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# RASP

RIVERMEAD ASSESSMENT OF SOMATOSENSORY PERFORMANCE

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RIVERMEAD  
ASSESSMENT OF  
SOMATOSENSORY  
PERFORMANCE

*Charlotte E Winward<sup>1</sup>, Peter W Halligan<sup>2</sup>, Derick T Wade<sup>3</sup>*

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OPERATOR  
MANUAL

*1 – Movement Science Group, Oxford Brookes University, Oxford, UK*

*2 – Cardiff University, Cardiff*

*3 – Oxford Centre for Enablement, Oxford University NHS Trust, Oxford, UK*

CONTACT: Charlie Winward [c.winward@brookes.ac.uk](mailto:c.winward@brookes.ac.uk)

# RIVERMEAD ASSESSMENT OF SOMATOSENSORY PERFORMANCE

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# RIVERMEAD ASSESSMENT OF SOMATOSENSORY PERFORMANCE

## INTRODUCTION

Although not as obvious as motor deficits, somatosensory loss is found in over 60% of stroke patients and has a significant influence on rehabilitation outcome. Moreover it is considered relevant by most therapists (Winward et al., 1999). Somatosensory impairments influence activities such as walking, dressing and cooking and contribute to an increased length of stay in hospital and the need for long-term care. (Winward et al., 2002, Welmer, von Arbin et al. 2007; Tyson, Hanley et al. 2008)

While most clinicians accept that somatosensory assessment contributes to diagnosis, few texts discuss the test procedures in detail or indicate the specific role such assessment plays in the rehabilitation and treatment of stroke. Indeed many medical texts consider the procedures difficult to implement, tedious and unreliable, particularly as the assessment is often carried out after motor testing when both patient and clinician are tired (Bickerstaff et al. 1989).

The Rivermead Assessment of Somatosensory Performance (RASP) offers clinician-friendly standardized instruments capable of providing accurate, reliable and comprehensive measures of different somatosensory functions used to inform and monitor rehabilitation and recovery. The RASP is a standardized test battery designed to provide therapist and doctors with a brief, quantifiable and reliable assessment of somatosensory functioning after neurological disorders such as stroke, MS, head injury and spinal cord injury.

The RASP was standardized using 100 stroke patients and 50 age matched controls (Winward et al. 2002) and the first edition was published in 2000. The RASP can be used to assess somatosensory performance in the first few months of stroke and can also inform intervention and recovery involving a number of different somatosensory modalities. (Winward et al., 2007).

## DESCRIPTION OF THE RASP

The RASP consists of 7 simple subtests covering a representative range of clinically established assessments traditionally used for somatosensory assessment. The test assumes that sensory modalities are non-hierarchical and quantifiably distinct. All subtests originate from established clinical practice, and have previously been used in a variety of non-standardized formats in medicine – some for well over a century. The RASP score considers both the (i) detection and (ii) the extent of somatosensory impairments when compared with age matched control performance. In particular, the RASP allows clinicians to choose those subtests they consider relevant for their patient. The results of the RASP however should be always considered within the overall clinical context of the patient.

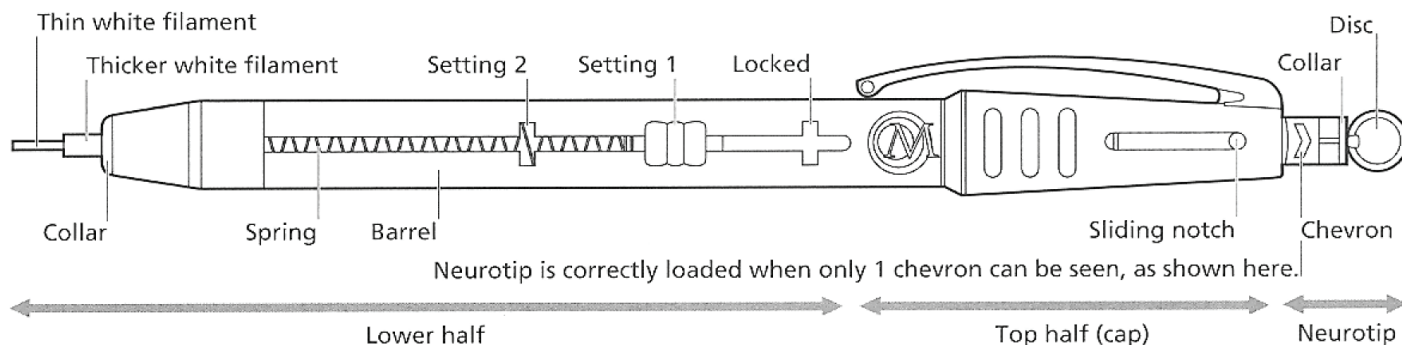
The RASP covers a wide range of body areas and sensory tests. The test is nevertheless short (approximately 25-35 minutes), easy to administer and simple to score. The RASP comprises seven objective quantifiable subtests that can be divided into 5 primary (sharp/dull discrimination, surface pressure touch, surface localization, temperature discrimination, movement and direction proprioception discrimination), and 2 secondary subtests (sensory extinction and two point discrimination).

## DESCRIPTION OF THE RASP INSTRUMENTS

### *Neurometer*

The Neurometer is used to test sharp/dull discrimination, surface pressure touch, surface localization and sensory extinction. For sharp/dull discrimination and sensory extinction two Neurometers are used. Each Neurometer has 2 distinct parts: A top half is for testing sharp dull discrimination and a lower half for measuring surface pressure touch, surface localization and sensory extinction. The diagram in Figure 1 shows the different parts of the Neurometer.

Figure 1: Neurometer



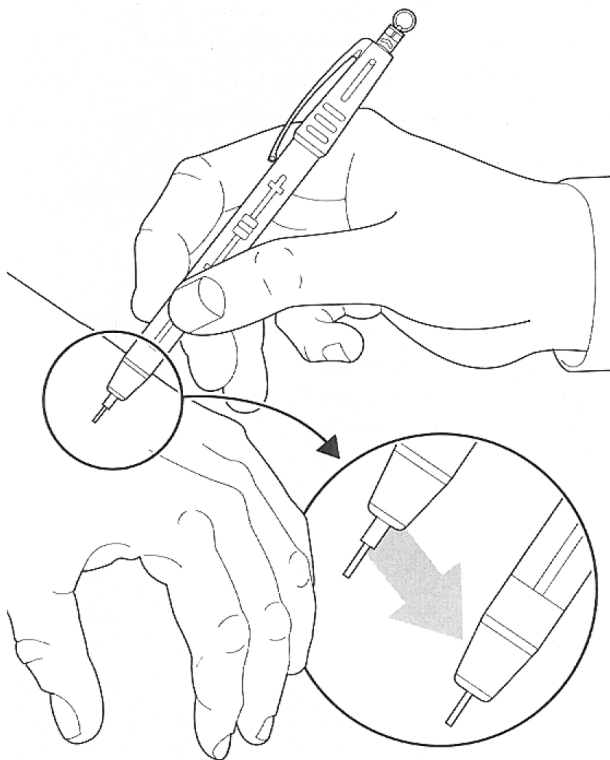
## Sharp/dull discrimination

To prepare for testing Sharp/dull discrimination, both Neurometers are required, each loaded with a new Neurotip in the special carrier located at the top end of the instrument. A spring-loaded collar holding the Neurotip has been calibrated such that it produces the same reliable pressure. Neurotips are sterile, single use neurological inserts designed with both a sharp and a dull end. The sharp end is protected by a round plastic disposable disc. When the operator is ready to start testing, this protected disc is removed by twisting. For health and safety reasons, all Neurotips should be disposed of in a sharps bin when testing is completed. Each Neurometer must be loaded with a Neurotip, one displaying the sharp end and one the dull. The operator should make sure each Neurotip is pushed firmly into the carrier until it engages fully and only one chevron is visible. The Neurometer should be applied perpendicular to the patient's skin. The operator knows the correct pressure has been applied when the collar of the Neurotip just disappears to the neck of the Neurometer. This procedure delivers a set pressure so long as the operator adheres to these guidelines. The Neurotip should never be depressed totally as this will apply a greater pressure than necessary and possibly damage the patient's skin.

## Surface pressure touch and localization

For each of these tests only one Neurometer is required. Only the lower half of the Neurometer is required. The lower half has a sliding mechanism controlled by a white pushbutton on the barrel. There are 3 positions on the barrel and all are identified by specific markings. The 3 positions are: locked, setting 1, and setting 2. To achieve setting 1 or 2 the operator will need to push the white button from the locked position to setting 1 (i.e. towards the pointed end of the Neurometer). As the operator pushes the button towards setting 1 they will see a white filament appear. This filament end remains constant even if the operator pushes the button further down to setting 2. The locked position ensures the filament is protected. For surface localization and pressure, touch setting 1 is used (15.5 g).

Figure 2: Using the Neurometer



The spring-loaded filament has been calibrated such that it produces the same reliable pressure for each of the settings. The Neurometer is applied perpendicular to the testing area (briefly) until the thicker white filament just disappears into the collar before being released. The procedure should take no longer than one second. It is important this procedure is adhered to, since pressing the neurometer less or more will alter the force applied.

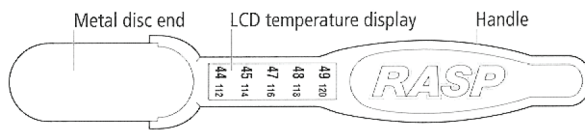
## Sensory extinction

When using the Neurometer for sensory extinction, setting 2 is always used (67.5 g).

## Neurotemps

These are the red and blue coloured designed instruments with liquid crystal displays (LCD) (figure 3). Each temperature display provides a specific range. The blue instrument displays temperatures from 6-10°C, the red instrument displays temperatures from 44-49°C. To ensure the correct temperature ranges are achieved the Neurotemps need to be prepared prior to administering RASP.

Figure 3: Neurotemp



Place the red Neurotemp in boiled water or under a hot tap for 30 seconds. When the Neurotemp is removed from the water, wait for the LCD thermometer to change colour to the 49°C mark. This ensures the Neurotemp is ready for use. It takes approximately 2 minutes for the Neurotemp to fall outside its testing range. This is indicated by changes in the colour of the LCD thermometer strip. When there is a colour change at or below 44°C, the tester should reheat the Neurotemp to bring it back to the proper testing range.

Place the blue Neurotemp in ice water or a fridge for approximately 30 seconds. When the Neurotemp is removed wait until the LCD thermometer colour changes at the 6° mark. This ensures that the Neurotemp is ready for use. It takes approximately 1 minute for the Neurotemp to fall outside its testing range. When there is a colour change at or above 10°C, the tester should place the Neurotemp back in ice water to bring it back into the testing range. The temperature of the room or testing area will influence the speed with which each of the LCD temperature meters fall outside the proper test range. For safety reasons, always ensure that temperature is within the specified testing range before applying to the skin.

## Two point discriminator

The 2-point discriminator can be adjusted to distances of 3, 4 and 5 mm. There is also a single-point. The tips are applied to the surface of the tip of the index finger. The examiner depresses it briefly by approximately 1 mm before releasing. The procedure should take no longer than one second.

## PATIENT AND CONTROL SAMPLE

Reliability and validity for the RASP has been established (Winward et al. 2002). Only those patients with a diagnosis of first ever unilateral stroke were included. Exclusion criteria included evidence of bilateral signs, noncompliance, severe visual or hearing impairment, cognitive impairments and demonstrable comprehension difficulties. Patients whose past medical history include the presence of another neurological condition or previous stroke were also excluded. Altogether 100 patients were used in the standardization for the complete battery at 7 subtests 50 had left-sided lesions and 50 had right-sided lesions.

A control group of 50 non-brain damaged subjects were seen in order to obtain normative data of RASP subtests. This reference group was recruited from several sources including hospital employees and volunteers from the local community. The performance levels for this control group are provided for the total RASP score and for each subtest. Table 1 provides basic demographic details for these patients and the reference control group.

Table 1: Patient and reference control group demographic details

|                                      | Left brain damage        | Right brain damage     | Age matched controls |
|--------------------------------------|--------------------------|------------------------|----------------------|
| Number of patients                   | 50                       | 50                     | 50                   |
| Time post: onset: mean, s.d. & range | 6.1 weeks, 8.6, 0.2-35.5 | 4.7 weeks, 5.4, 0.2-26 |                      |
| Age: mean, s.d. & range              | 64.2 (15.6) 23-96        | 64.0 (15.4) 35-86      | 60.0 (12.7) 24-80    |
| Sex ratio: M/F                       | 27:23                    | 26:24                  | 21:29                |

### Test reliability

Interrater reliability was established by comparing performance of 15 different patients scored independently but sequentially by 2 different raters and the original research therapist. Order of assessment was counterbalanced. The correlation between the research therapist and the 2 independent raters for the total score on the 5 primary RASP subtests was 0.92. See figure 4.

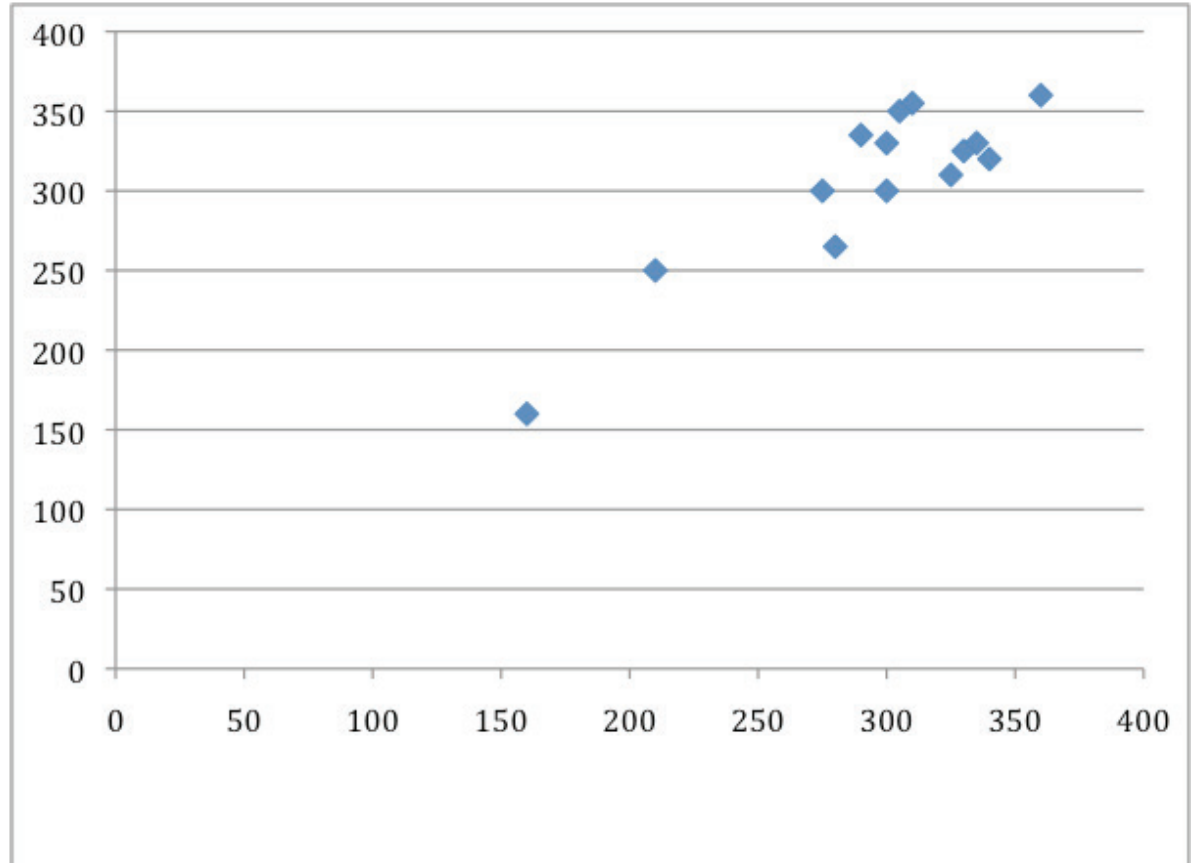


Figure 4- Interrater scores obtained by two raters within 5 days (x = rater 1, y = rater 2)



Another way of establishing the extent of agreement between raters is to construct a Bland and Altman distribution graph as shown in figure 5. This shows the difference between scores given by two raters plotted against the mean score of those two raters for each patient. Figure 6 demonstrates that the majority of differences for the total primary somatosensory test lies between +/-30 points on the RASP. This revealed no consistence bias between observers (confirmed by t-test) and the difference between raters is not proportional to the mean score.

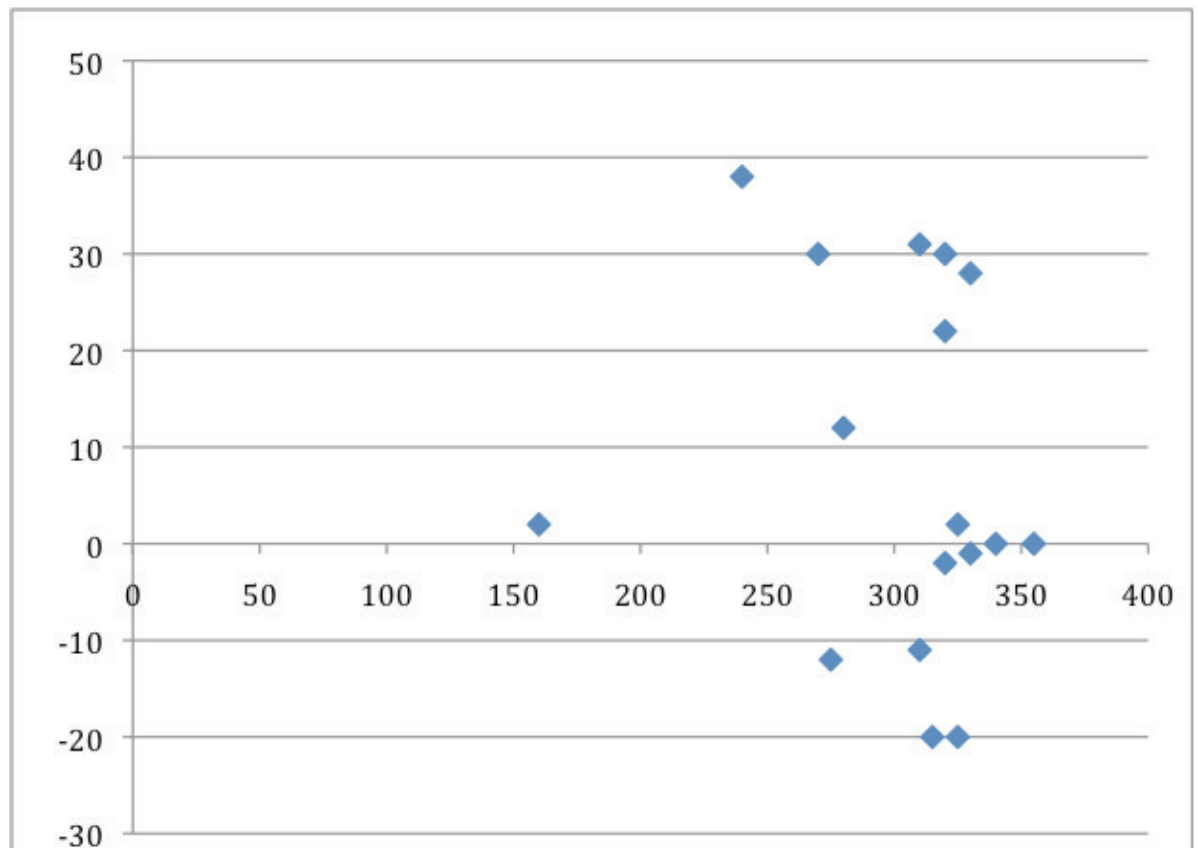


Figure 5 – Bland and Altman distribution graph showing agreement between raters (x= averages and y = differences in totals)

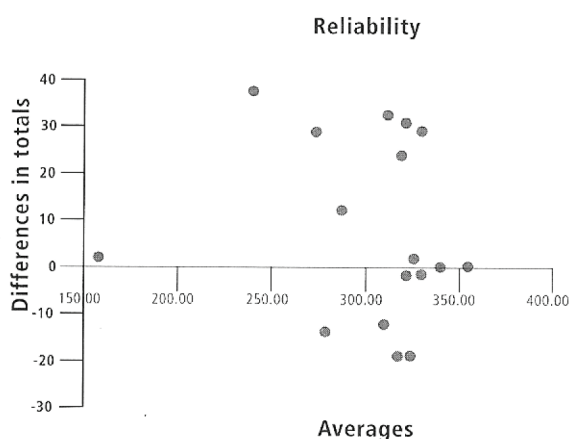


Figure 6 – Bland and Altman distribution graph showing agreement between raters

## *Patient reliability*

Although it is possible to reduce the unreliability of sensory testing by employing standardized procedures and quantifiable instruments, patient reliability issues remains a problem. Unlike many other clinical tests, the RASP attempts to control for possible sources of unreliability by providing a quantifiable indicator of the reliability of the patient's subjective responses. To do this the RASP employs a series of sham trials on 2 of the 5 primary subtests (sharp/dull discrimination and surface pressure touch). A sham trial is when the examiner pretends to give a stimulus when in fact none is applied. The sham trial allows the examiner to identify those patients who indicate a stimulus was felt when none is given. If the patient consistently demonstrates detection or discrimination of sham trials, then it is possible to conclude that such a patient's performance may be unreliable. Although shams do not prevent unreliable patient performance, they help identify and perhaps exclude those patients whose performance demonstrates florid unreliability.

It should be noted that sham or non-touch trials are also an important procedure component of sensory testing in that they help maintain the patient's interest and attention. Using control performance, we established the likelihood of normals producing false positives (that is experiencing sensation when no stimulus was applied). On the sharp/dull test, 5 normals demonstrated one false-positive out of a maximum of 10 per side. One showed two shams. In the case of surface pressure touch no controls produced a false positive.

Given that no control made more than two shams on sharp/dull, the following scoring system was used to describe subject unreliability. Less than or equal to 2 shams = normal; 3-5 shams = mild; 6-8 shams = moderate and 8-10 shams = severe. On the sharp/dull subtests, 8 patients with right brain damage (RBD), and 5 patients with left brain damage (LBD) showed shams. No patient showed extensive shaming.

On the surface pressure touch subtest, 10 subjects with right brain damage and 2 patients with left brain damage showed shams. Of the right brain damaged subjects 9 showed mild in one moderate sham performance. The 2 left-brain damaged subjects showed only mild shaming.

## *General Information*

The RASP can be used by medical doctors, neurologists, General Practitioners, physiotherapists, occupational therapists, speech and language therapists, nurses, research psychologists, therapists and other clinically qualified staff when they wish to document sensory loss in a patient for clinical or research purposes.

### **The patient should be:**

- Attired so the examiner is able to assess all 10 areas of the body
- Have the purpose of each assessment explained to the them
- Always shown what the test involves prior to administration
- Made aware they will first be assessed on the unaffected side
- Informed they will need to keep their eyes closed for all tests
- Discouraged from guessing and ask only to respond positively on those occasions when they have been touched
- Reassured not to be surprised if sometimes they cannot feel anything during the tests

### **The tester should:**

- Be aware that altered tone, reflexes and muscle length may affect test procedures and limit access to certain tests regions: i.e. the examiner may be unable to test 2 point discrimination due to increased tone in the fingers.
- Always allow for a few practice trials prior to administration. It is important to carry out practice trials with the subject prior to each subtest to ensure that they fully understand all the requirements of the task.
- Carryout testing in a quiet setting with the patient positioned in an armchair, wheelchair or bed.
- Ensure the patient is sufficiently comfortable so as to maintain the testing position for up to 30 minutes
- Record relevant patient details on the score sheet
- Use clinical judgment in deciding the number and types of subtest to employ

## Scoring

For each subtest 10 anatomically referenced test regions are tested as set out on the body reference chart (Appendix 1) following an alternating pattern moving from the unaffected side to the affected side, head to feet. The examiner should be familiar with all 10 test areas, test materials and scoring procedures. For the purpose of testing, each test region is approximately 25 mm square. This allows for multiple trials in the same area. There are 6 trials per test area.

Scoring for each subtest is recorded on the specific table/body chart provided in the scoring sheet. A total RASP score represents the extent to which a subject can reliably detect and discriminate sensory stimulation. For each stimulus correctly identified the patient scores one, i.e. within each test area the patient can score a maximum of 6. Shams are always scored separately. In the case of sham trials, false positives are scored 1, and the maximum sham score for each test area is 2.

## Limitations

As with all tests requiring a verbal response, subjects with speech or language difficulty will need to be considered carefully. Throughout all subtests, the examiner has 2 options for patients who can understand but are unable to respond verbally. These are 1) to point to pictures, objects or words on designated cards and 2) use hand signals. These options are clearly described in the relevant subtests.

The examiner should be clear how the patient will deliver their response for each test administered - i.e. verbally, using hand signals or descriptive cards.

## Test Sequence:

1. Sharp/dull discrimination
2. Surface pressure touch
3. Surface localization
4. Sensory extinction
5. Two point discrimination
6. Temperature discrimination
- 7 a. Proprioceptive movement
- 7 b. Proprioceptive direction

## 1 Sharp/dull discrimination

### Test equipment needed:

2 neurometers, 2 Neurotips, scoring sheet.

### Regions on the body to be tested:

face (1 and 2), hand (3-6), foot (7-10)

### Procedure:

This subtest is administered with the patient's eyes closed. Working from unaffected side to the affected side, each Neurometer is applied to the test area in a pseudo-randomized order. Let the patient know which area you are going to touch first in order to avoid surprise, particularly in the case of the face. Each Neurometer is then applied in a perpendicular manner to the subjects skin. Using the designated trial sequence, each Neurometer is depressed until the Neurotip collar just disappears below the neck of the instrument. This ensures the same pressure each time.

A total of 60 trials (30 left, 30 right) and 20 shams (10 left and 10 right) are administered. For each of the 10 test regions, 6 stimuli are presented per region: 3 dull (D), 3 sharp (S) and 2 sham (§) trials in the following order:

S § D D S S § D

Sham trials are recorded separately on the scoring sheet.

### Explanation to the patient:

The patient is shown two Neurometers, with the sharp and dull ends clearly pointed out. Say - "I'm going to use these to test whether you can feel sharp or dull. Before each trial I'm going to say "What's this?" Tell the patient not to worry if they don't feel all the trials and remember it is important to only indicate when they actually felt something.

If the patient has a speech or language difficulty they may use the picture card to indicate their choice (Appendix 2).

### Sham trials:

Sham trials are introduced after the first stimulus and second last. Sham trials consist of the examiner saying "What's this?" when moving the Neurometer within 15 cm of the subjects skin surface, but not making contact. In order to ensure the Neurometer makes the same audible sound during the sham the examiner uses the Neurometer on himself/herself at the same time.

### Scoring and interpretation:

For scoring purposes, only correct detections are noted. Record the patient's response for each stimulus in the boxes provided on the scoring sheet. This test provides a single score representing the patient's ability to detect sharp/dull discrimination. The performance for Right Brain Damage and Left Brain Damage patients is provided in Table 2a. Normative performance and impairment cut offs are shown in Table 2b.

Table 2a: Sharp/dull discrimination – performance of brain damaged patients

| Subtest 1                    | Patient performance       |                               |
|------------------------------|---------------------------|-------------------------------|
|                              | Sharp/dull discrimination | RBD                           |
| Left side affected<br>(n=50) |                           | Right side affected<br>(n=46) |
| Max Score (30)               |                           |                               |
| Mean                         | 17                        | 19.7                          |
| sd                           | 8.2                       | 6.3                           |
| Range                        | 0-30                      | 3-30                          |

Table 2b: Sharp/dull discrimination – normative performance and impairment cut-off (Suggested impairment cut-off < 22)

| Subtest 1      | Control performance       |                     |
|----------------|---------------------------|---------------------|
|                | Sharp/dull discrimination | Left side<br>(n=50) |
| Max Score (30) |                           |                     |
| Mean           | 26.6                      | 26.5                |
| sd             | 2.6                       | 2.5                 |
| Range          | 18-30                     | 21-30               |

## 2 Surface Pressure Touch

### Test equipment needed:

1 neurometer, scoring sheet.

### Regions on the body to be tested:

face (1 and 2), hand (3-6), foot (7-10)

### Procedure:

This subtest is administered with the patient's eyes closed. The Neurometer is set to level one and used throughout the testing. The Neurometer is applied perpendicular to the designated testing area briefly until the thicker white filament tip just disappears before releasing. This procedure should take no longer than 1 second. The procedure is altered due to tester or Neurometer error; re-administer this trial within the sequence.

A total of 60 trials (30 left and 30 right) and 20 shams (10 left and 10 right) are administered. For each of the

10 test regions, 6 touch (T) stimuli and 2 sham (§) trials are presented in the following order:

T § T T T T § T

Sham trials are recorded separately on the scoring sheet.

**Explanation to the patient:**

Patients are informed that the Neuropen will be used to touch certain areas on their face, arms and legs. Say “I want to see if you can feel this light touch. Before each trial I’m going to say “Do you feel this?” Tell the patient not to worry if they don’t feel all the trials and remember it is important to only indicate when they actually felt something.

If this patient has a speech or language difficulty they may use the picture card to indicate their choice (Appendix 2).

**Sham trials:**

Sham trials are introduced after the first stimulus and second to last. Sham trials consist of the examiner saying “What’s this?” when moving the Neurometer within 15 cm of the subjects skin surface, but not making contact. In order to ensure the Neurometer makes the same audible sound during the sham the examiner uses the Neurometer on himself/herself at the same time.

**Scoring and interpretation:**

For scoring purposes, only correct discriminations are noted. Record the patients response for each stimulus in the boxes provided on the scoring sheet. Impairments are calculated using age matched normative performance. The performance for Right Brain Damage and Left Brain Damage patients is provided in Table 3a. Normative performance and impairment cut offs are shown in Table 3b.

Table 3a: Surface touch – performance of brain damaged patients

| Subtest 2              | Patient performance |                     |
|------------------------|---------------------|---------------------|
|                        | RBD                 | LBD                 |
| Surface pressure touch | Left side affected  | Right side affected |
|                        | (n=50)              | (n=50)              |
| Max Score (30)         |                     |                     |
| Mean                   | 21.2                | 23.2                |
| sd                     | 9.2                 | 8.0                 |
| Range                  | 0-30                | 2-30                |

Table 3b: Surface touch – normative performance and impairment cut-off (Suggested impairment cut-off < 29)

| Subtest 2              | Control performance |                      |
|------------------------|---------------------|----------------------|
|                        | Left side<br>(n=50) | Right side<br>(n=50) |
| Surface pressure touch |                     |                      |
| Max Score (30)         |                     |                      |
| Mean                   | 29.9                | 29.9                 |
| sd                     | 0.3                 | 0.7                  |
| Range                  | 28-30               | 25-30                |

### 3 Surface localization

**Test equipment needed:**

1 neurometer, scoring sheet.

**Regions on the body to be tested:**

face (1 and 2), hand (3-6), foot(7-10)

**Procedure:**

This subtest is administered with the patient’s eyes closed. The Neurometer is set to level one and used throughout the testing.

A total of 60 trials (30 left and 30 right) are administered. After each stimulation wait for the patient to indicate the location clearly. The number of touches at each site will vary.

The sequence of the number of touches for each region is: 1 time (unaffected side), 2 times (affected side), 3 times (unaffected side), 1 time (affected side), 2 times (unaffected side), 3 times (affected side).

Example: Start with the unaffected side first touching the hand once, then move to the affected hand and touch this area twice. Return to the unaffected hand and touch this area 3 separate times then touch the affected hand once followed by the unaffected twice and finally the affected hand 3 times.

**Explanation to the patient:**

This patient is requested to identify where on their body they have been touched. Responses can include a verbal description, indicating that they’re intact and on their own body, or use of a body chart, where necessary. If the patient indicates they have not felt the stimulus it can be repeated once.



**Sham trials:**

There are no sham trials in this subtest.

**Scoring and interpretation:**

For scoring purposes only correct localizations are recorded. Record the response for each stimulus in the boxes provided on the scoring sheet. Felt and localized responses should be within 50 mm of the stimulus site to be considered correct. The performance for Right Brain Damage and Left Brain Damage patients is provided in Table 4a. Normative performance and impairment cut offs are shown in Table 4b.

Table 4a: Surface localization – performance of brain damaged patients

| Subtest 3<br>Surface localization<br>pressure | Patient performance                 |                                      |
|---|-------------------------------------|--------------------------------------|
|   | RBD<br>Left side affected<br>(n=50) | LBD<br>Right side affected<br>(n=50) |
| Max Score (30)                                |                                     |                                      |
| Mean  | 21.7                                | 23.9                                 |
| sd  | 11.1                                | 10                                   |
| Range   | 0-30                                | 0-30                                 |

Table 4b: Surface localization – normative performance and impairment cut-off  
(Suggested impairment cut-off: left < 29, right <28)

| Subtest 3<br>Surface localization<br>pressure | Control performance |                      |
|---|---------------------|----------------------|
|   | Left side<br>(n=50) | Right side<br>(n=50) |
| Max Score (30)                                |                     |                      |
| Mean  | 29.9                | 29.8                 |
| sd  | 0.4                 | 1.1                  |
| Range   | 27-30               | 22-30                |

## 4 Sensory extinction

(bilateral simultaneous touch discrimination)

### **Test equipment needed:**

2 neurometers, scoring sheet.

### **Regions on the body to be tested:**

face (1 and 2), hand (3-6)

### **Procedure:**

This subtest is administered with the patient's eyes closed. The Neurometer is set to level two and used throughout the testing. Before testing begins the examiner needs to establish whether the patient can feel the recommended setting used on the Neurometer on the affected side. If the patient fails to identify a single stimulus at setting 2 for any region then the test is discontinued for that region. Only homologous regions are tested. In bilateral conditions both neurometers are applied simultaneously to both affected and unaffected sides. The Neurometers are applied to the designated testing areas briefly until the thicker white filament tip just disappears before releasing. The procedure should take no longer than 1 second. If this procedure is altered due to the tester or Neurometer error, re-administer this trial within the sequence.

A total of 12 bilateral and 4 single trials are administered.

For each of the 4 test regions, 6 bilateral stimuli (B) are applied together with 2 single stimuli (S). The first single stimulus is applied to the unaffected side, the second to the affected side. The sequence is as follows:  
B S B B B B S B

### **Explanation to the patient:**

The patient is told that they may feel either one or 2 touches on similar areas e.g. both hands. They are simply asked to say whether they felt being touched in one or two places simultaneously. Say "You may feel me touching either just your left hand, just your right hand or both hands together" The patient potential replies "left", "right" or "both". If a patient, for whatever reason, has difficulty with expression/language they can indicate their choice by hand signaling or pointing to a chart (Appendix 3) with the three possible options.

### **Sham trials:**

There are no sham trials in this subtest.

### **Scoring and interpretation:**

Control performance (n= 50) demonstrated that no control subject failed to detect bilateral stimuli on any of the 6 trials. Consequently, any patient scoring less than 6 is judged to show sensory extinction. Score values obtained for left and right brain damage patients are divided into face and hand and shown for those patients that could be legitimately assessed in table 5 a/b. Extinction performance has been classified into the 4 levels shown in tables 5a and 5b.

Table 5a: Sensory Extinction – score values for right brain damaged subjects

| Subtest 4                            | Right brain damage |                |
|--------------------------------------|--------------------|----------------|
|                                      | Face<br>(n=42)     | Hand<br>(n=38) |
| Sensory extinction                   |                    |                |
| Number of bilateral stimuli detected |                    |                |
| 6 Normal                             | 26                 | 24             |
| 4-5 Mild                             | 7                  | 4              |
| 2-3 Moderate                         | 2                  | 0              |
| 0-1 Severe                           | 7                  | 10             |

Table 5b: Sensory Extinction – score values for left brain damaged subjects

| Subtest 4                            | Left brain damage |                |
|--------------------------------------|-------------------|----------------|
|                                      | Face<br>(n=48)    | Hand<br>(n=42) |
| Sensory extinction                   |                   |                |
| Number of bilateral stimuli detected |                   |                |
| 6 Normal                             | 41                | 32             |
| 4-5 Mild                             | 4                 | 3              |
| 2-3 Moderate                         | 1                 | 2              |
| 0-1 Severe                           | 2                 | 5              |

## 5 Two Point discrimination

### Test equipment needed:

Discriminator, scoring sheet.

### Regions on the body to be tested:

Fingertip of index finger on both hands

### Procedure:

This subtest is administered with the patient's eyes closed. It is important to ensure that other parts of the hand do not come in contact with the discriminator. The discriminator is applied to the fingertip, depressing the skin with either the single point (1) or one of the two points (2) by approximately 1 mm before releasing. The procedure should take no longer than 1 second. Always start on the unaffected side.

The sequence of administration is 2 1 2 2 2 2 1 2

**Impairment detection:**

Formal testing involves using the index finger of both hands to see if this subject can discriminate reliably between 1 and 2 points. The values 3, 4, 5 mm are used as the literature indicates most normals are capable of distinguishing 2 distinct points within this range. Patients failing to detect within the designated 3-5 mm range are considered to show impairment. The two point stimulus of 3 mm is first applied to the index finger for 6 trials interspersed with 2 trials of single points. If the patient is unable to feel 2 points reliably (i.e. less than 4 trials for the two points stimulus) the examiner moves to 4 mm and then to 5 mm to determine whether they are able to detect at this level or not. If the patient is unable to distinguish between one and two points reliably (i.e. less than 4 trials of the 2 points are felt) at any one of the 3 levels then the subtest is discontinued.

**Explanation to the patient:**

The patient is shown the discriminator and told that it will be used to find out whether they can feel one or two points on the tip of their index finger. The patient is required to simply report what they feel – that is one or two points on the fingertip. As with other subtests, practice trials are given.

**Sham trials:**

There are no sham trials in this subtest.

**Scoring and interpretation:**

A patient's test performance involves determining whether a designated normal range of discrimination (3-5 mm) is achieved or not using the patient's index finger. The score range is used to diagnose operationally whether the patient is impaired on two-point discrimination. Most controls (49/50 left hand, 48/50 right) are capable of reliably indicating two-point discrimination within 3-5 mm. Two control subjects who failed to detect within this range on the index finger had suffered peripheral nerve damage to the fingers. Patients failing to detect within the designated 3-5 mm range are considered to show impairment. The distribution for the controls and patients for each of the 3 values are shown in table 6a and 6b.

Table 6a: Two point discrimination – index finger performance controls

| Subtest 5                         |     |     |                           |     |     |
|-----------------------------------|-----|-----|---------------------------|-----|-----|
| Reliable two point discrimination |     |     |                           |     |     |
| Right hand controls (n=48)        |     |     | Left hand controls (n=49) |     |     |
| 3mm                               | 4mm | 5mm | 3mm                       | 4mm | 5mm |
| 16                                | 18  | 14  | 18                        | 15  | 16  |

Table 6b: Two point discrimination – index finger performance patients

| Subtest 5                         |     |     |                        |     |     |
|-----------------------------------|-----|-----|------------------------|-----|-----|
| Reliable two point discrimination |     |     |                        |     |     |
| LBD – right hand (n=18)           |     |     | RBD – left hand (n=13) |     |     |
| 3mm                               | 4mm | 5mm | 3mm                    | 4mm | 5mm |
| 1                                 | 7   | 10  | 0                      | 11  | 2   |

## 6 Temperature discrimination

### **Test equipment needed:**

2 Neurotemps, scoring sheet.

### **Regions on the body to be tested:**

face (1 and 2), hand (3-6), foot (7-10)

### **Procedure:**

This subtest is administered with the patient's eyes closed.

Both Neurotemps need to be prepared prior to testing to ensure that the temperature settings are at the warmest or coolest end of the designated temperature window (Warm = 44-49°C, Cold = 6-10°C). A total of 60 trials are administered. Always let the patient have a small number of practice trials before starting the test.

The Neurotemp should be placed in contact with the test region briefly for up to one second, during which time the patient should indicate the temperature setting. The tester should only touch the handle of the Neurotemp. Expect that there will be slight differences in time to detect stimulus for each region, i.e. the face region will often take a relatively short time to detect the stimulus compared with the foot. If the patient has difficulty with language, he/she can indicate a choice by pointing to the warm and cold signs provided (Appendix 4). For each of the 10 tests regions, 6 stimuli are presented: 3 warm and 3 cold in the following order:

W C C W W C

### **Explanation to the subject:**

Say: "I'm going to use these Neurotemps to test whether you can feel warm or cold. Just before the trial I am going to say "What's this?" Don't worry if you don't feel all the trials and remember to indicate only warm or cold.

### **Sham trials:**

There are no sham trials in this subtest.

### **Scoring and interpretation:**

The patient responses for each of the stimuli are recorded in the box provided. Total score for the warm/cold stimuli is 60 (30 left/30 right). The performance for RBD and LBD patients are provided in table 7a. Normal performance and impairment cut offs are shown in table 7b.

Table 7a: Temperature discrimination – performance of brain damaged patients

| Subtest 6                  | Patient performance          |                               |
|----------------------------|------------------------------|-------------------------------|
|                            | RBD                          | LBD                           |
| Temperature discrimination | Left side affected<br>(n=45) | Right side affected<br>(n=44) |
| Max Score (30)             |                              |                               |
| Mean                       | 20                           | 22.4                          |
| sd                         | 7.7                          | 6.2                           |
| Range                      | 0-30                         | 0-30                          |

Table 7b: Temperature discrimination – normative performance and impairment cut-off (Suggested impairment cut-off < 25)

| Subtest 6                  | Control performance |            |
|----------------------------|---------------------|------------|
|                            | Left side           | Right side |
| Temperature discrimination | (n=50)              | (n=50)     |
| Max Score (30)             |                     |            |
| Mean                       | 28.4                | 28.6       |
| sd                         | 1.7                 | 1.8        |
| Range                      | 24-30               | 23-30      |

*7a Proprioception movement discrimination*

*7b Proprioception direction discrimination*

**Test equipment needed:**

Scoring sheet.

**Joints to be tested:**

Elbow (L/R)

Wrist (L/R)

Thumb or finger (L/R)

Ankle (L/R)

Toe (L/R)

**Procedure:**

These subtests involve the detection of limb position and limb movement. The “up/down” test described below is a simple method where the subject indicates in which direction, up or down, a certain joint on the body is being passively moved up or down (up = towards the head, down = towards the feet). The patient is given several practice trials and then instructed to close his/her eyes while the examiner creates movement about the joint. A total of 30 trials (5 joints by 6 trials) per side are administered.

This subtest is administered with the patient’s eyes closed. The patient is instructed to evaluate both the (i) detection of movement and the (ii) direction of movement. It is important to ensure that each joint is held by the lateral surfaces or in such a way as to minimize any clues as to the direction of movement. The starting position maybe up to 20° either side of the mid-joint position. Only move each joint approximately 20° for each test movement, in the plane of flexion and extension.

Each of the 10 joints (5 left/5 right) is moved 6 times in the following order:

Up, down, down, up, up, down

Wait 1-2 seconds between successive movements for the patient to respond to whether they can feel movement and secondly the direction (up or down).

Record the patient’s response for both detection and direction of movement in the box provided on the scoring sheet.

**Explanation to the patient:**

The patient is told different joints will be moved to find out if they can detect movement and the direction of movement.

Say: “I am going to move your [elbow, etc] up and down and I want you to tell me whether you can feel me moving this joint and in which direction. Up is towards your head and down is towards your feet. Before each trial I am going to say ‘What’s this?’ Don’t worry if you don’t feel all the trials and remember only to indicate when you’re actually feel something.

To ensure that the patient response is clear, the examiner should specifically inquire for movement and direction.

**Sham trials:**

There are no sham trials in this subtest.

**Scoring and interpretation:**

The scoring considers to related features of the subject performance:

Detection of movement (move/no movement)

Detection of the direction of that movement (up/down)

RBD and LBD patient performance is shown in table 8a and 9a. Normative performance and impairment cut-offs are shown in table 8b and 9b.

Table 8a: Proprioceptive movement discrimination – performance of brain damaged patients

| Subtest 7a<br>Proprioceptive movement | Patient performance                 |                                      |
|---------------------------------------|-------------------------------------|--------------------------------------|
|                                       | RBD<br>Left side affected<br>(n=49) | LBD<br>Right side affected<br>(n=47) |
| Max Score (30)                        |                                     |                                      |
| Mean                                  | 23.9                                | 24.3                                 |
| sd                                    | 9.2                                 | 8.1                                  |
| Range                                 | 0-30                                | 0-30                                 |

Table 8b: Proprioceptive movement discrimination – normative performance and impairment cutoff  
(Suggested impairment cut-off : left < 28, right <30)

| Subtest 7a<br>Proprioceptive movement | Control performance |                      |
|---------------------------------------|---------------------|----------------------|
|                                       | Left side<br>(n=50) | Right side<br>(n=50) |
| Max Score (30)                        |                     |                      |
| Mean                                  | 29.9                | 30                   |
| sd                                    | 0.8                 | 0.1                  |
| Range                                 | 24-30               | 29-30                |

Table 9a: Proprioceptive direction discrimination – performance of brain damaged patients

| Subtest 7b<br>Proprioceptive movement | Patient performance                 |                                      |
|---------------------------------------|-------------------------------------|--------------------------------------|
|                                       | RBD<br>Left side affected<br>(n=49) | LBD<br>Right side affected<br>(n=47) |
| Max Score (30)                        |                                     |                                      |
| Mean                                  | 21.5                                | 21.8                                 |
| sd                                    | 10                                  | 9.3                                  |
| Range                                 | 0-30                                | 0-30                                 |



Table 9b: Proprioceptive direction discrimination – normative performance and impairment cutoff  
 (Suggested impairment cut-off < 28)

| Subtest 7b<br>Proprioceptive movement | Control performance |                      |
|---------------------------------------|---------------------|----------------------|
|                                       | Left side<br>(n=50) | Right side<br>(n=50) |
| Max Score (30)                        |                     |                      |
| Mean                                  | 29.8                | 29.8                 |
| sd                                    | 0.9                 | 0.9                  |
| Range                                 | 24-30               | 29-30                |

*Abbreviations*

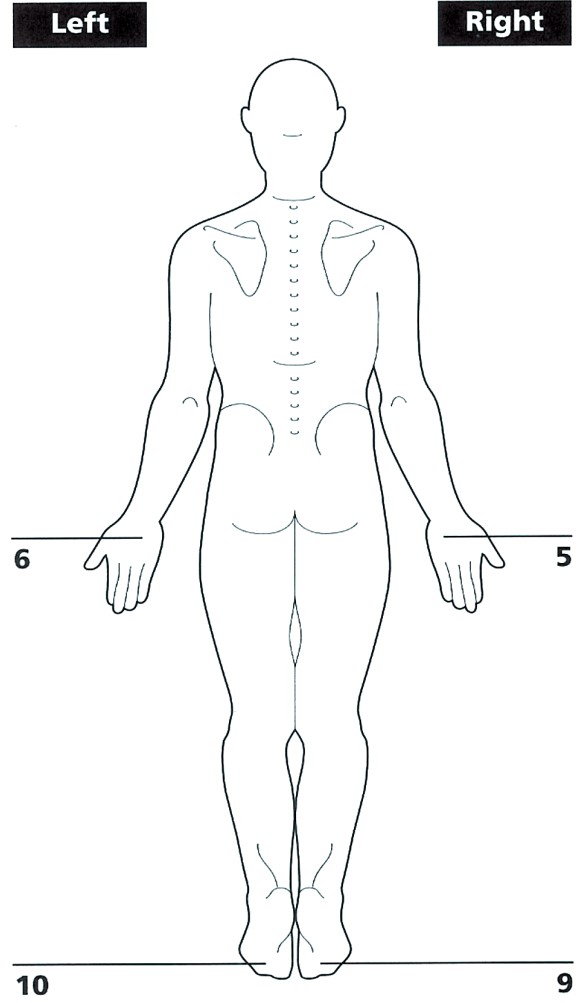
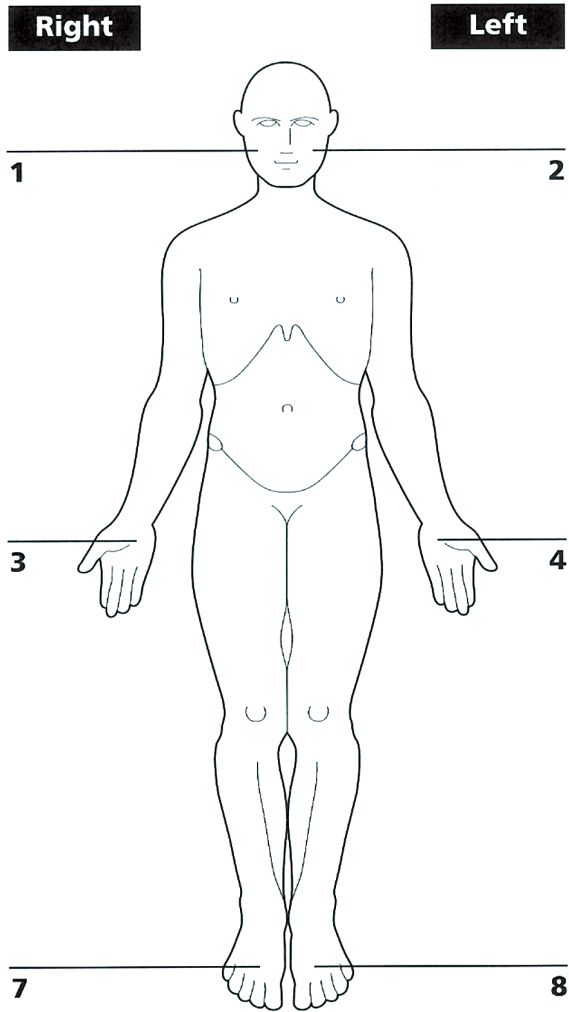
RBD – right brain damaged

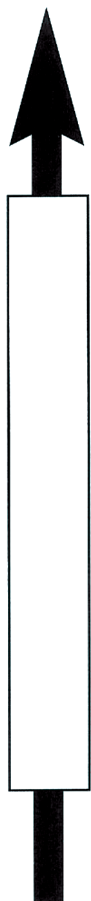
LBD – left brain damaged

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APPENDIX 1 *Anatomical references*





**sharp**

---

**dull**

---

**nothing**

**left**

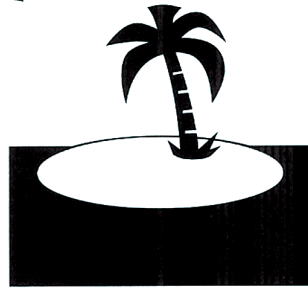
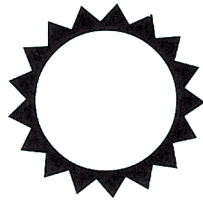
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**right**

---

**both**

# warm



# cold