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صدق الله العظيم

الآيه(32) سوره البقره

EXAMINATION
&
EVALUATION OF SENSORY SYSTEMS

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Sensation

- **"a feeling; the translation into consciousness of the effects of a stimulus exciting any of the organs of sense"** (Stedman, 1982).

- ✓ The term sensation implies that *the feeling or impression is conveyed to and processed by the central nervous system*.
- ✓ However, some important sensory systems will be discussed (e.g., spinocerebellar **"unconscious" proprioception**) that are *processed primarily at a subconscious or unconscious level although,*
- ✓ **Most sensation is processed at an awareness level** and is therefore termed **conscious sensation.**
- ✓ **Sensation reflects information from the internal or external environment.**
- ✓ The modalities of sensation are the specific types of sensation including pain, pressure, and joint position sense.

INTRODUCTION

Sensation includes all incoming information brought into the nervous system, whether processed consciously or subconsciously.

- ❑ **sensibility:** "the capability of perceiving sensible stimuli"
- ✓ **Cortical sensibility** processed by the cerebral cortex is the *recognition of sensory information & related discrimination of sensory impression*.
- ✓ **threshold stimulus :** the minimal stimulus level that will produce a sensation.
- ✓ **afferent impulses** is used for sensory or incoming signals, while
- ✓ **efferent impulses** are those that transmit information away from the NS to an effector organ (muscle or gland).
- ❑ The examination methods described in detail in this chapter address sensory components from four categories: **superficial sense**, **discriminative sense**, **proprioceptive sense**, and **chronic pain**.

CATEGORIES OF SENSATION

Sensory modalities or the types of sensory input can be generally divided into two broad categories: superficial or deep.

- **Superficial sensation (tactile sensation):**

✓ all sensations detected **by** receptors at the surface of the body and are usually associated with the skin or skin appendages.

✓ **includes** pain, temperature, light touch, and pressure touch.

- **deep sensations generally called(proprioception) :**

✓ may be **processed** consciously or subconsciously and

✓ It **include** sensations related to position or movement of a joint or body segment or awareness of length of a specific muscle.

SUPERFICIAL SENSATION

- **pain sensibility :** the unpleasant feeling resulting from a sensory stimulus that is sharp or pinpoint, especially when the stimulus has the potential to cause tissue damage.

✓ This sensory modality, protective in nature, can also be referred to as *sharp/dull discrimination.*

- **Temperature sensibility** interprets the heat or cold state of an object or environment and also plays a protective role.
- **Light touch** is the sensation caused by the mildest of tactile stimulation even slight contact + separate receptor types in skin with hair and hairless or glabrous skin.
- **Pressure touch** sensation results from mechanical stimulation due to a greater magnitude of pressures with deeper skin deformation.

DISCRIMINATIVE SENSATIONS

include **vibration, tactile localization, two-point discrimination, graphesthesia, stereognosis.**

The last four of these are often considered to be **perceptual processes** requiring *integration of numerous sensory signals* + *multiple sensory modalities* + *not purely sensory.*

- **Vibration** is the sensation experienced from tactile contact with an object that is shaking or oscillating at a particular frequency.

Tactile localization is awareness of the specific skin surface site to which stimulation was applied and is

- ✓ **characterized & documented by** *the distance error between the actual site of stimulus and the subject-reported site of stimulus*.

Twopoint discrimination sensibility is the ability to distinguish two simultaneously applied blunt points as two discrete stimuli.

- ✓ **The smallest interpoint distance still perceived as two points** ***quantifies the threshold of two-point discrimination.***

DISCRIMINATIVE SENSATIONS

- **Graphesthesia** is **the recognition of symbols traced on the patient's palm** including **shapes**, **numbers**, or **letters**.

Stereognosis is **the ability to recognize, by tactile manipulation only**, **the form** and characteristics of an object including **size**, **shape**, **weight**, **consistency**, and **texture**.

DEEP SENSATIONS

include **joint position sense** and **joint movement sense**

They are very important components of **feedback as a basis for motor control**.

- **Joint position sense**, sometimes simply referred to with the generic term **proprioception**, is the awareness of static positions of a single joint or body segment detected without use of vision.

- **Joint movement sense**, often called **kinesthesia**, is awareness of the degree, velocity, and direction of movement at a single joint or body segment also internally detected through muscle and joint receptors.

SENSORY RECEPTORS

- **Each sensory modality has specific sensory receptors (Fig. 5-1) converting the specific form of energy** (mechanical, thermal, chemical, or electromagnetic) into an **action potential** transmitted into the CNS as **afferent action potentials** or impulses.
- The modalities of light touch, pressure touch, pain, vibration, and proprioception use receptors categorized as **mechanoreceptors**.
- Pain impulses can be initiated by a class of receptors called **nociceptors** or nocioceptors, most commonly **free nerve endings**, but also from the effect of temperature extremes on heat and cold receptors.
- Temperature sensation is detected by **thermal receptors**. **Cold and warmth receptors**, located under the skin with *cold receptors positioned at greater depth than warmth receptors*

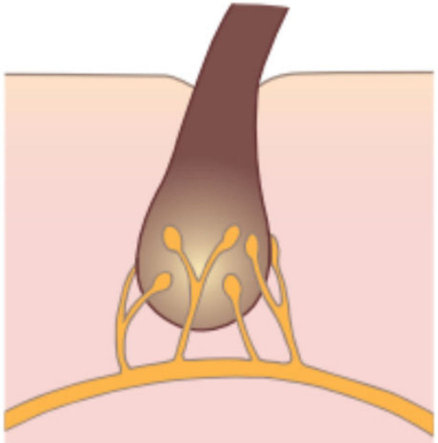
✓ *3 to 4 times as many cold receptors as warmth receptors in most areas of the body,*

✓ *greatest density in the **lips** (15 to 25 cold points per square centimeter) compared with **fingers** (3 to 5 cold points per square centimeter) and certain broad surface areas like the **trunk** (less than 1 cold point per square centimeter).*

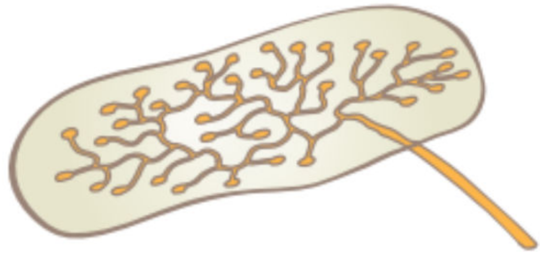
A **Superficial Mechanoreceptors:** detect mechanical deformation

- in the skin includes (especially for **temperature, touch,** and **pressure):**

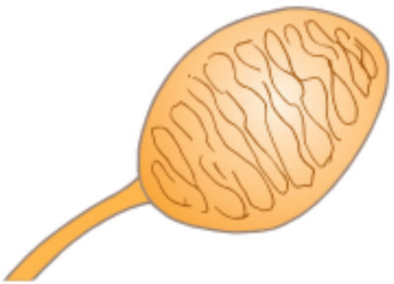
Free nerve endings
(touch and temperature)



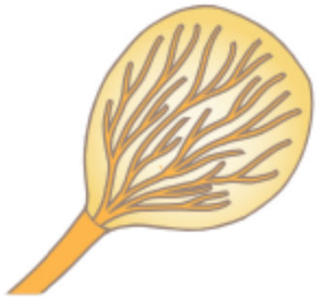
Hair end organs
(light touch)



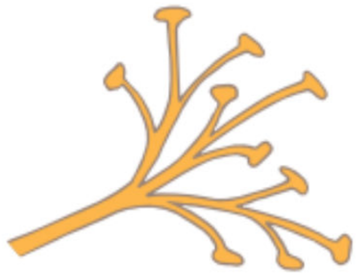
Ruffini's spray endings
(warmth and movement)



Encapsulated Meissner's corpuscles
(light touch and vibration)



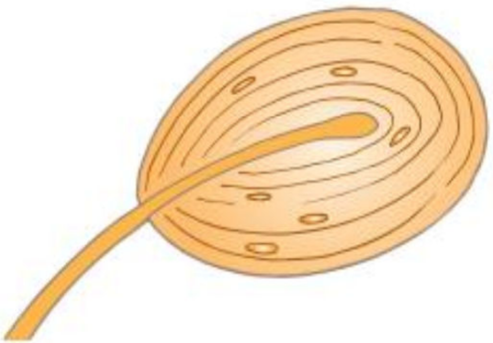
Encapsulated Krause's corpuscles
(cold)



Expanded endings = Merkel's dis
(light touch)

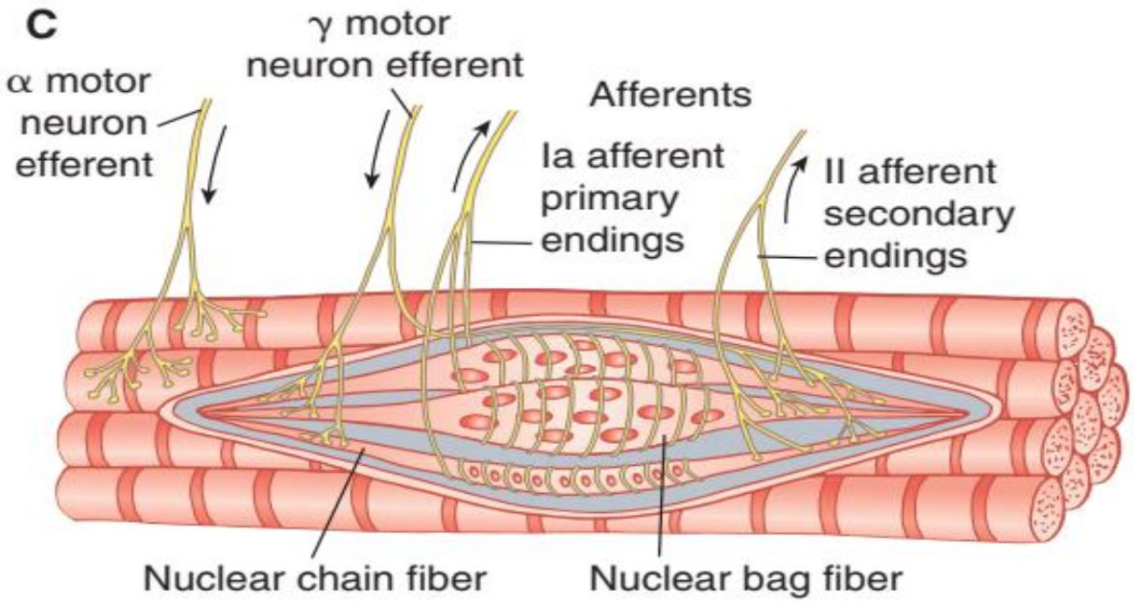
B **Deep Mechanoreceptors** (especially for **pressure**):

- in the deeper tissues include **free nerve endings**, **expanded nerve endings**, and

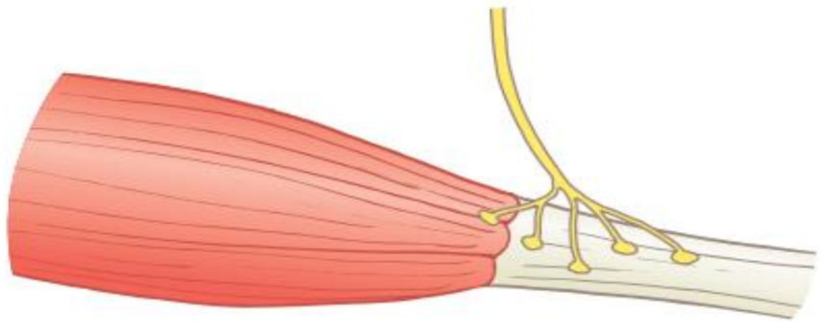


encapsulated Pacinian corpuscle
(deep pressure and vibration)

C



Muscle spindles
(unconscious proprioception)



Golgi tendon organs
(unconscious proprioception)

FIGURE 5-1 Drawing of sensory receptor types. Sensory mechanoreceptors from skin, deep tissue, and muscle. **A.** Superficial mechanoreceptors: detect mechanical deformation in the skin includes (especially for temperature, touch, and pressure): **B.** Deep mechanoreceptors (especially for pressure) in the deeper tissues include free nerve endings, expanded nerve endings, and encapsulated Pacinian corpuscles (deep pressure and vibration). **C.** Deep mechanoreceptors for proprioceptive muscle awareness.

TABLE 5-1 Sensory Modality Details

SENSORY MODALITY	RECEPTORS UTILIZED	NAME (AND LOCATION OF SPINAL PATHWAY)	LEVEL AND NAME OF DECUSSATION
*Pain (sharp/dull)	Free nerve endings (FNE) (also in muscle and joint capsule), thermoreceptors	Lateral spinothalamic tract (in contralateral anterolateral spinal cord)	Fibers from posterior horn cells cross within one to two levels of entry into the spinal cord through the "anterior commissure"
*Temperature	Free nerve endings	Lateral spinothalamic tract (in contralateral anterolateral spinal cord)	Fibers from posterior horn cells cross within one to two levels of entry into the spinal cord through the "anterior commissure"
*Touch	Merkel's disks*, FNE, hair follicle endings, Ruffini endings, Krause's end-bulb, and possibly Meissner's corpuscles*	Anterior spinothalamic tract (AST) (in contralateral anterolateral spinal cord) and medial lemniscal (ML) system (in ipsilateral posterior columns of spinal cord)	AST fibers from posterior horn cells cross within one to two levels of entry into the spinal cord through the "anterior commissure;" ML fibers cross from nucleus cuneatus and nucleus gracilis in low medulla as the "internal arcuate fibers"

*Pressure	Pacinian corpuscles, **FNE** (also in muscle), Ruffini endings (especially for maintained pressure), **Krause's end-bulb**	Medial lemniscal system: fasciculus gracilis and fasciculus cuneatus (in ipsilateral dorsal column of spinal cord); becomes the medial lemniscus (in the low medulla of the brainstem)	Fibers cross from nucleus cuneatus and nucleus gracilis in low medulla as the "internal arcuate fibers"
*Two-point discrimination	**Merkel's disks***	(Same as pressure)	(Same as pressure)
*Tactile localization	**Merkel's disks***, **Meissner's corpuscles**	(Same as pressure)	(Same as pressure)
*Discriminative touch (stereognosis, texture)	**Meissner's corpuscles***	(Same as pressure)	(Same as pressure)
*Vibration	**Pacinian corpuscles*** Pacinian corpuscles are located subcutaneous and within deep tissues (muscle, tendon, and joint soft tissue)	(Same as pressure)	(Same as pressure)

*Joint Position and Movement sense (conscious)	Muscle spindles, joint receptors, golgi-type endings in ligaments, Ruffini endings in joint capsule and ligaments (for direction and velocity), free nerve ending in joint capsule (for crude awareness), Paciniform endings in joint capsule (especially for rapid joint movements)	(Same as pressure)	(Same as pressure)
*Tension of muscle	**Golgi tendon organ** (protective function for muscle)	(Same as pressure)	(Same as pressure)

*Pacinian and Meissner corpuscles are ***quickly adapting receptors*** for moving touch. **Merkel's disks**, in hairy and glabrous skin, are **slowly adapting** to detect constant touch, low intensity, and velocity of touch.

FUNCTIONAL IMPLICATIONS

- The sensory systems & the information they provide CNS *are essential for optimal control and efficiency of movement*.
- **Tactile sensation** *provides important clues regarding the interaction of each body part with the environment*, including supporting structures, perturbing objects, and external forces.

For example, **pressure sensation from the sole of the foot** *provides feedback related to COG location essential for optimal balance control in standing*.

When leaning forward, more weight is sensed through the forefoot plantar surface. Leaning backward causes increased pressure through the heel of the foot and less through the forefoot.

Joint position sense & **movement sense** *provide feedback about muscle length & joint angles* as movement occurs.

This **proprioceptive feedback** is essential for optimal motor control and the fine adjustments needed for *skilled coordinated movement during tasks and activities*

FUNCTIONAL IMPLICATIONS

- In neuromuscular disease or trauma,
- damage may occur to the **peripheral receptors**,
- **afferent pathways** (peripheral nerve, spinal cord, brainstem, or cortical white matter),
- **central relay nuclei** (brainstem nuclei, thalamus, basal ganglia),
- **areas of sensory cortex** (primary, secondary, or association).

the person may experience

partial or complete loss of sensation.

increases the risk of injury to self and requires *increased visual attention to affected areas* for minimizing injury risk. Impaired joint position sense could diminish ongoing motor adjustments resulting in poorly controlled movement.

WHERE IS IT?

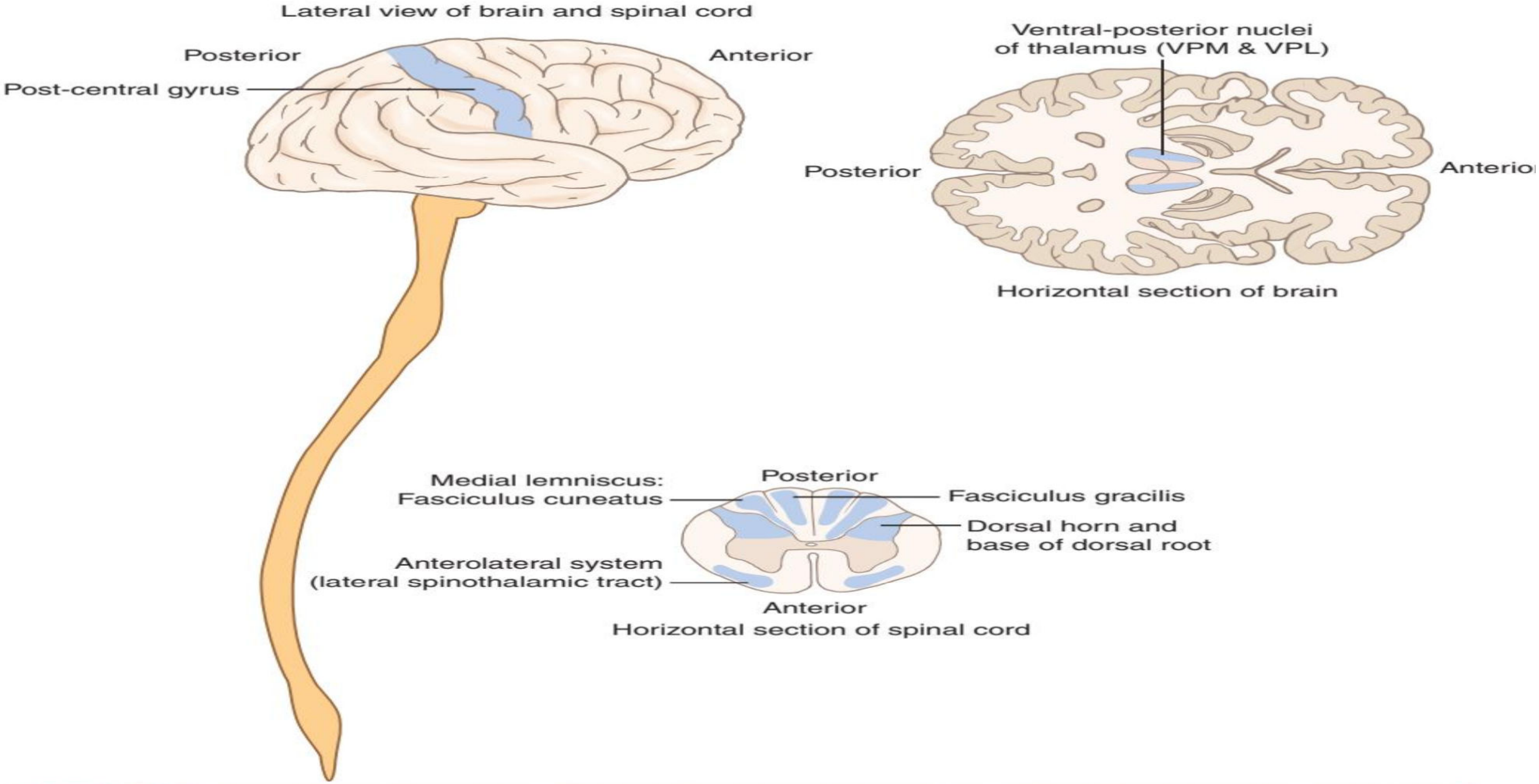


FIGURE 5-2 Major sensory locations of the central nervous system (within brain, brainstem, and spinal cord). These drawings highlight neuroanatomic sites related to sensation. In the brain, the **postcentral gyrus** is the primary somatosensory cortex, and ventral posteromedial **(VPM)** and ventral posterolateral **(VPL) of the thalamus** are processing and relaying nuclei for *sensory information from the face and body, respectively,* traveling to the cortex. In the spinal cord, the **posterior funiculus** carries the discriminative general senses of the medial lemniscal system, the **posterior horn of the spinal cord** houses most sensory nuclei, and the anterolateral system of the spinal cord carries *light-touch and pain/temperature sensations*.

WHERE IS IT?

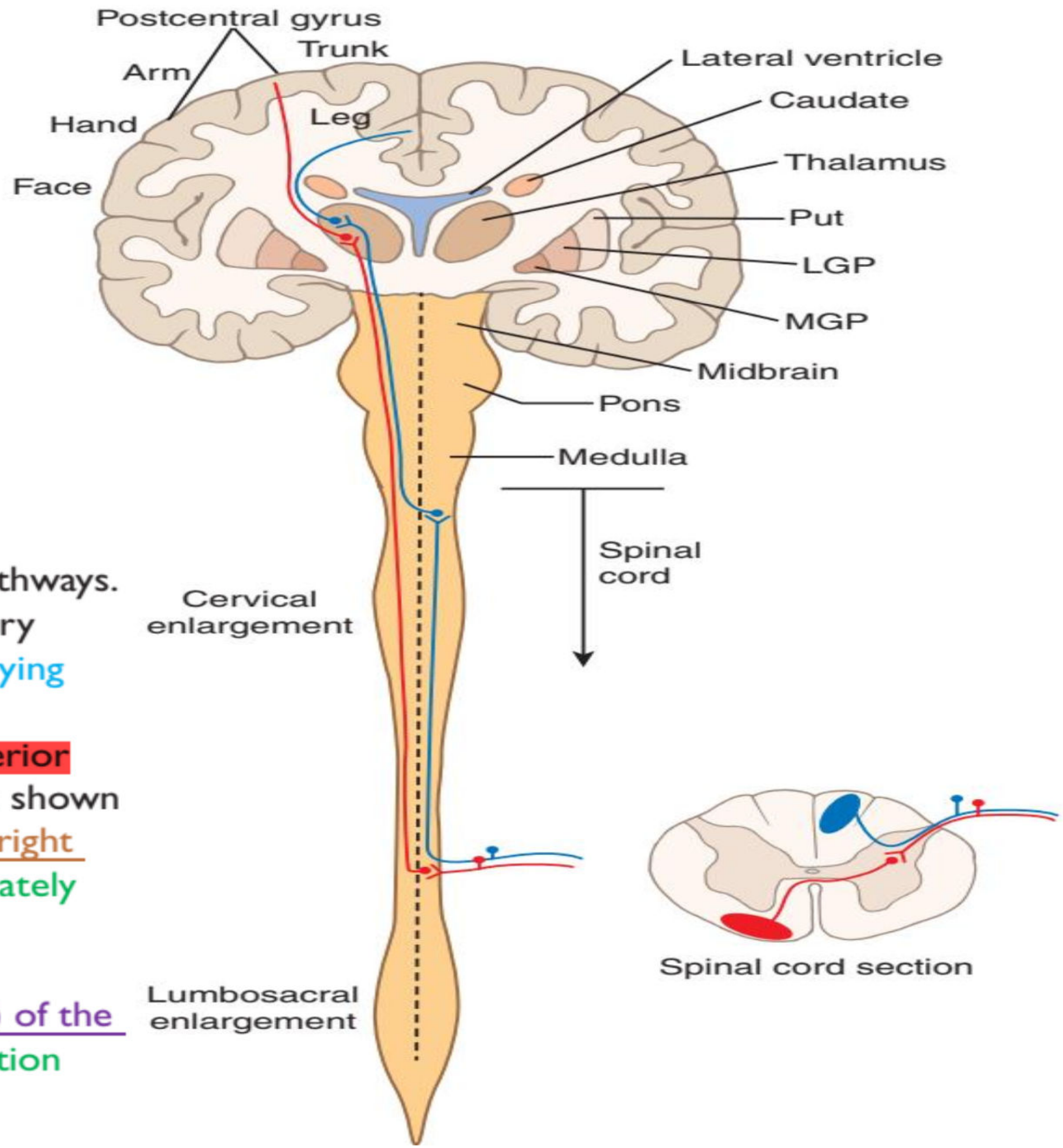


FIGURE 5-3 Longitudinal drawing of major sensory pathways. This figure illustrates the central nervous system sensory pathways for medial lemniscus/posterior columns (carrying discriminative general senses) in blue and both lateral spinothalamic (carrying pain and temperature) and anterior spinothalamic (carrying light touch) in red. The location shown for terminus of medial lemniscus fibers on the inferior right postcentral portion of the paracentral lobule approximately represents sensation carried from the distal left lower extremity. The location shown for terminus of lateral spinothalamic fibers on the lateral surface (midportion) of the right postcentral gyrus approximately represents sensation carried from the proximal left upper extremity.

GENERAL PRINCIPLES FOR SENSORY

I- primarily investigates the status of the **consciously processed** sensory modalities.

For most aspects of sensory examination, you will *ask the patient to respond based on his or her awareness of the sensory input given*.

II- For unconscious sensations systems, we can *only make indirect inferences or deductions based on what we observe to be contributions make to movement*.

Example is the **spinocerebellar system** *processing unconscious proprio-ception at the level of the cerebellum*.

start with screening questions such as, "Are there any areas of your skin where your feeling has changed or decreased?"

- In **cerebrovascular pathology**, *with expected asymmetry*, you might ask the question, "Does the skin of one side of your body feel different to you than the other side? What parts?"

quickly draw your attention to problem areas, although the whole body needs to be tested.

For each modality tested, **visually demonstrate the method** to the patient before you start the actual testing so the patient knows what to expect.

Apply the stimulus first to an area where you don't expect to find impairment (for example, the "unaffected side" in a person with CVA or UL in a person with paraplegia) allowing the patient to watch.

At this point, as the patient watches, **you should also clearly define response terms and response options with the patient**: "This is sharp," "This is dull," or "We'll call this right and this left."

After demonstrating the method, **vision should be eliminated during each sensory test.**

- ✓ As with other aspects of examination, the patient may want to "perform well" and may, without intention, be driven to give the "right" response whether it is felt or not.
- ✓ In some cases, this may be a reflection of cognitive and perceptual status, including impulsivity.
- ✓ Elimination of vision will assure patient responses *are strictly based on the sensation being tested without visual compensation.*

Each stimulus or test position should be maintained for several seconds and not just applied instantaneously.

- ✓ allowing sufficient time for central processing and response.
- ✓ Do not move too quickly from one test site to the next, especially if it is an adjacent area.

This may interfere with central processing and verbal response and may have a summation effect as a previous stimulus may reinforce the current stimulus.

If the patient is unable to respond verbally, you will need to develop an alternative method for patient response such as, "Blink your eyes if 'dull,' or open your eyes wide if 'sharp.'"

If cognitive deficits prevent accurate responses (also in pediatric patients), the therapist may have to infer sensibility based on the patient's nonverbal and motor response to introduced stimuli.

All parts of the sensory examination **(superficial, deep, and discriminative senses)** **should be performed bilaterally for comparison** of specific locations on right and left sides.

the sequence of specific locations tested is different depending on whether you are doing superficial or deep sensation testing.

SEQUENCE OF SENSORY TESTING

testing modalities of superficial sensation is best organized around **dermatomes**.

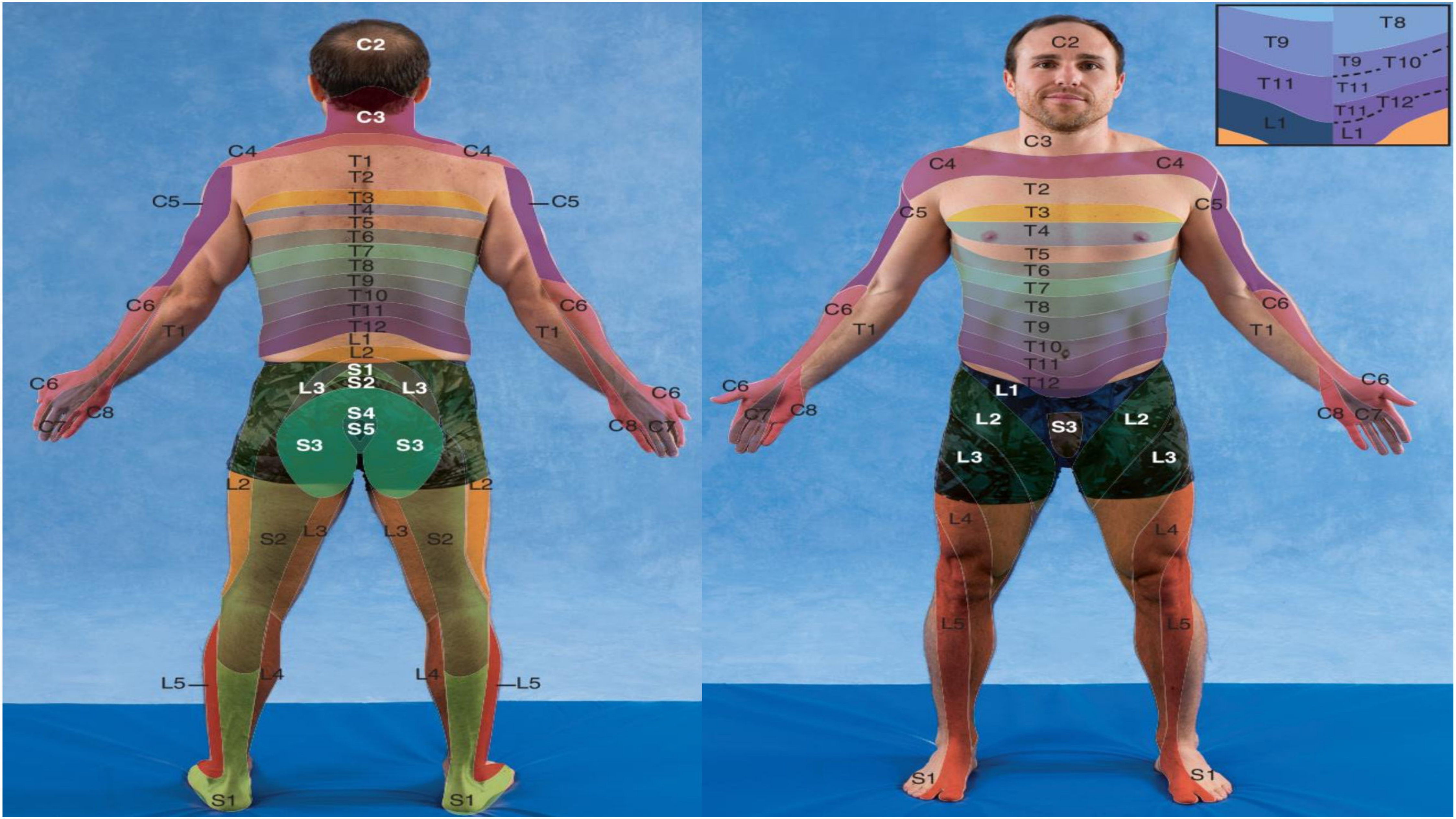
- It is important to remember the top half of one dermatome overlaps with the lower half of the dermatome above it, and the bottom half of a dermatome overlaps with the top half of the dermatome below it, as shown in Figure 5-4.
- Also remember that **C5-T1 roots** supply the *brachial plexus to serve the upper extremity*, and **L2-S3 roots** contribute to the *lumbosacral plexus for the lower extremity*. Therefore, **T2-L1 roots** are dedicated to *trunk dermatomes alone*.
- Some of the key surface landmarks associated with dermatome levels are summarized in Table 5-2
- The skin of the *face & cheek mucosa* is actually supplied by **the Trigeminal nerve**, and full assessment of this cranial nerve

testing modalities of superficial sensation is best organized around dermatomes.

For sensory evaluation of the body, it will enhance consistency ***if you always test the dermatomes in a systematic order.***

For example, you could test top to bottom,

- for example, top and back of head for **C1-2**;
- back of neck and upper trunk for **C3-4**;
- circumferentially around each arm and forearm and across the fingertips of first, third, and fifth digits for **C5-T1**;
- paramedian along the anterior trunk for **T2-L1**; and
- circumferentially around lower extremity beginning with anterior iliac crest and including the superior surface of the foot for **L2-S3**.
- Testing **anteriorly on the trunk** will reveal peripheral nerve lesions there that you may miss if you test on the posterior trunk only.



C2
C3
C4
C4
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
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T12
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L2
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L5
L5
S1
S1

TABLE 5-2 Key Surface Landmarks for Sensory Testing

DERMATOME	SKIN OVER THIS SURFACE STRUCTURE
C2	Posterior half of skull
C3	Medial end of clavicle
C4	Medial acromion and below clavicle
C5	Lateral elbow (and lateral acromion)
C6	1st digit (and 2nd digit)
C7	3rd digit
C8	5th digit (and 4th digit)
T1	Medial elbow
T2	Anterior axilla
T4	Nipple line
T6 or T7	Xiphoid process
T10	Umbilicus
T12	Anterior iliac crest/pubic symphysis
L1	Inguinal region (upper medial thigh)
L2	Medial thigh–mid-distance
L3	Medial knee
L4	Medial malleolus
L5	Base of great toe (and lateral aspect leg/plantar aspect to heel)
S1	Lateral heel (base of 5th digit, fibula head, lateral malleolus, little toe)
S2	Posterior knee
S3	Ischial tuberosity

SEQUENCE OF SENSORY TESTING

The testing sequence for **discriminative and deep sensations** is not organized around dermatomes but ***joints & body regions***.

- Because these tests are performed more globally than superficial sensation tests, a chart organized by body region is ideal for documentation of these sensations.
- The testing sequence for discriminative and deep sensation testing as part of a comprehensive sensory **evaluation therefore includes:**

1) **areas of the face** (forehead, cheek, lips) and,
2) for proprioception, joint regions including jaw, neck, shoulder, elbow, wrist, interphalangeal (IP) joints, spine, hip, knee, ankle, and toes.

PARAMETERS OF SENSORY IMPAIRMENT TO INVESTIGATE

- **Based on the medical diagnosis** of the patient + **an understanding of the related pathophysiology,** *the therapist will have some idea of possible sensory de*ficits and *their expected body distribution even before starting the examination*.
- **When a sensory impairment is identified in a particular patient,** the next step is to determine the parameters or characteristics of the identified sensory impairment including

(1) quantity of the sensory impairment

(2) quality of the sensory impairment.

Quantity of sensory impairment

- includes all characteristics related to the **extent**, **size**, and **regional dimensions of the deficit (five possible distribution patterns):** .

1. Sensory deficits associated with cerebral or brainstem pathology (central nervous system) usually occur in **a unilateral distribution .**

(often involving both the arm and leg on the side of the body contralateral to the central nervous system pathology).

2. Either **a paraplegic distribution** (Fig. 5-5B) **(involvement of lower extremities and trunk, but arm function is unimpaired).** **a tetraplegic (quadriplegic) distribution** (lower extremities and upper extremities) of sensory loss is associated with spinal cord injury with *sensory loss only in tissues innervated from below the injury level.*

3. Dermatomal distribution of sensory symptoms is related to nerve root lesions resulting in band-like areas of sensory loss as shown earlier in the **dermatomal maps** (Fig. 5-4). A peripheral nerve lesion will result in a peripheral nerve distribution of sensory loss characteristic of **the particular cutaneous nerve distribution for the lesioned nerve** (Fig. 5-5C).

Quantity of sensory impairment

4. A general peripheral distribution of sensory deficits, also described as **"stocking/glove distribution,"** occurs *generally in the distalmost parts of the limbs (feet and hands)*. Figure 5-5D

✓ most commonly with peripheral neuropathy, especially chronic diabetes and other metabolic conditions. For comparison, an L5 dermatomal distribution of sensory loss is shown in Figure 5-5E.

5. A distribution of sensory deficits sometimes occurs that follows no pattern and is termed **a sporadic distribution**. A sporadic distribution is usually asymmetrical, perhaps affecting both sides *but different regions on each side* (see Fig. 5-5F).

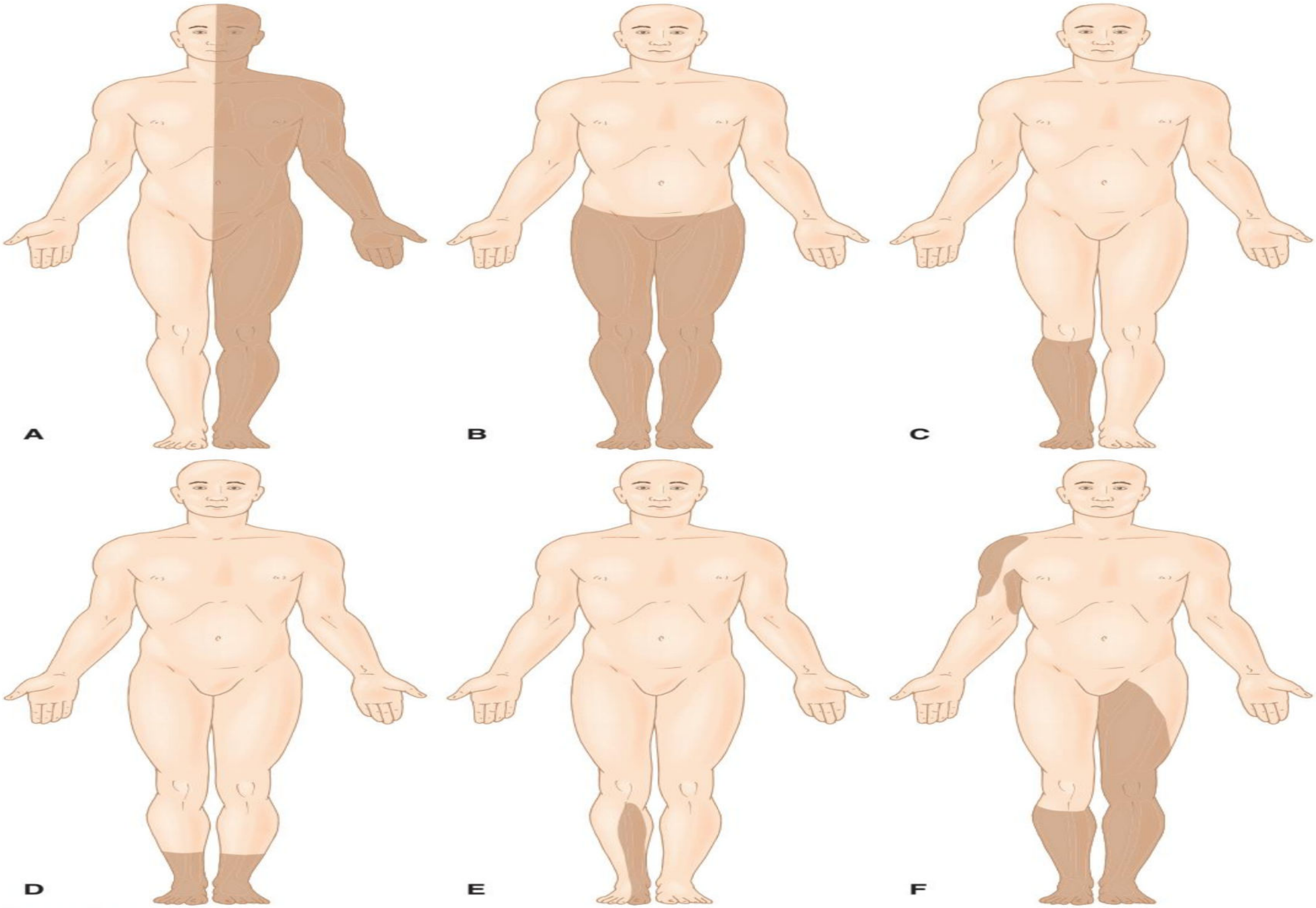

FIGURE 5-5 A-F. Diagrams of typical distributions for sensory deficits.
Comparison of various distributions of sensory loss: **A.** unilateral distribution (e.g., cerebrovascular accident), **B.** paraplegic distribution (e.g., spinal cord injury), **C.** peripheral nerve distribution (e.g., lesion to any specific nerve), **D.** general peripheral neuropathy (e.g., diabetic neuropathy), **E.** L5 dermatomal loss, and **F.** a sporadic distribution of sensory deficits (e.g., multiple sclerosis).

Quality of sensory impairment

- includes characterization of the degree of sensory dysfunction.

1) *If sensation is unimpaired* or *meets some established norms for sensory function*, terms like **normal or intact** are used in the documentation.
2) if *sensation is completely lost* and the individual has no sensibility in the affected region, the term **absent** is used.
3) If all sensory modalities are lost, the term **anesthesia** is used.
4) In between these two extremes are the cases where there is some degree of sensation detected in the affected region, but subjectively the patient reports *a decrease in intensity compared with what is typically felt for that region* or the *person is less consistent in the report or performance* used to demonstrate the sensory ability. In this case, the sensation is categorized as **impaired**.

Quality of sensory impairment

4) …………..Several terms are used to describe abnormalities of sensory integrity (**impaired)**:

A. **Hypoesthesia or hypesthesia** is *a decrease in sensibility or awareness*.

B. **Hyperesthesia or hypersensitivity** is an *excessive or increased sensitivity to sensory stimuli.*

C. **Dysesthesia**, literally **"difficult sensation,"** occurs when *an ordinary stimulus results in a disagreeable sensation*, and

D. **allodynia** is an *exaggerated or painful response to a stimulus that should not be painful.*

E. **Paresthesia** is *an abnormal negatively perceived sensation* that may include burning, pricking, tickling, tingling, or numbness without apparent cause, even in the absence of a known stimulus.

Keep in mind

impaired sensation from injury to a single nerve root

***will not result in** absence of sensation in the affected dermatome,*

but rather hypoesthesia

***because of** the overlap with dermatomes above and below.*

SPECIFIC SENSORY EXAMINATIONS

- The sensory evaluation is usually performed in a logical order, including

I. tests of superficial or tactile sensibility,

II. discriminative sensibility, and

III. proprioceptive sensibility.

SPECIFIC SENSORY EXAMINATIONS

Superficial (Tactile) Sensation

includes modalities of:

- sharp/dull (pain),
- temperature,
- light touch, and
- pressure touch.

SPECIFIC SENSORY EXAMINATIONS

Testing Sharp/Dull Discrimination

- Sharp/dull testing is used to assess integrity of the "pain" pathway **(lateral spinothalamic tract).**

Equipment: There are several instruments with both a sharp and a dull end that can be used (see Fig. 5-6):

- An opened safety pin with partially sanded point (using **rounded cap** for dull).
- A partially opened paperclip (using the **curved end** for dull).
- The pin in the handle of a commercially available neurological reflex hammer.

SPECIFIC SENSORY EXAMINATIONS

Testing Sharp/Dull Discrimination

Method:

- In each instrument, there is **a pointed end** for *sharp input* to the skin and **a flat or rounded end** for *dull input*.
- Care must be taken when using **safety pins**, *gently sanding the points*, as to not pierce the skin.
- For **infection control** of bloodborne pathogens, the safety pin or paperclip *should be discarded* after each patient and use of reflex hammer pins is discouraged.

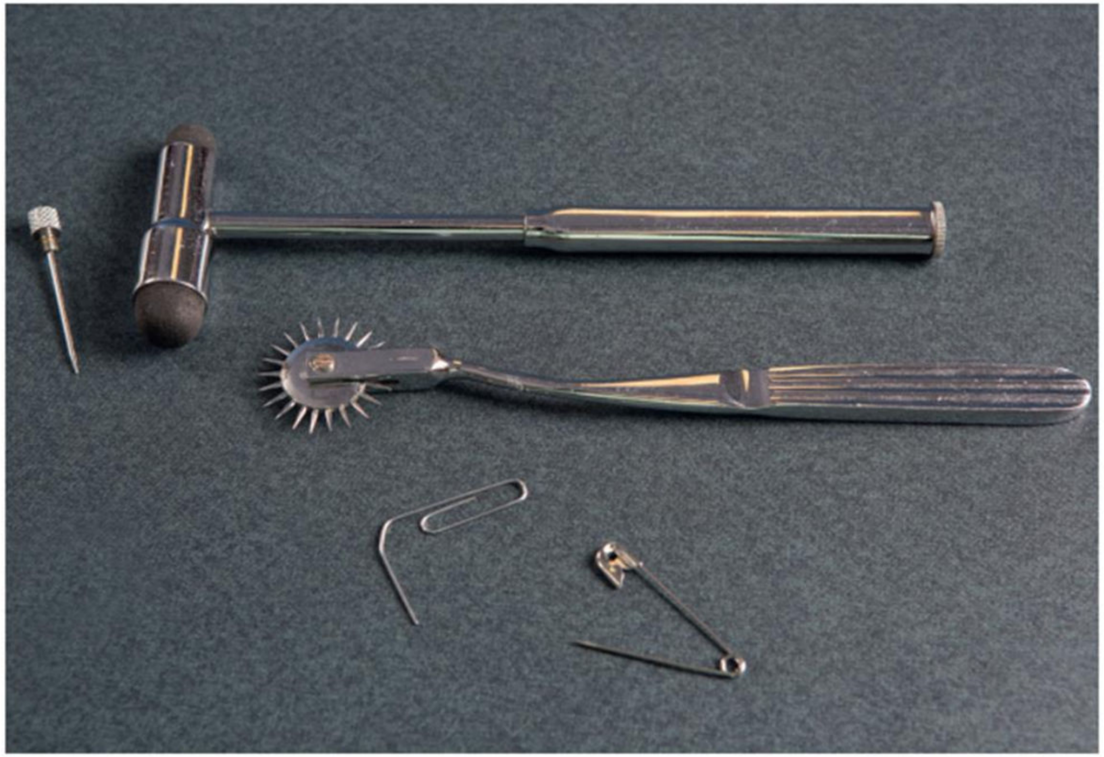

FIGURE 5-6 Instruments used for sharp/dull testing. Several instruments useful for testing sharp/dull sensibility.

SPECIFIC SENSORY EXAMINATIONS

A. Regardless of the instrument used, *deliver the inputs of sharp and dull in a variable order following a systematic dermatomal sequence as previously described*.

B. After demonstrating the sensations to be felt for the patient, the specific method and guidelines for sharp/dull testing are:

1. Apply the pinpoint with **enough force** to indent the skin but with very slight or no blanching seen in the adjacent skin.
2. Hold the pinpoint in place, **maintaining the stimulus for several seconds** to allow time for central processing and response.
3. **For each input, ask the patient to respond to the question**, "Does it feel sharp or dull?"

Each time a stimulus is felt, the patient should respond "sharp," "dull," or "can't tell."

SPECIFIC SENSORY EXAMINATIONS

Testing Temperature Sensation

- Temperature sensation, carried by the same afferent pathway as pain sensation **(lateral spinothalamic tract)**, is typically evaluated using test tubes of cold and hot water (Cooke, 1991; Harlowe, 1985).
- If your evaluation purpose is to test the integrity of the lateral spinothalamic system, there is no need to test both pain sensation and temperature sensation, and most therapists would test for sharp/dull sensation.
- **Temperature sensation is not frequently tested as part of the neurological evaluation.**
- **Equipment:** There is sophisticated equipment that has been described for use in testing temperature sense (Horch, 1992; Waylett-Rendall, 1988). In the typical clinical setting, the test is accomplished with much simpler and less expensive equipment:

- Two test tubes with stoppers:

One filled with hot water, 104°F to 113°F (40°C to 45°).

One filled with crushed ice and water, 41°F to 50°F (5°C to 10°C).

SPECIFIC SENSORY EXAMINATIONS

- Exceeding these temperature limits may cause a pain response that would interfere with the validity of the testing (Schmitz, 1994).
- **Method:**

If temperature sensation is tested as part of the neurological examination to determine distribution and severity of sensory impairment, the dermatomal sequence and general procedure for tactile sensations should be followed but with hot and cold stimuli as described:

1. **First,** test the temperature of the water-filled tubes on your own skin to assure safety.
2. **Then** apply hot and cold randomly following the *dermatomal sequence, maintaining each contact for several seconds.*

3. The patient is asked to verbally respond for each contact they detect with either **"hot,"** **"cold,"** or **"can't tell."**

SPECIFIC SENSORY EXAMINATIONS

Testing Light-Touch Sensation

- **Little research has been published** regarding the technique of light-touch evaluation except the **Semmes-Weinstein monofilament (SWM) test** .
- **Equipment:** Several options exist **clinically** for light touch:
- A wisp pulled from a cotton ball is most often used.
- A thin piece of facial tissue or Kleenex.
- A camel hair brush.

SPECIFIC SENSORY EXAMINATIONS

Testing Light-Touch Sensation

Method:

Following the general procedure and sequence for superficial sensation:

1. Apply *the selected light-touch sensory input* to the skin **by very lightly and slowly stroking the surface at one small location.**

2. Ask the patient to *respond each time* they feel the sensation with an affirmative response such as "O.K." or "now."

3. *To introduce variability in testing,* either alter the time interval between applications to *prevent patient prediction of the next application or by asking the patient, "Do you feel anything?"* at times when you are not applying a light-touch stimulation.

SPECIFIC SENSORY EXAMINATIONS

Testing Light-Touch Sensation

- **In skin with hair,** ***even the fine hairs on the back of the hand and fingers,***

the stimulus *does not have to be applied directly to the skin surface* itself
but
lightly across the hairs only.

The **light-touch receptors** wrapped around the base of each hair follicle are exquisitely sensitive.

- **In glabrous or hairless skin like the palm and sole,**

the wisp is *lightly applied to the surface of the skin.*

SPECIFIC SENSORY EXAMINATIONS

Testing Pressure Touch Sensation

- **often assessed grossly** *using pressure through* **a pencil eraser** or **pushing deeply with a finger** *and asking the patient to distinguish between touch of deep and light pressures by responding to each touch with either* **"deep"** or **"light."**

- Pressure touch has been **evaluated more objectively** using **a system of graded weights** (Sieg, 1986) *but has not gained widespread clinical use*.

Weights of 0.5, 1, and 2 ounces *were placed in* a metal capsule with the blunt end placed on the skin surface to be tested.

You would ask the patient to distinguish between the different weights.

- ❑ **A more objective method for evaluating both light touch and deep pressure** uses **the SWM aesthesiometer**, which has been widely researched (Birke, 1985; Waylett-Rendall, 1988; Weinstein, 1993; Mueller, 1996; Sloan, 1998).

- ✓ **It is most commonly used in populations** where more specific measures of sensibility need to be monitored for change, **particularly hand injuries** including _nerve damage_, _reattachments_, or in _peripheral neuropathies_ *such as diabetic neuropathy.*

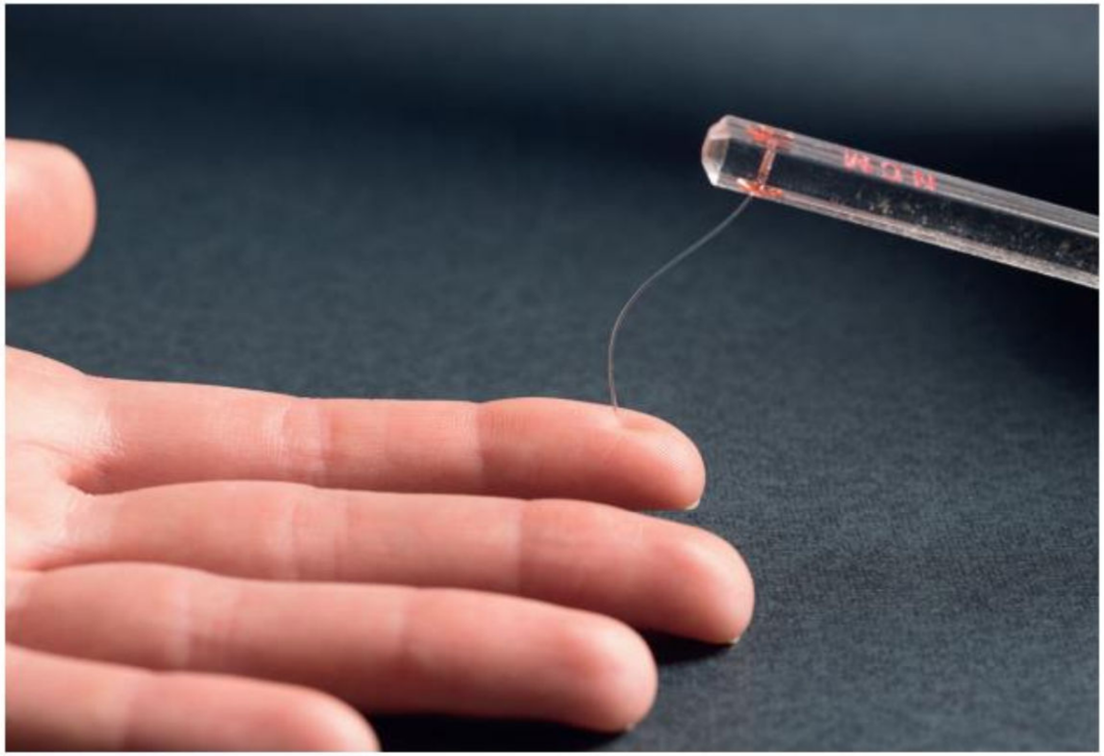

FIGURE 5-7 Semmes-Weinstein monofilament testing. Administration of a monofilament to the second digit; note that enough pressure is being applied to cause the filament to bend.

- **Each aesthesiometer** consists of **a nylon monofilament** (like fishing line) embedded near the end of a plastic rod and emerging at a right angle.
- Standardization of each filament by *generating a reproducible buckling stress allows quantification of applied forces* (Mueller, 1996).
- The color-coded number engraved on the rod, ranging from **1.65 to 6.65** (see Table 5-3), represents the logarithm to the base 10 of the *force in milligrams required to bow the filament* (Waylett-Rendall, 1988).
- The higher the assigned number, *the more force is required for the filament to bend*.

➢ **Equipment: Depending on the purpose of evaluation, there are several SWM sets commercially available:**

- **A full set consists of 20 filaments** (ranging from 1.65 to 6.65), each with a different strength related to length and thickness of the monofilament.

- **The smaller kit with five varied filaments** has been reported as *time-efficient and adequate for most clinical settings* (Bell-Krotoski, 1993).

- **The single 2.83 filament** can be used alone *for upper extremity screening* (Bell-Krotoski, 1993; Van Deusen, 1997). This 2.83 filament has also been supported as *"suitable for testing most of the body" (Bell-Krotoski, 1993).*

- **A single 5.07 filament,** calibrated to bend at 10 grams of force, has been suggested as the best *indicator of protective sensation in the feet*. (Birke showed that no patient with neuropathic ulcer was able to sense the 5.07 monofilament) (Birke, 1985; Sloan, 1998; Boyko, 1999).

Callous formation *on the plantar surface of the foot* may cause increased pressure thresholds (Bell-Krotoski, 1997).

❑ **Method:**

✓ Have the patient seated or lying and follow the general procedures previously described (including blocking vision).

✓ One possible exception to the testing sequence is that testing may be applied from ***distal to proximal*** *if the expected impairment is likely in a peripheral distribution*. The method can be divided into the following steps:

1) Apply the filament at 90° to the skin surface with enough force to make the filament bend slightly or buckle (see Fig. 5-7) and maintain for approximately 1 second (Birke, 1985) to 1.5 seconds (Bell-Krotoski, 1997) but not at predictable intervals. A slight adaptation of the application technique shown in Table 5-4 has been suggested depending on the grade of the filament used (Waylett-Rendall, 1988).

2) Instruct the patient to say "yes" each time sensation of the application of the filament is perceived ("yes-no" method).

3) At least five trials are recommended at each site before progressing to the next location (Mueller, 1996).

4) **Response must be correct for 80% of the trials (4/5 trials)** at a site to be graded with that SWM value at that site (Mueller, 1996). A ratio of two correct responses out of three has also been suggested to be considered intact in that area (Waylett-Rendall, 1988).

5) **If a patient senses less than 80% of trials at a site**, ***proceed to test that area with the next stronger monofilament*** (the next higher number).

6) Compare results to normative data (see Box 5-1), especially if cerebral damage has taken place even if unilateral because of a likelihood that both hands are affected (Dannenbaum, 1993).

BOX 5-1 Expected Pressure Sensibility Ranges by Body Regions

Hand localizes pressure between probes 2.44 to 2.83 (Waylett-Rendall, 1988)
Proximal upper extremity localizes between 4.08 to 4.17 (Waylett-Rendall, 1988)

TABLE 5-3 Clinical Significance of a Variety of Semmes-Weinstein Monofilaments

SEMMES-WEINSTEIN FILAMENT	FORCE APPLIED WITH FILAMENT	CLINICAL SIGNIFICANCE
1.65	4.5 mg	• The smallest filament in the complete set
2.44		• **Useful predictor of normal in females** *because of a lower threshold for pressure sensitivity* (Bell-Krotoski, 1993)
2.83		• **Considered "within normal limits"** • Useful to screen for sensory *abnormality anywhere in the upper extremity* (Bell-Krotoski, 1993;Van Deusen, 1997) • Suprathreshold for the face, subthreshold for foot callous areas (Bell-Krotoski, 1993)
3.22	166 mg	• Threshold mapping at this level indicates an area with less than normal sensitivity (Bell-Krotoski, 1993)
3.61	200 mg	• Pressure threshold at this level is associated with some loss of graphesthesia and texture recognition (Bell-Krotoski, 1993)
3.84	500 mg	• Pressure threshold at this level is associated with diminished protective sensation, impaired stereognosis, and usually loss of two-point discrimination (Bell-Krotoski, 1993)
4.17	1 gram	• **Normal sensation**
4.31	4 grams	• Pressure threshold at this level is associated with absent stereognosis + protective sensation (Bell-Krotoski, 1993)
≥4.56	>4 grams	• These larger filaments simply measure degrees of deep-pressure sensation (Bell-Krotoski, 1993) • One author reported, from clinical experience only, that patients who responded only to these larger filaments *may have response to pinprick, but not enough protective sensation to respond to stimuli such as **a hot cup** fast enough to prevent injury* (Bell-Krotoski, 1993)
5.07	10 grams	• Useful to screen for **sensory abnormality in the feet** (Mueller, 1996; Sloan, 1998) • Pressure threshold at this level is the best indicator of protective sensation in the feet (Birke, 1985). Another study concluded that 4.21 was the threshold to differentiate risk of foot ulcers (Sosenko, 1990). • Useful as a predictor of foot ulceration in patients with noninsulin-dependent diabetes mellitus (compared with a neurometer, which was optimal at 2,000 Hz with high sensitivity (92.9%) and low false-positive rate (26.2%). (Olmos, 1995)
6.10	75 grams	• **Marked sensory loss** if unable to feel this monofilament
6.65	447grams	• The largest filament in the complete set

DISCRIMINATIVE SENSES

DISCRIMINATIVE SENSES

- ✓ hey are the group of sensations carried by the **lemniscal system**.
- ✓ These sensations **require cortical processing** and integrating information from more than one type of tactile sensory modality to perceive qualities of the object being explored by touch.
- ✓ Discriminative sensibility has been defined as *the capacity for precise interpretation of sensation* (Omer, 1983).

For example, **if you explore an object using touch only**, you would **use a combination of** pressure touch, light touch, and position sense of the finger joints to determine the *weight*, *size*, *shape*, *texture*, and *consistency* of the object, **then apply meaning to the perceived qualities.**

DISCRIMINATIVE SENSES

Testing Vibration Sensation

- While some might **not consider** vibration testing to be clinically relevant in nervous system pathology (Bell-Krotoski, 1997; Dannenbaum, 1993), especially related to limited evaluation time, others have identified vibratory sense as an important screen for neuropathy (Vijay, 2001; Kastenbauer, 2004) and preferred to monofilament testing (Oyer, 2007).
- Testing vibration **has no obvious relevance to function** but may be *useful to monitor sensory recovery in patients with brachial plexus injuries or high peripheral nerve lesions* (Waylett-Rendall, 1988).
- **The Automated Tactile Tester (ATT)** is a reliable method for testing vibratory sensibility, both high and low frequency (Horch, 1992). **Vibrometers**, sometimes with fixed frequency of **120 Hz** (cycles per second), are also commercially available (Waylett-Rendall, 1988). **Tuning forks** are also used for several auditory screening method.

DISCRIMINATIVE SENSES

- **Equipment:**

A 30-Hz tuning fork has been shown to be more specific for *Meissner corpuscles* while **256 Hz** evaluates *Pacinian corpuscles* (Dellon, 1981). For clinical assessment, **a 128-Hz tuning fork** is most often used with *a moderate frequency to potentially affect both types of vibratory receptors.*

- **Method:**

Following appropriate demonstration and general procedures for sensation evaluation, including **elimination of vision**, steps to evaluate vibratory sensibility include:

1) Hold the fork by the post (not the tines) (see Fig. 5-8) and

✓ strike the tines or pronged end of the tuning fork on a firm but nonsolid surface like the therapist's hypothenar eminence or heel of the palm.

(*Allow it to quickly bounce off the striking surface to create optimal amplitude of vibration*) so the vibration will be stronger and last longer.

✓ Striking a solid surface like a table or chair will damage the tuning fork and the furniture.

DISCRIMINATIVE SENSES

2) Apply the post or stem of the vibrating fork to **a bony prominence** in the area to be tested (e.g., epicondyles, knuckles, etc.; see Fig. 5-8) following the regional sequence of testing locations described earlier. *Use enough pressure to make firm contact with the underlying bone.*

3) **Hold the fork in place**, being careful not to touch the vibrating tines because *touching the tines will dampen the vibration.*

4) **Ask the patient, "Is it vibrating?"** The patient should respond **"yes," "no,"** or **"can't tell."**

5) **Introduce randomization of input** *by occasionally and quietly touching the tines after you strike the post* to stop the vibration before you apply the post to the bony prominence. They will still hear you strike the tines but will not be able to hear or see you dampen the vibration.

FIGURE 5-8 Testing vibration sensibility. Correct technique for holding and placing a tuning fork at the patient's wrist. Do not contact the vibrating tines of the tuning fork because it will cause the vibration to fade rapidly.

DISCRIMINATIVE SENSES

Testing Tactile Localization

- it is the ability to localize or identify the site of touch sensation on the skin.
- **It may be tested simultaneously with the specific tests** previously discussed, especially **sharp/dull**, **light touch**, or **pressure touch** since ***localization** is **actually a perceptual process that can be applied with any receptor type.***
- Like ***two-point discrimination***, *accuracy is probably a reflection of the density of receptors for the given region of skin.*

Equipment:

Equipment for tactile localization differs depending on which modality of sensation you choose to use as the test stimulus:

- **A blunt probe** for pressure touch (Dannenbaum, 1993)
- **A paperclip, safety pin,** or **other pin for sharp/dull**
- **A cotton wisp** for light touch
- And **a ruler** to measure the error distance

DISCRIMINATIVE SENSES

Testing Tactile Localization

Method:

After demonstration and vision elimination, follow these steps using a regional sequence of testing:

1) **Apply the test stimulus to the skin** *(pressure touch with a blunt probe has been the most commonly described stimulus for tactile localization)* and **ask for the appropriate response** for testing the primary modality as previously described **("sharp" / "dull," or "yes" / "no").**

2) For each stimulus and after the patient responds, **ask a second question, "Where did you feel it?"** *The patient may open the eyes during the response phase of the test (Trombly, 1989) because you are not testing proprioceptive ability but the ability to feel the location where the stimulus was originally applied*.

DISCRIMINATIVE SENSES

Testing Tactile Localization

3) The patient may be **allowed to verbally describe the location of touch as specifically as possible**, using familiar terms and including right or left.

4) **For a more specific response**, have the patient pinpoint the location using an open paperclip or blunt probe in the available hand.

- ✓ Ask the patient to touch as close to the test site as possible.
- ✓ Allow as many trials or touches as needed until the patient is certain the same spot has been found. If you allow the patient **only one touch to the skin to localize the test site, you are probably actually testing proprioceptive joint position sense in the arm** that is pointing and not tactile localization because the tactile localization is not experienced until the clip actually touches the skin.
- ✓ After each touch, allow the patient to adjust the position if necessary.

DISCRIMINATIVE SENSES

Testing Tactile Localization

5) **For more objective documentation,** measure the error as distance in millimeters between the test site and the site indicated by the patient.

✓Test and record this distance for each body region.

✓Norms are not abundant for this test.

DISCRIMINATIVE SENSES

Testing Tactile Localization

- **An alternative method** has been described (Corkin, 1970; Weinstein, 1968) that **uses a probe to apply two successive suprathreshold stimuli, then asking the patient to report whether the** *two stimuli were at the same place* **or** *at two different places in the palm.*

- ✓ Usually each trial begins with a stimulus at a standard reference point followed by a second comparison stimulus applied at varying distances and different relative directions.

- ✓ The **patient's score** is *the smallest distance that can be discriminated*.

- ✓ **Normative data** using this method have been described for the **palm of the hand** *where the minimal distance that can be discriminated is* **3 mm** (Weinstein, 1968).

DISCRIMINATIVE SENSES

Testing Two-point Discrimination Sensation

- it is the ability to perceive two simultaneously applied stimuli as two discrete sensations.

Clinically,
it is usually a measure of the shortest distance between two points at which two light-touch stimuli are still perceived as two distinct sensations.

Among all cutaneous sensory tests, this one has been cited as "among the most practical and easily duplicated" (O'Sullivan, 1994, p.92).

- Concern has been raised regarding the reliability and validity with using any handheld tool to measure two-point discrimination (Bell-Krotoski, 1997).

- Norms from healthy adults, ages 20 to 24, have been investigated and described by Nolan.

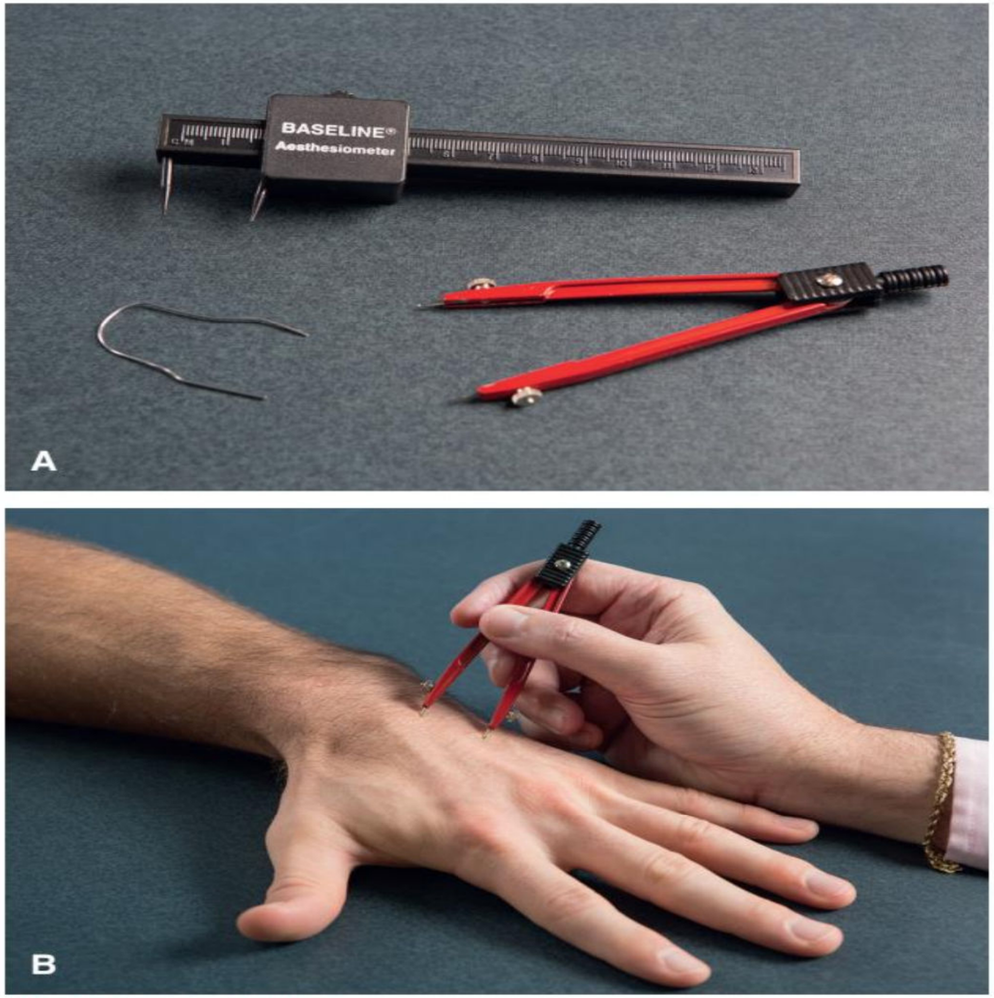

FIGURE 5-9 A AND B. Measuring two-point discrimination. **A.** A variety of simple tools can be used to apply two simultaneous points of tactile stimulation. **B.** Testing two-point discrimination requires simultaneous administration of two precise points of tactile stimulation, the distance between which can be measured at the closest distance that can still be discerned as two inputs.

TABLE 5-5 Two-point Discrimination Limits for Face/Trunk

Over eyebrow**	14.9 ± 4.2 mm
Tip of tongue*	2 mm
Cheek**	11.9 ± 3.2 mm
Lower lip and upper lip*	4 mm
Over lateral mandible**	10.4 ± 2.2 mm
Ear*	20 mm
Lateral neck**	35.2 ± 9.8 mm
Lateral to C7 spine**	55.4 ± 20.0 mm
Lateral to nipple**	45.7 ± 12.7 mm
Over inferior angle of scapula	52.2 ± 12.6 mm
Side of chest*	34 mm
Abdomen, lateral to umbilicus**	36.4 ± 7.3 mm
Over iliac crest**	44.9 ± 10.1 mm
Lateral to L3 spine**	49.9 ± 12.7 mm

Adapted from Weber, 1978* and Nolan, 1985**

*Values from E.H. Weber's translation of 1834 *De Tactu,* converted to millimeters from original Paris lines. From Weber EH. *E.H. Weber: The Sense of Touch* (translated from *De Tactu* by E. H. Weber, 1834). New York, NY: Academic Press; 1978.

** Mean values, among healthy 20 to 24 year-olds (n = 26–43). From Nolan MF. Quantitative measure of cutaneous sensation: Two-point discrimination for the face and trunk. *Phys Ther.* 1985;65(2):181–185.

TABLE 5-6 Two-point Discrimination Limits for Upper Extremity

Arm, upper lateral**	42.4 ± 14.0 mm
Arm, lower lateral**	37.8 ± 13.1 mm
Arm, midmedial**	45.4 ±15.5 mm
Arm, midposterior**	39.8 ± 12.3 mm
Forearm, midlateral**	35.9 ± 11.6 mm
Forearm, midmedial**	31.5 ± 8.9 mm
Forearm, midposterior**	30.7 ± 8.2 mm
Over first dorsal interosseous muscle**	21.0 ± 5.6 mm
Palm of hand*	13 mm
Back of knuckles*	16 mm
Thumb, palmar distal phalanx**	2.6 ± 0.6 mm
Long finger, palmar distal phalanx**	2.6 ± 0.7 mm
Little finger, palmar distal phalanx**	2.5 ± 0.7 mm
Tip of 2nd finger*	1 mm

Adapted from Weber, 1978* and Nolan, 1982**

* Values from E.H. Weber's translation of 1834 *De Tactu*, converted to millimeters from original Paris lines. From Weber EH. *E.H. Weber: The Sense of Touch* (translated from *De Tactu* by E.H. Weber, 1834). New York, NY: Academic Press; 1978.

** Mean values, among healthy 20 to 24 year-olds (n = 43). From Nolan MF. Two-point discrimination assessment in the upper limb in young adult men and women. *Phys Ther.* 1982;62(7):965–969.

TABLE 5-7 Two-point Discrimination Limits for Lower Extremity

Thigh, proximal anterior**	40.1 ± 14.7 mm
Thigh, distal anterior**	23.2 ± 9.3 mm
Thigh, midlateral**	42.5 ± 15.9 mm
Thigh, midmedial**	38.5 ± 12.4 mm
Thigh, midposterior**	42.2 ± 15.9 mm
Leg, proximal lateral**	37.7 ± 13.0 mm
Leg, distal lateral**	41.6 ± 13.0 mm
Leg, medial**	43.6 ± 13.5 mm
foot top surface*	27 mm
Over metatarsal interspace 1–2**	23.9 ± 6.3 mm
Over metatarsal 5**	22.2 ± 8.6 mm
Sole of big toe*	13 mm
Tips of toes*	9 mm
Great toe, tip**	6.6 ± 1.8 mm

Adapted from Weber, 1978* and Nolan, 1983**

* Values from E.H. Weber's translation of *De Tactu*, 1834, converted to millimeters from original Paris lines. From Weber EH. *E.H. Weber: The Sense of Touch* (translated from *De Tactu* by E. H. Weber, 1834). New York, NY: Academic Press; 1978.

** Mean values, among healthy 20 to 24 year-olds (n = 43). From Nolan MF. Limits of two-point discrimination ability in the lower limb in young adult men and women. *Phys Ther.* 1983;63(9):1424–1428.

❑ Equipment:

This test is administered with an instrument with two points (Fig. 5-9A) that can be applied to specific areas of skin (see Fig. 5-9B) and progressively moved closer together:

- **A large paperclip**, *opened and bent into a V-shape with two points* (Nolan, 1984)
- **ECG calipers** with points lightly sanded to prevent skin puncture or painful stimulation (Nolan, 1984) or **a geometric compass** with points lightly sanded
- **A ruler** to measure distance between the caliper points
- **The DiskCriminator** includes a set of *two plastic octagonal disks each containing a series of paired metal rods with interpoint intervals ranging from 1 to 25 mm apart*.
- Limitations of the paperclip include burrs or rough edges on the metal points (Waylett-Rendall, 1988), which can present a problem if moving the tips across the skin.

❑ Method:

Methods have been described for static or moving stimuli two-point discrimination testing (Waylett-Rendall, 1988; Van Deusen, 1997)

❑ only the static method will be described here:

1. After visual demonstration of the test, select a distance for initial testing**. A 10-mm distance** is recommended to start testing of the hand (Waylett-Rendall, 1988).
2. Apply the two points parallel to the peripheral nerve trunk innervating that area. *For the digits of the hand and foot, Nolan used applications perpendicular to the axis of the digit* (Nolan, 1982; Nolan, 1983).

3) The two points should make contact with the skin at the same time and ensure equal pressure between the two points.

✓ Pressure that depresses the **skin no more than 1 mm** has been suggested (Nolan, 1982) or a minimum force "so as not to blanch the skin" (Waylett-Rendall, 1988).

4) Up to 20 randomly ordered one- or two-point applications should be used for each skin area with approximately two seconds allowed between each application.

5) For each application, ask the patient to respond to the question, **"Do you feel one or two points?" The patient should respond with either "two" or "one."**

6) **If the patient is accurate at a certain interpoint distance** (8 correct of 10 successive touches; Nolan, 1982; Nolan, 1983; Nolan, 1985) or five correct responses in a row (Waylett-Rendall, 1988), then *narrow the distance between the two points and start the method again for the same skin area.*

Testing Graphesthesia

Evaluation of graphesthesia is a simple but poorly studied aspect of discrimination testing. It is also difficult to quantify. No special equipment is needed.

Method:

1. Explain the procedure to the patient, including demonstration on the less-affected hand or other body location with intact sensation, then eliminate vision.

2. **Using your** fingertip or a blunt probe, trace various letters, numbers, or shapes **on the person's palm.**

3. **Ask the patient to identify and name the symbol as they recognize it.**

Testing Stereognosis

- The recognition of a familiar object involved in stereognosis is often considered to be a perceptual function and not a pure sensation, but it is often tested with the sensory evaluation.
- Recognizing an object only by touch **requires the person to discern qualities of the object including** size, shape, weight, consistency, and texture **using both tactile sense and proprioception but not vision.**
- The patient **must have enough motor control** in the hand to manipulate the object for intact stereognosis (Dannenbaum, 1993).

Testing Stereognosis

Equipment:

According to the definition of stereognosis, the objects to be recognized should be items familiar to the patient and could include any of the items listed here. **Clinically, it is usually sufficient to include three to five objects.**

- ***A stopwatch*** to time the response.
- ***Objects to identify:*** **coin** (especially a quarter), **house key** or car key, **standard wooden pencil**, **ballpoint writing pen**, **paperclip**, **fork or a spoon**.

Method:

After visual demonstration of the task, have the patient close the eyes as with all sensory testing. For testing stereognosis:

Testing Stereognosis

1) **Place the objects, one at a time, in the patient's hand** *(each hand should be tested separately)*. Measure the time required to name the object correctly (Wynn Parry, 1988).

2) After the patient manipulates the object, ask them, "What is this object?" If the patient cannot state the name of the object, ask them to describe it to you.

3) If the patient is unable to respond verbally because of communication deficits, *they may be able to choose the item they just felt from a group of three objects* (Semmes, 1965; Weinstein, 1962), but this method does require short-term memory in the patient (Dannenbaum, 1993).

4) **As related to cerebral impairment**, if **anomia** or **the inability to name an object** is expected as a potential deficit, *follow-up the tactile testing with opportunities for the patient to name the same objects based on visual exploration and input to differentiate*.

Testing Stereognosis

- **Normal subjects should be able to name a familiar object within 5 seconds of contact** (Wynn Parry, 1966; Klatzky, 1985).
- Additionally, **specific tactile discrimination tests have been developed that focus** on shape, texture, or size perception rather than using familiar objects (Benton, 1983; Brink, 1987; Wynn Parry, 1976; Roland, 1976; Roland, 1987)

PROPRIOCEPTIVE SENSATION

Proprioceptive Sensation

Proprioception is sometimes a confusing term because of its use at two different levels of meaning.

- Sometimes it is used in a broad sense for the **category of all sensations that are considered deep,** especially joint position sense and joint movement sense.
- Other times, the term is used to refer **specifically** to joint position sense.
- In this text, the term **proprioception** will be used in the general sense, and
- the terms **"joint position sense" and "joint movement sense"** will be used to refer to the specific modalities of sensory awareness of position and movement respectively of specific joints.

Proprioceptive Sensation

The techniques for testing position and movement sense involve:

- passively positioning or moving the test joint (Westlake, 2006) then soliciting a response from the patient regarding the subjective sensation of the joint position or segment movement that took place.
- To test a joint, you will need to use one hand to stabilize the joint to be tested while your other hand grasps a joint distal to the test joint.
- As you passively position or move the patient's limb, you should hold and support the test joint with your fingers only on neutral surfaces (probably bony prominences).
- Avoid contact with skin surfaces in the plane of movement because the patient may receive tactile clues from stretch applied to these skin surfaces.

Proprioceptive Sensation

- For example, if you are testing elbow proprioception for flexion and extension, contact should be with medial and lateral epicondyles, avoiding contact on flexor and extensor surfaces of the arm and forearm as shown in Figure 5-10.

- ✓ For joint position sense, you ask the patient for a response once you have the limb positioned.

- ✓ For movement sense testing, you ask for the patient response during the movement.

FIGURE 5-10 Hand placement for elbow proprioception examination. When testing joint position or movement sensibility, it is important to avoid hand contact over skin surfaces where stretch or contact to the skin or active muscles may provide proprioceptive or sensory clues to the patient.

There are at least three methods to solicit a patient response indicating the degree of proprioceptive awareness.

- **In the first method,** which is a screening method, you move the test limb, then have the patient move the opposite limb similarly (Trombly, 1989) in a mirror position.
- **The second method** uses active patient movement in the test limb to mimic the passive movement you performed earlier on the same limb.
- **The third method,** useful especially if the patient is unable to produce a motor response because of weakness or motor deficits, requests a verbal description of the position or movement from the patient (Trombly, 1989; Dannenbaum, 1993).

Testing Joint Position Sense

Joint position sense has been discussed by others (Trombly, 1989; Dannenbaum, 1993). The key characteristic in testing this modality is that you position the limb and encourage patient attention to the position *while the limb is held in the position.*

Equipment: Often none is used, however standardization may be improved with:

- A goniometer to quantify impairment.
- A protractor has been described for use in one method.

Method: After explaining the test procedure to the patient, including visual demonstration and defining the response, you will request of the patient:

1. Passively position the joint to be tested very slowly, 10° per second has been suggested, (Trombly, 1989) and hold the position briefly.
2. Request a response from the patient regarding the perceived position using one of the three methods previously described. If you use the verbal response method, the terminology should be common and not medical, reflecting the static nature of this proprioceptive modality, including "up" or "down," "bent" or "straight," "in" or "out," "right" or "left," or "forward" or "back."
3. Test for at least several responses at each joint, including very subtle, small-range, random position changes. Individuals with normal proprioception should be able to detect even small changes in position (perhaps as little as several degrees of range in many joints).
4. Compare your results to normative data. Normative data is available for the IP joints of the finger, and the scores obtained can be used to classify impairment as slight, moderate, or severe (Corkin, 1970; Corkin, 1973).

Testing Joint Movement Sense

Joint movement sense utilizes the same receptors and pathways as joint position sense. The major difference is probably the requirement for additional temporal processing of the proprioceptive sensation in the central nervous system because the patient must detect *changes in position during movement.* This processing facilitates detection of the characteristics of joint movement over time including direction, speed, and magnitude.

Equipment: Same as joint position sense.

Method: Testing is similar to the method previously described for position sense but notably requires a response from the patient *while you are passively moving* the target joint.

1. Passively move the joint to be tested very slowly in a very small range.
2. Solicit a response during the movement. If using the verbal response method to test joint movement sense, the common terminology used should reflect the directional


Thanks!