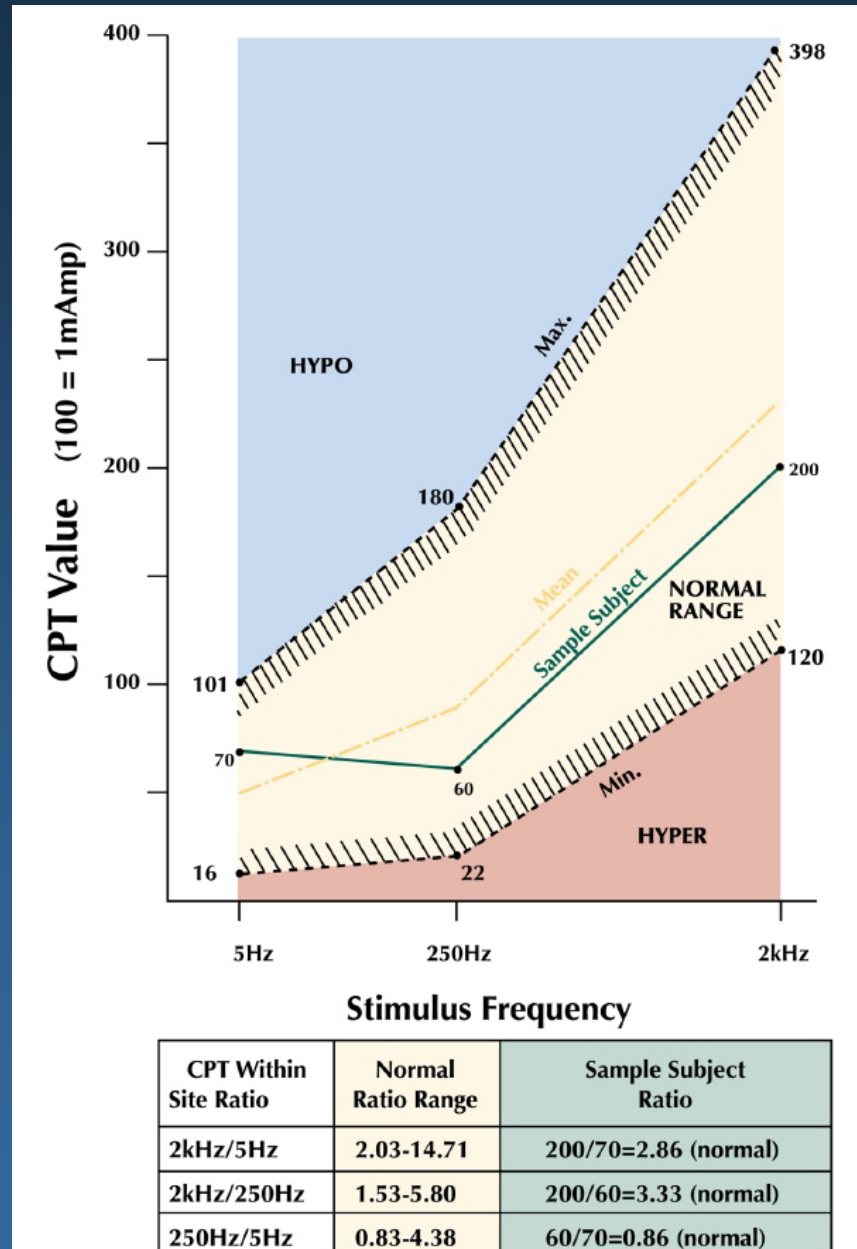
Neuval[®] Analysis of CPT Test Results

- ***Range Analysis*** - compares raw CPT measures to an established normative database. Quantifies hyperesthesia and hypoesthesia.
- ***Ratio Analysis: Within Site*** - compares the three CPT measures from one site to one another.
- ***Ratio Analysis: Between Sites*** - compares the CPT measures at different sites taken with the same frequency to one another.

CPT Range Analysis

- **Hyperesthetic** - inflamed or irritated nerves, CPTs abnormally low.
- **Hypoesthetic** - loss of function, CPTs abnormally elevated.
- **Anesthetic** - CPTs unobtainable, no response to a maximum stimulus intensity of 9.99 mAmperes.

Median Nerve CPT Range & Ratio Values, Normal

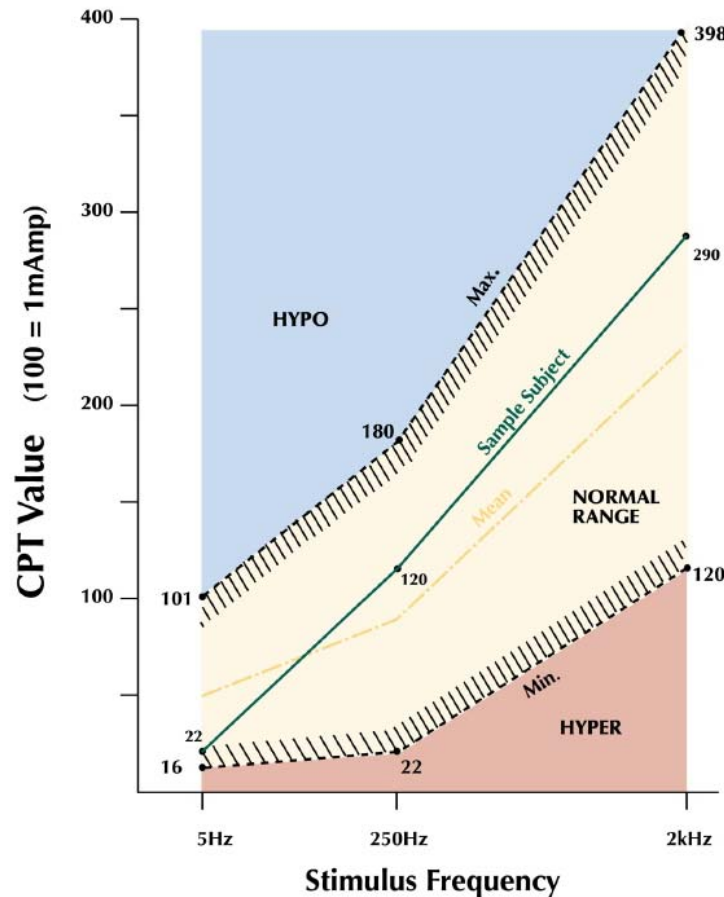


CPT Within Site Ratio Analyses

- Within Site Ratio abnormalities indicate the early stage of a neuropathy when the nerve is not impaired enough to be classified as hyperesthetic or hypoesthetic.

Within Site Ratio Abnormality

Median Nerve CPT Range Value Normal, Ratios Abnormal



CPT Within Site Ratio	Normal Ratio Range	Sample Subject Ratio
2kHz/5Hz	2.03-14.71	290/22=13.18 (normal)
2kHz/250Hz	1.53-5.80	290/120=2.42 (normal)
250Hz/5Hz	0.83-4.38	120/22=5.45 (abnormal)

As a CPT abnormality goes through the transition from hyperesthetic to hypoesthetic in the development of a progressive peripheral neuropathy it will pass through the normal range, this is characterized as “pseudo-normal”. Not all 3 subpopulations of sensory nerve fibers represented by the 3 frequency dependent CPT measures are effected equally. This permits a within site ratio analysis for the detection of this “pseudo-normal” condition by comparing between two CPT frequency measures. In the present example, the abnormality is detected between the middle frequency 250Hz CPT and the low-frequency 5 Hz CPT measures.

Hypoesthetic Range Analysis Scoring Parameters

RANGE SCORE	CONDITION	DEFINITION
+4	Profound Hypoesthesia	Unobtainable CPT
+3	Severe Hypoesthesia	CPT >4 SD above mean
+2	Moderate Hypoesthesia	CPT 3- 4 SD above mean
+1	Mild Hypoesthesia	CPT above healthy range & 2- 3 SD above mean
0	CPT in Healthy Range	

SD = Standard Deviation. Normative values available from:

http://www.neurotron.com/documents/Neurometer_NormativeData.pdf

Hyperesthetic Range Analysis Scoring Parameters

RANGE

SCORE

CONDITION

DEFINITION

0

CPT in Healthy Range

-1

Mild Hyperesthesia

CPT < healthy range
1-2.5 SD < mean

-2

Moderate Hyperesthesia

CPT < healthy range
& <2.5 SD below
mean

Ratio Scoring Parameters

RATIO

SCORE

DEFINITION

- | | |
|---|--|
| 0 | -Within Healthy Range |
| 1 | -Mild Detection - The ratio is within 30% above or below the healthy range |
| 2 | -Moderate Detection - The ratio is > 30% above or below the healthy range |

Neuval[®] Grading Significance

MOST SIGNIFICANT

Anesthesia (999)

Hypoesthesia

Hyperesthesia

Within Site Ratio

Between Site Ratio

LEAST SIGNIFICANT

CPT Grading Parameters

TYPE OF ANALYSIS	SCORE	GRADE	MAX ADDER	MAX GRADE	COMMENTARY SENSORY CLASSIFICATION
RANGE	+4	10	1.00	12.00	Completely Anesthetic
RANGE	+3	9	0.45	9.90	Severe <u>Hypoesthesia</u>
RANGE	+2	8	0.41	8.82	Moderate <u>Hypoesthesia</u>
RANGE	+1	7	0.37	7.74	Mild <u>Hypoesthesia</u>
RANGE	-2	6	0.31	6.62	Moderate <u>Hyperesthesia</u>
RANGE	-1	5	0.27	5.54	Mild <u>Hyperesthesia</u>
W/S RATIO	2	4	0.41	4.82	Mild Dysfunction
W/S RATIO	1	3	0.35	3.70	Very Mild Dysfunction
B/S RATIO	2	2	0.39	2.78	Extremely Mild Dysfunction
B/S RATIO	1	1	0.33	1.66	Slight Dysfunction
ALL	0	0	0.00	0.00	No Abnormal Measures

CPT Neuval[®] Grading Example

MAX

ANALYSIS	SCR	GRADE	ADDER	GRADE	CLASSIFICATION
RANGE	+4	10	1.00	12.00	Completely Anesthetic
RANGE	+3	9	0.45	9.90	Severe <u>Hypoesthesia</u>
RANGE	+2	8	0.41	8.82	Moderate <u>Hypoesthesia</u>
RANGE	+1	7	0.37	7.74	Mild <u>Hypoesthesia</u>

Neuval CPT Grading – highest score gets grade others scores get adders only

2K HZ	scr	250 Hz	scr	5 Hz	scr	GRADE
540	(+1)	343	(+3)	198	(+2)	
adder=0.37		grade=9.00		adder=0.41		9.78

Report Layout:

Current Perception Threshold (CPT) Measures & Range Analysis

	2K Hz	scr	250 Hz	scr	5 Hz	scr	GRADE
L_MEDIAN_thumb	245	(0)	092	(0)	058	(0)	0.00
L_MEDIAN_index	230	(0)	101	(0)	064	(0)	0.00
L_ULNAR_little	251	(0)	089	(0)	052	(0)	0.00

Within Site CPT Ratios & Analysis

	2K:5	scr	2K:250	scr	250:5	scr	GRADE
L_MEDIAN_thumb	4.22	(0)	2.66	(0)	1.59	(0)	0.00
L_MEDIAN_index	3.59	(0)	2.28	(0)	1.58	(0)	0.00
L_ULNAR_little	4.83	(0)	2.82	(0)	1.71	(0)	0.00

Between Sites CPT Ratios & Analysis

	2K:2K	scr	250:250	scr	5:5	scr	GRADE
L_MED_indx:L_MED_thmb	0.94	(0)	1.10	(0)	1.10	(0)	0.00
L_ULN_lttl:L_MED_thmb	1.02	(0)	0.97	(0)	0.90	(0)	0.00
L_ULN_lttl:L_MED_indx	1.09	(0)	0.88	(0)	0.81	(0)	0.00

Current Perception Threshold (CPT) Measures & Range Analysis

	2K Hz	scr	250 Hz	scr	5 Hz	scr	GRADE
R_MEDIAN_thumb	256	(0)	085	(0)	049	(0)	0.00
R_MEDIAN_index	380	(0)	184	(+1)	110	(+1)	7.37
R_ULNAR_little	262	(0)	098	(0)	066	(0)	0.00

Within Site CPT Ratios & Analysis

	2K:5	scr	2K:250	scr	250:5	scr	GRADE
R_MEDIAN_thumb	5.22	(0)	3.01	(0)	1.73	(0)	0.00
R_MEDIAN_index	3.45	(0)	2.07	(0)	1.67	(0)	0.00
R_ULNAR_little	3.97	(0)	2.67	(0)	1.48	(0)	0.00

Between Sites CPT Ratios & Analysis

	2K:2K	scr	250:250	scr	5:5	scr	GRADE
R_MED_indx:R_MED_thmb	1.48	(0)	2.16	(1)	2.24	(0)	1.00
R_ULN_lttl:R_MED_thmb	1.02	(0)	1.15	(0)	1.35	(0)	0.00
R_ULN_lttl:R_MED_indx	0.69	(0)	0.53	(0)	0.60	(0)	0.00

Bilateral/Between Sites CPT Ratios & Analysis

	2K Hz	scr	250 Hz	scr	5 Hz	scr	GRADE
MEDIAN_thumb _ L:R	0.96	(0)	1.08	(0)	1.18	(0)	0.00
MEDIAN_index _ L:R	0.61	(1)	0.55	(0)	0.58	(0)	1.00
ULNAR_little _ L:R	0.96	(0)	0.91	(0)	0.79	(0)	0.00

Left Range

Within Site Ratio

Between Sites Ratio

Right Range

Within Site Ratio

Between Sites Ratio

Bilateral Ratio

Report Layout:

CPT Grade Summary

Report Observations

Physician's Impression

SENSORY NERVE CONDUCTION THRESHOLD (CPT) TEST: DATA ANALYSIS SUMMARY SHEET

Sample page 2 of 2

PATIENT NAME: Smith, Joe, R
ID: 000_00_0000 DOB: 02_19_1958 SEX: M
NOTE: Pt reports neck pain radiating into R arm

CPT Measures and Analysis Summary

	2K Hz	250 Hz	5 Hz	GRADE
MEDIAN_thumb :L	245	092	058	0.00
:R	256	085	049	0.00
MEDIAN_index :L	230	101	064	0.00
:R	380	184	110	7.37
ULNAR_little :L	251	089	052	0.00
:R	262	098	066	0.00

CPT Summary Report Observations

CPT Measures were taken from 6 sites. Bilateral measurements were obtained from the median n. on the thumb; C6. The grade of the left side measures was 0.00 which indicates no abnormal measures. The grade on the right side was 0.00 indicating no abnormal measures.

Bilateral measurements were obtained from the median n. on the index finger; C7. The grade of the left side measures was 0.00 which indicates no abnormal measures. The grade on the right side was 7.37 indicating a mild hypoesthetic condition.

Bilateral measurements were obtained from the ulnar n. on the little finger; C8. The grade of the left side measures was 0.00 which indicates no abnormal measures. The grade on the right side was 0.00 indicating no abnormal measures.

Physician's Impression: Abnormal values detected were confined to the right C7 dermatome. These electrodiagnostic findings combined with the history and physical findings and other diagnostic test findings are consistent with a mild right C7 radiculopathy. This type of condition would be best managed conservatively. If the patient's condition deteriorates or fails to respond appropriately to conservative management a repeat sNCT/CPT is indicated.

Borderline Measures

- Resolution of automated CPT measures is +/- 2 CPT units (20 μ Amperes)
- Neuval does not recognize borderline measures.
- Clinician evaluates using Neuval® Normative Data Booklet or accessing norms from Neuval Windows software ***Advanced Mode -> File -> Normative Data***

Normative Data: Cervical Sites (C6-8 fingers, n=334)

	Range			
CPT Frequency	Min	Max	Mean	S.D.
2000 Hz	120	398	226	80
250 Hz	22	180	81	42
5 Hz	16	101	46	27

Ranged, R-CPT Measures

NEUROMETER® R-CPT NEUROSELECTIVE SENSORY NERVE EVALUATION

		MEDIAN+ULNAR-rng			D.+S.PERONEAL-toe1											
		LEFT	RIGHT		LEFT	RIGHT										
Hypoesthetic	25															
	24															
	23															
	22															
	21															
	20															
	19															
	18															
	17															
	16															
Normal Range	15															
	14															
	13															
	12															
	11															
	10															
	9															
Hyperesthetic	8															
	7															
	6															
	5															
	4															
	3															
	2															
	1															
		2000	250	5	2000	250	5	2000	250	5	2000	250	5	2000	250	5

EXAM NOTE: