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INTRODUCTION

Neurology is a fascinating area of medicine that unfortunately often fills students with dread and thoughts of impossibly complex neuro-anatomy, incredibly rare diagnoses, and patients who we can do little for.

This couldn’t be further from the truth. We believe that neurology is often presented in a confusing and complicated way that puts students off. This booklet is not intended to be a comprehensive textbook of neurology but a quick reference guide for how we think the neurological examination should be performed and thought about. Our hope is that it will make learning neurology easy, rewarding, and most of all interesting!

Finally, we would like to point you in the direction of https://teesneuro.org, a website lovingly built by Dr Archibald with recordings of neurology lectures, videos of how to perform a neurological examination, revision notes on neurological disorders, and neurology cases to work through. We hope you find it useful!

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CRANIAL NERVE EXAMINATION

You will have all been taught to examine the cranial nerves in order from I – XII. Not only is this really difficult to remember, it takes ages and is not how any neurologist actually examines cranial nerves. It also makes you think all abnormalities are caused by problems with the cranial nerves when they can be caused by any part of the motor pathway. You aren’t just testing the cranial nerves when you examine the face; in the same way as testing the power in the arms tests the motor cortex, white matter tracts, brain stem, spinal cord, peripheral nerve, neuromuscular junction, and muscle, testing the motor function of the face tests all these parts of the motor pathway too!

The easiest and quickest way to examine the cranial nerves is to split it into 3 parts, each with 5 bits to examine:

- **Visual assessment:**
  1. Visual acuity
  2. Visual fields
  3. Eye movements
  4. Pupils
  5. Fundi

- **Motor assessment:**
  1. Forehead
  2. Eyes
  3. Mouth
  4. Neck
  5. Shoulders (Trapezius)
• Sensory assessment:
  1. Taste
  2. Smell
  3. Facial sensation
  4. Hearing
  5. Consider the corneal and gag reflex

And that’s it!

Let’s go through each section in a bit more detail.

**VISUAL ASSESSMENT**

**VISUAL ACUITY**

Check **corrected** visual acuity (i.e. glasses/contacts should be worn) and document that it was corrected.

A full size Snellen chart should be used from 6 metres away (half size ones for 3 metres are also available).

Ask the patient to cover one eye stand the appropriate distance away and read down to the smallest letters they can see.

The visual acuity is the distance the patient is from the chart/the distance from which a person with normal acuity could see the letters. For example, 6/18 would mean that a person could read letters at 6 metres that a person with normal visual acuity could read at 18 metres.

Near vision can also be checked using a Jaeger chart.
VISUAL FIELDS

When testing a patient’s visual fields you are *crudely* checking them against your own. To do this:

1. Sit approximately 1 metre away from the patient with your eyes at the same level as the patient.
2. Ask the patient to cover one eye and cover your mirror image eye e.g. if the patient covers their right eye, cover or close your left eye.
3. Ask the patient to look at your eye and make sure they keep looking at your eye throughout the visual field check (ensure you are also looking at the patient’s eye!).
4. Ensure your hand is halfway between you and the patient (otherwise the test will be invalid) and gradually move your fingers from the beyond you peripheral vision into the centre. Do this from each of the four quadrants in each eye.
5. Ask the patient to tell you as soon as they see your fingers.

You and the patient should see your fingers at the same time (if you both have normal visual fields). Check all four quadrants of the visual field for each eye. Subtle visual field defects will not be picked up with this technique (they will need specialist equipment in the ophthalmology department) but it can be useful for large defects. See Figure 1 for the classic visual field defects and their associated lesions.

You can also check the blind spot during this part of the examination. To do this, stay in the same position as for visual fields (level with the patient, approximately 1 metre away, both of you covering/closing one eye, and both looking at each other’s eye).

1. Hold a red hat pin (because everyone has one of those lying around) in your hand at eye level, equidistant between the patient and yourself.
2. Starting in the midline slowly move the pin laterally.
3. You should notice the red pin disappear in your peripheral vision.
4. Ask the patient if the pin has disappeared. If it hasn’t, you can move the pin slowly forwards and backwards to make sure you are holding the pin equidistantly between you.
5. When the pin has disappeared for both you and the patient, you can work out how big their blind spot is compared to yours by moving it up and down, and side to side, and asking the patient when it reappears.

The pin should reappear for you both at roughly the same time, if it reappears for you significantly before the patient this can indicate an enlarged blind spot. This is often due to optic nerve swelling (which can be caused by increased intracranial pressure).
Figure 1 - Visual field defects
EYE MOVEMENTS

Eye movements are complicated but there are a few tricks to help.

Firstly, give yourself enough time in the examination to think about what you’re examining and if it is normal or abnormal. It is helpful to hold the patient’s head in a fixed position; this also allows elevation of eyelids in case of ptosis and for downgaze and puts you at arm’s length. The further back you are and the slower you conduct your examination of smooth eye movement the more you will see. Ensure you go to the extremes of lateral and vertical gaze.

In neurology we are particularly interested in whether the eyes turn together in the same direction, if they don’t we call this dysconjugate gaze.

Eye movement examination should include:

- Voluntary saccades
- Pursuit
- Targeted saccades

VOLUNTARY SACCADeS

Saccades are the small rapid movements of the eye seen as it jumps from fixation on one point to another.

Examine these by asking the patient to look to the right then to the left. You can repeat this a couple of times. Then ask them to look up and down. Again, repeat this a couple of times. You may need to hold the eyelid up when observing downwards gaze.

From this brief examination you should have some idea if there is any restriction in movement of the eyes and you may see nystagmus.
PURSUIT

Ask the patient to follow your finger in the shape of an “H” and look for any restriction in eye movements and any nystagmus (see Figure 3).

TARGETED SACCades

Ask the patient to look at your nose and then your hand held to the lateral extreme of field and repeat this in quick succession. This may reveal ‘overshoot’ (hypermetria) or stepwise movements of the eyes (hypometria). This is also a really good way to see dysconjugate gaze for example in patients with internuclear ophthalmoplegia (INO, see Figure 2).

Figure 2 - Right INO - ipsilateral failure of adduction and contralateral nystagmus
Figure 3 - Eye Movements
**PUPILS**

To examine the pupils you need to check the pupillary reflexes to light and accommodation.

To assess the reflex to light, shine a pen torch into each pupil in turn and check if the pupil constricts.

To assess the accommodation reflex, ask the patient to fix their gaze on something in the distance then hold your finger in front of their nose. Ask the patient to then fix their gaze on your finger. A normal response is for the eyes to converge on the target and for the pupils to constrict.

You can also check for a relative afferent pupillary defect (RAPD) using the “swinging light test”. Perform this by moving the pen torch from one pupil to another, if one of the pupils dilates when light shines into it then this is evidence of a RAPD.

**FUNDI**

Examination of the fundi with an ophthalmoscope is challenging and takes lots of practice! However, it is important that you can recognise a normal fundus.

*Figure 4 - What you see in a text book vs what you see in reality!*
Ideally you will need a dark room and pupil dilating eye drops to get a good view. However, this isn’t always possible.

The biggest tip is to get very close to the patient (and then get closer again!); you really do need to be as close as possible to the patient to have a chance of seeing anything. Make sure you look in the patient’s right eye with your right eye and their left eye with your left eye so that you don’t end up with your face directly in front of the patient’s face.

Start the dial at 0 (but know you may need to change this – if you are short sighted you’ll need to rotate the dial through the red numbers until the fundus is in focus) and look through the ophthalmoscope for the red reflex. Move toward the patient’s eye following the red reflex in. With a bit of luck, you’ll see some blood vessels. In the eye “all roads lead to Rome”, so, if you follow the blood vessels you should make your way to the optic disc. Have a look at the colour (pale or not?) and the contour (swollen or not?) of the optic disc. Then, have a good look at the blood vessels, looking for haemorrhage or exudates. Finally, ask the patient to look directly at the light to look at the macula.

Keep practicing this again and again. If you get good at only one bit, then it MUST be the ability to see the optic nerve margins reliably. One day, when you can’t see them, and you normally can, it will tell you the patient has optic disc swelling and you might just save their life!
MOTOR ASSESSMENT

With motor assessment of the cranial nerves you are checking for any weakness of the muscles of facial expression (CN VII) and the muscles of mastication (motor component of CNV). See https://teesneuro.org/how-to-examine/motor-cranial-nerves/ for a video.

1. Forehead
   - “Raise your eyebrows” - check for any asymmetry (CN VII). Weakness of the forehead indicates a lower motor neurone (LMN) CN VII (usually Bell’s) palsy.

2. Eyes
   - “Screw your eyes up tightly” - try to open the patient’s eyes, you may notice that one of the eyes is easier to open than the other. This will help pick up on any subtle weakness you might not see on inspection alone (CN VII). Again weakness of eye closure is most common with a LMN palsy.

3. Mouth
   - “Show me your teeth” – look for any drooping of the mouth (CN VII).
   - “Clench your jaw” – feel the masseter muscle bulk, and “open your mouth against my hand” (pterygoids CNV – muscles of mastication).
   - “Open your mouth wide” – inspect the tongue for wasting, fasciculation, deviation by ask the patient to move their tongue from side-to-side looking for speed, and smoothness of the movement (CN XII).
• “Purse your lips together” – try to open each side of the patient’s lips, again this will test for more subtle weakness (CNVII).
• Speech is often assessed during the history, but you can also assess it here as the CNs can cause a dysarthria or dysphonia (CNIX, X, XII. See the speech section for more details Pg.37).

4. Neck
• “Turn your head to the side” – ask the patient to keep their head in place whilst attempting to pull it towards the midline (CNXI).

5. Shoulders
• “Shrug your shoulders” – push down on the patient’s shoulders to check for power of the trapezius muscle (CNXI).

Once you’ve learnt this sequence, you’ll be able to assess the motor cranial nerves in about 1 minute.

SENSORY ASSESSMENT

See https://teesneuro.org/how-to-examine/sensory-cranial-nerves/ for a video of this.

1. Ask about taste (CNVII – anterior 2/3s, CNIX – posterior 1/3)

2. Ask about smell (CNI)

3. Test light sensation with cotton wool, on each side of the face, on the forehead, cheeks, and chin (i.e. the three divisions of CNV). Also consider the oral cavity (CNV) and corneal reflex (CNV – see below).
4. Briefly check hearing by whispering a number in each of the patient’s ears and asking them to repeat the number (CNVIII). You can consider Rinne’s and Weber’s tests at this point:

- Rinne’s – alternate a vibrating 512Hz tuning fork between the patient’s mastoid process (bone conduction) and just next to their ear (air conduction). Ask which is louder. A normal result is for air conduction to be louder than bone conduction. In neural deafness air conduction is better than bone; in conductive deafness bone conduction is better than air.
- Weber’s – place a vibrating 512Hz tuning fork in the centre of the patient’s forehead and ask if the sound is heard loudest left / right / centre. A normal result is the centre. In neural deafness, sound is heard best in the unaffected ear, in conductive deafness the sound is heard best in the affected ear.

5. Mention the corneal reflex (afferent - CNV and efferent - CNVII) and gag reflex (afferent - CNIX and efferent - X).
UPPER LIMB MOTOR EXAMINATION

Motor examination is frequently taught or written about in a way which is complicated and confusing. We hope the approach below will be simple, quick, and most importantly make you look like you know what you’re doing!

Having said all that, you should still use a traditional structured approach to examination with inspection, tone, power, reflexes, and coordination in that order. See https://teesneuro.org/how-to-examine/motor-assessment/ for a video.

INSPECTION

This is an active process (i.e. see don’t just look!). Invaluable features of neurological disease will not fall into your eyeballs as you absent-mindedly gawp at the patient! You also need to make sure that you actively seek diagnostically important negative or positive inspection findings. Do this by closely looking at the patient’s arms, ensuring they are properly exposed. Key things to look for are:

- **Wasting** – look at the muscle bulk in the arms and hands. The thenar and hypothenar eminences are often missed.
- **Tremor** – or any additional/abnormal movements.
- **Fasciculation** (not fasciculations! Fasciculation is always singular like constipation, not constipations!) – small areas of involuntary muscle fibre contraction. **DO NOT** flick the patient’s muscles, but do take time to be confident that fasciculation is either present or not!
TONE

In simple terms, tone is normal, increased, or decreased. Increased tone can be categorised as spasticity or rigidity.

SPASTICITY

Spasticity is seen in patients with upper motor neurone problems e.g. a stroke. It is ‘velocity-dependent’ meaning that you may need to move the limb quickly to pick it up.

To examine for spasticity, take the patient’s hand as though you are shaking it and turn it quickly from prone to supine, whilst at the same time flexing and extending at the wrist and elbow. If spasticity is present, you will feel a ‘catch’ as you move the arm.

RIGIDITY

Rigidity is seen in patients with basal ganglia (extrapyramidal) problems such as Parkinson’s disease. It is present through the full range of movement and regardless of whether the movement is quick or slow. It is often described as “lead pipe” rigidity because the patient’s limb feels like bending a lead pipe (which we all obviously do on a regular basis).

To examine for rigidity, you can gently and slowly passively flex and extent a patient’s wrist. You are feeling for resistance on movement.

Counter-activation is a Neurologist’s trick to accentuate rigidity. To do this, ask the patient to perform a counter-activation task with their other arm (e.g. pretend to paint a wall or open and close their fist approx. once per second) whilst you assess tone. This can dramatically increase rigidity and importantly it looks like you know what you’re doing!
POWER

There is a whole range of different techniques and practice regarding which movements to check and how to grade them. However you should generally assess two movements, typically flexion and extension, at each of the major joints in the upper and lower limbs. The key movements you need to assess are:

- Shoulder abduction and adduction - proximal power.
- Elbow flexion and extension
- Wrist flexion (median nerve) and extension (radial nerve)
- Finger extension (radial nerve) and flexion (median and ulnar nerves) – distal power.
- Finger abduction (ulnar nerve) – intrinsic hand muscle function.
- Thumb abduction (median nerve) – intrinsic hand muscle function.

Most of the other upper limb movements you can test are not particularly helpful where weakness is generalised, but are vital when considering individual nerve or myotomal problems – generally a more specialist examination. However, you should be able to pick up features of an isolated median, ulnar, or radial nerve palsy.

Weakness can be described simply as mild, moderate, or severe or alternatively using the MRC power scale.

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<th>Description</th>
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<td>0</td>
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</tr>
<tr>
<td>5</td>
<td>Normal power</td>
</tr>
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</table>

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GENERAL TIPS

Try to classify the weakness using the following descriptors:

- Mild, moderate, or severe
- Bilateral or unilateral
- Symmetrical or asymmetrical
- Proximal, distal, global, or pyramidal

REFLEXES

Trying to assess reflexes fills students with fear. We’ve all heard the phrase “I’m not that good at reflexes” echo through the corridors of the undergraduate centre. Assessing reflexes takes practice (like any other examination technique) but you need to be comfortable with your technique and trusting of your tendon hammer! Reflexes may be absent and if consistent with other clinical features, can be a major diagnostic clue!

You are looking to assess if any reflex(es) is normal, absent or brisk (exaggerated).

In general, hold the tendon hammer loosely at the end of the handle and let it fall like a pendulum to strike the tendon, rather than holding it tight like your life depends on it! Watching a practiced neurologist or a video can help (https://teesneuro.org/how-to-examine/how-to-improve-your-motor-exam/ 12:53).

In the upper limb we routinely check three reflexes:

- Biceps (C5/6) – place your non-dominant thumb over the biceps tendon at the distal end of the upper arm. Strike your thumb with
the tendon hammer and look for contraction of the biceps tendon and feel for this underneath your thumb.

- **Supinator (C5/6)** – place two of your non-dominant fingers over the tendon of brachioradialis (approximately 5-10cm proximal to the wrist on the radial side). The elbow should flex slightly and the hand should supinate.
- **Triceps (C7)** – strike the triceps tendon (just proximal to the elbow directly with the tendon hammer and look for contraction of the triceps muscle.

If you are having difficulty, reinforcement techniques, such as asking the patient to clench their teeth (for upper limbs) or interlock their hands and pull them apart (for lower limb reflexes), can help to confirm the presence or absence of reflexes.

**COORDINATION**

You are mainly looking for signs of incoordination in this part of upper limb assessment (although you may have already found signs of this with eye movement – nystagmus, dysarthria, or gait assessment – broad-based and unsteady).

Ask the patient to touch their nose and then your extended index finger tip. Ensure your finger tip is far enough away that the patient’s arm is fully outstretched when the patient touches your finger. You are looking to see if this can be conducted with “speed and neatness”, but also for tremor (called an “intention tremor” if at the end of the movement to your finger tip) and ‘past-pointing’ (dysmetria or inaccuracy of the movement), which are usually caused by an ipsilateral cerebellar lesion (cerebellar ataxia) or a major loss of sensory function in that limb (sensory ataxia). **Do not** move your finger about when doing this, it
serves no purpose to make interpretation of inaccurate movements more difficult!

Then ask the patient to tap on the back of one of their hands or on their thigh with their hand as quickly as possible. Patients with ataxia struggle with this movement, appearing clumsy. Listen and look for consistent rate, rhythm and force of movement (the key components of normal cerebellar function).

Finally, you can ask the patient to place one hand on top of the other and then turn it over repeatedly. This rapid alternating movement tests for evidence of dysdiadochokinesia which again, is seen with cerebellar lesions. This is not a helpful sign as patients with problems like Parkinson’s, arthritis, weakness etc. will all struggle with this. As such, it adds little or nothing to the information gleaned from the “hand tapping” test above.

OTHER TESTS

FATIGABILITY

If you are suspicious of a neuromuscular junction problem such as myasthenia gravis, you may want to check for signs of fatigability which is one of the hallmarks of myasthenia. There are a couple of ways of testing for this:

- Check if the patient has any weakness in shoulder abduction. Then, ask the patient to quickly abduct and adduct their arms with their elbows flexed for about 1 minute (as though they are flapping wings). Again check for weakness of shoulder abduction. If there is now weakness present this is evidence of fatigability.
• Fatigability can also be checked by asking the patient to look upwards at your finger for >1 minute. If their eyelids droop this is evidence of fatigability.

BRADYKINESIA

If you are suspicious of a movement disorder e.g. Parkinson’s disease, you may want to check for further evidence of bradykinesia (i.e. slow movement). There are a couple of ways to test for this (see Figure 5):

• Ask the patient to bring their forefinger and thumb together and then move them fully apart. Ask them to do this repeatedly and as quickly as they can. Patient’s with Parkinson’s disease will struggle to move their finger/thumb quickly and will display gradually smaller movements as they go on.
• Ask the patient to rotate their hand as though they are polishing a door knob. Again, the movements will get slower and smaller.

Figure 5 - Tests for bradykinesia
LOWER LIMB MOTOR EXAMINATION

The same principles of motor examination of the upper limb apply.

INSPECTION

As in the upper limbs, the key things to look for are:

- **Wasting** – look at the muscle bulk of the quads and both anterior and posterior compartments of the calf
- **Tremor** – or any additional/abnormal movements.
- **Fasciculation** – small areas of involuntary muscle fibre contraction (DO NOT flick your patient!)

TONE

To assess tone in the lower limb, ask the patient to relax their legs and then roll each in turn from side to side. Look at the foot to make sure it is passively flopping from side to side as you roll the leg and remember this is also informing you about tone at the hip (you get that for free!).

Next briskly lift the patient’s knees whilst the leg is relaxed and extended on the bed/couch. You may feel a catch as you do this if tone is increased. The patient’s heel should stay on the bed if tone is normal.

Finally, assess for clonus by supporting the patient’s knee, flexing it to 90°, and then briskly dorsiflexing and partially everting the foot and holding it there (video of how to assess for clonus https://teesneuro.org/how-to-examine/tone/). A couple of beats of clonus or more can be normal, especially in young female patients, or patients with heightened anxiety. Prolonged or in particular asymmetric
clonus may be of significance (but of course consider other signs of spasticity such as increased tone and increased reflexes).

**POWER**

The key movements to assess in the lower limb are, again, those of flexion or extension at the major joints (hips, knees, and ankles where this is referred to as dorsi- and plantar flexion) and occasionally of the great toe.

- Hip flexion and extension
- Knee flexion and extension
- Ankle dorsiflexion and plantar flexion

Again, weakness can be described simply as mild, moderate or severe or alternatively by using the MRC power scale.

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**GENERAL TIPS**

Try to classify the weakness using the following descriptors:

- Mild, moderate, or severe
- Bilateral or unilateral
- Symmetrical or asymmetrical
- Proximal, distal, global, or pyramidal
REFLEXES

You are looking to assess if any reflex(es) is normal, absent or brisk (exaggerated).

In general, hold the tendon hammer loosely at the end of the handle and let it fall like a pendulum to strike the tendon, rather than holding it tight like your life depends on it! In the lower limbs we routinely check three reflexes:

- **Knee (L3/4)** – strike the patella tendon (distal to the patella) directly with the tendon hammer and look for contraction of the quadriceps.

- **Ankle (L5/S1)** – partially dorsiflex the foot and strike the Achilles tendon directly. This can be done by externally rotating the patient’s leg to expose the Achilles tendon. Look for contraction of the gastrocnemius muscles and plantarflexion of the foot.

- **The plantar reflex** – run a **blunt** object (e.g. an orange stick or a thumb nail) up the lateral border of the sole of the foot and across the base of the metatarsals. A normal response is for the toes to flex. An abnormal response is for the 1st toe to extend and the other toes to splay.

If you are having difficulty, reinforcement techniques, such as asking the patient to clench their teeth (for upper limbs) or interlock their hands and pull them apart (for lower limb reflexes), can help confirm the presence or otherwise of reflexes.

COORDINATION

Ask the patient to run their heel from the opposite knee down to the tip of the opposite great toe. Look for uncoordinated or clumsy movements that might be in keeping with ataxia.
GAIT

A neurological examination is not complete without an assessment of the patient’s gait. Assessing gait can be tricky but it can tell you a huge amount about the patient in front of you (for example a patient who can walk probably does not have significant lower limb weakness). There are a few characteristic gaits you should be aware of. This video helpfully highlights several important abnormal gaits.


ATAXIC GAIT

This is the classic “drunk” gait. It is broad based (the feet are far apart) and unsteady, with irregular stride length and frequency. Patients will struggle with tandem gait.

PARKINSONIAN GAIT

This is typically a narrow gait with small shuffling steps. The patient’s steps accelerate as they walk (festination). You may also notice reduced arm swing (unilateral or bilateral) and/or a tremor.

HEMIPLEGIC GAIT

Most commonly seen following a stroke, the patient typically has a flexed upper limb on the affected side and drags their extended and stiff lower limb in a semi-circle motion (circumduction).
SENSORY ATAXIC GAIT

This gait is due to problems with loss of sensory or proprioceptive feedback from the lower limbs (e.g. a peripheral neuropathy). The gait is broad based and stomping (the patient stomps their feet down on the ground to increase sensory feedback and be sure they are on the ground!). Symptoms are typically worse in the dark as the patient loses visual input to enable them to determine their body position (so-called symptomatic Rombergism).

Formal Romberg testing (see below) is often positive. Ask the patient to stand with their feet together and close their eyes, in a positive test, the patient will fall (and should be caught!).
**UPPER LIMB SENSORY EXAMINATION**

In real life, neurologists rarely perform a sensory examination – just ask them. Generally a sensory history is far more important and informative than is an actual sensory examination. It is the least objective component of the neurological examination and as such it should be focused and only conducted to confirm the sensory history or clinical diagnosis.

How you test sensation should to some extent be driven by the pattern of sensory loss you are looking for or expecting from the history, e.g. starting distally to proximally for a suspected peripheral neuropathy.

**SUPERFICIAL PAIN (PIN PRICK)**

Use a “Neurotip” to test for pin prick sensation. Be sure to explain to the patient that you are testing their ability to feel a sharp pin or a significant change in that sensation. You do not need to alternate sharp and dull sides of the “Neurotip” as this adds nothing, and you do not need the patient to close their eyes.

Test the sternum or neck as the ‘normal’ area. Then map out the dermatomes (by asking the patient if they can feel the pin and if it feels the same on both sides). See suggested points for testing on Figure 6. If you find an abnormality, map it out a bit (not too much) and try to decide if this is:

a) Dermatomal (nerve root)  
b) A particular nerve (peripheral nerve)  
c) Glove & stocking (peripheral nerves)  
d) Something else (!)

If it is patchy, just call it patchy and move on.
TEMPERATURE

You can crudely test temperature sensation using a tuning fork and asking the patient if this feels cold. Usually, this is performed for peripheral neuropathy or a spinal cord lesion, so start distally and work proximally, asking the patient if they can feel the cold of the tuning fork.

VIBRATION

Use a 128Hz tuning fork and ask the patient if they can feel a buzzing sensation – establish this first by placing a vibrating tuning fork on the sternum (and perhaps even asking that they recognise when you stop the vibration with you hand). Start at the distal IP joint of the 2nd digit and if sensation is impaired, work proximally (MCP → radial styloid → olecranon → acromion).

JOINT POSITION SENSE

Demonstrate this to the patient by moving the distal phalanx of the thumb either up or down. Then ask the patient to close their eyes and tell you whether you are moving their thumb up or down. The sensitivity of joint position sense (JPS) is ≤ 1° of arc, so only small deviations up or down are required if JPS is preserved. If sensation is impaired move to a more proximal joint e.g. the wrist.

LIGHT TOUCH

Light touch sensation is the least useful and most subjective part of a sensory examination and is deliberately placed it at the end. Use cotton wool and follow the same approach as pin prick sensation. See suggested points for dermatomal testing on Figure 6.
In reality, light touch sensation can be easily, effectively and reliably assessed with the finger tips.

**CORTICAL SENSATION**

If you are suspicious of a parietal lobe lesion you can assess for:

- **Sensory inattention** – ask the patient to close their eyes and ask them which hand is being touched – left, right, or both. If they don’t register one of the arms when both are touched this can indicate a contralateral parietal lesion. Only very light touch should be used.

- **Astereognosis** – the patient will be unable to identify objects (e.g. a coin or key) by touch with their eyes close.
Figure 6 - Dermatomes of the upper and lower limb with suggested points for testing
LOWER LIMB SENSORY EXAMINATION

The approach to the lower limb sensory examination is similar to that applied in upper limb sensory examination.

SUPERFICIAL PAIN (PIN PRICK)

Use a “Neurotip” to test for pin prick sensation. Be sure to explain to the patient that you are testing their ability to feel a sharp pin or a significant change in that sensation. You do not need to alternate sharp and dull sides of the “Neurotip” as this adds nothing, and you do not need the patient to close their eyes.

Test the sternum or neck as the ‘normal’ area. Then map out the dermatomes (by asking the patient if they can feel the pin and if it feels the same on both sides). See suggested points for testing on Figure 6. If you find an abnormality, map it out a bit (not too much) and try to decide if this is:

a) A sensory level (spinal cord)
b) Dermatomal (nerve root)
c) A particular nerve (peripheral nerve)
d) Glove & stocking (peripheral nerves)
e) Something else (!)

If it is patchy, just call it patchy and move on.

TEMPERATURE

You can crudely test temperature sensation using a tuning fork and asking the patient if this feels cold. Usually, this is performed for
peripheral neuropathy or a spinal cord lesion, so start distally and work proximally, asking the patient if they can feel the cold of the tuning fork.

**VIBRATION**

Use a 128Hz tuning fork and ask the patient if they can feel a buzzing sensation – establish this first by placing a vibrating tuning fork on the sternum (and perhaps even asking that they recognise when you stop the vibration with you hand). Start at the distal IP joint of the 2nd digit and if sensation is impaired, work proximally to various bony prominences (base of great toe → medial malleolus → tibial plateau → ASIS).

**JOINT POSITION**

Demonstrate this to the patient by moving the distal phalanx of the great toe up or down (make sure you hold the toe at the sides, not on top). The sensitivity of JPS is ≤ 1° of arc, so only small deviations up or down are required if JPS is preserved. If sensation is impaired move to a more proximal joint e.g. the ankle.

**LIGHT TOUCH**

Light touch sensation is the least useful and most subjective part of a sensory examination and is deliberately placed at the end. Use cotton wool and follow the same approach as pin prick sensation. See suggested points for dermatomal testing on Figure 6.
ADDITIONAL TESTS

ROMBERG’S SIGN

Maintaining upright position requires intact functioning of at least 2 of: vision, vestibular function and proprioception. Romberg’s test eliminates vision so that patient has to rely on proprioception and vestibular function to maintain stability. It is a sign of impaired proprioception, i.e. sensory ataxia.

Ask the patient to stand with their feet together with hands to their sides and look straight ahead. Watch for any swaying of the trunk. Then ask the patient to close their eyes and look for any swaying or instability (give assurance to patient that you will catch if they fall). If the patient stumbles or falls when their eyes are closed, Romberg’s is positive.

NB: if the patient has cerebellar ataxia they will be unsteady with their eyes open and closed.

TANDEM WALKING

Ask patient to walk in a straight line with their feet heel-to-toe. Patients with cerebellar or sensory ataxia will be unsteady when trying to perform this gait.
Assessing higher mental function consists of the following:

- Intellect, memory, personality and mood
- Speech and cognitive function

Taking a history is often the first step in assessing higher mental function as the way the patient presents their story and answers questions often reveal deficits. It is often necessary to take a collateral history if the patient has cognitive deficits.

When taking a history from a patient with suspected impairment of higher mental function you should cover:

- Orientation – this is really useful to see if the patient knows who, where and when they are.
- Onset – a sudden onset and fluctuating cognitive problem could make you suspect delirium, a sub-acute onset could indicate depression, and a chronic progressive course may be the result of a neurodegenerative disorder (remember cognitive failure is seen in a number of neurodegenerative disorders, not just Alzheimer’s!).
- Memory - recent events, significant life events and memory regarding general and factual knowledge.
- Language - difficulties with spoken language, reading, and writing.
- Visuospatial and executive skills - the ability to carry out day to day activities such as dressing, DIY projects, planning social events etc.
- Visual perception - the ability to recognize faces, objects, signs, and colours.
- Personality, mood and appetite - cognitive dysfunction can be due to psychiatric problems such as depression. For this reason, it is also important to ask about anxiety, hallucinations, and delusions.
SPEECH

Abnormalities of speech include problems with language, articulation, and phonation and are often first noticed in the history. There are 3 d’s to look for in an assessment of speech:

DYSPHASIA

Dysphasia is an impairment of higher language function, which is typically either an inability to comprehend or produce fluent spoken or written (dysgraphia) language, or sometimes both! This is a cortical hemispheric problem (i.e. not a cranial nerve problem). There are two important broad patterns to know about and recognise (although patient’s often have incomplete or mixed features):

- Receptive, Wernicke’s or fluent dysphasia – patients cannot understand language. This is classically a temporal lobe lesion (Wernicke’s area). Patients will speak fluently but what they say will be nonsense. Test this by asking them to follow 1, 2, or 3 stage commands (e.g. stick out your tongue). Patients will be unable to follow commands because they cannot understand them. Make sure you don’t inadvertently demonstrate the instruction as this somewhat gives the game away!

- Expressive, Broca’s or non-fluent dysphasia – patients cannot produce language. This is classically due to a frontal lobe lesion (Broca’s area). Patients’ speech will be effortful but convey meaning. They are able to understand language. Test this by asking them to name objects (e.g. a pen), patients will struggle to name the object and find this frustrating. They may display circumlocution – talking around an object (e.g. “writing ink tube” for a pen).
Dysarthria is abnormal articulation resulting from damage to nerves or the muscles responsible for speech production. The patient can understand and produce language but their speech is slurred due to weakness of the muscles involved in delivering speech such as the palate, tongue and mouth.

To examine for dysarthria listen to the patient’s speech during the history, it typically sounds slurred. You can ask the patient to say the days of the week / months of the year to get a sample of their speech. Then ask the patient to say repeat consonants “b-b-b-b” (lips), “t-t-t-t” (tongue), “k-k-k-k” (tongue and palate), “g-g-g-g” (palate).

Dysarthria can be:

- Spastic – due to UMN lesions (e.g. stroke, MND) and the patients typically have stiff tongues. They may also have a brisk jaw-jerk reflex. Sometimes referred to as a pseudobulbar palsy.
- Ataxic – due to cerebellar or brainstem lesions. The patient sounds “drunk”. Listen for rate, rhythm and force of the speech.
- Flaccid – due to lower LMN or NMJ weakness (e.g. myasthenia gravis, GBS). The patient’s voice sounds slurred, nasal and breathy. Sometimes referred to as a bulbar palsy.

To try and distinguish the type of dysarthria, and look for other signs on examination (e.g. signs of spasticity for spastic dysarthria, signs of ataxia for ataxic dysarthria, LMN signs for flaccid dysarthria) that might help to establish the cause.
**DYSPHONIA**

Dysphonia is an abnormality with the voice producing organs such as vocal cords and resonating sound boxes. The content of speech and articulation are normal but voice production is low in volume or abnormal in sound. This is often present in basal ganglia disorders such as Parkinson’s disease.

To examine for dysphonia ask the patient to cough or say “eeeeeeeeeeeee”.

**HIGHER CORTICAL FUNCTIONS**

This refers to the capacity to perceive one’s surroundings and one’s self in relationship to those surroundings and to perform complex pre-programmed function (like walking!).

- **Agnosia** - is the inability to recognize objects in space, colours, faces or one’s own body parts.
- **Apraxia** - is the inability to undertake a skilled motor act despite intact power, sensation and co-ordination.

Patients presenting with cognitive disorders should have a detailed history taken and a full neurological examination. You can also use specific cognitive screening tools such to assess for cognitive problems.

- The Montreal Cognitive Assessment (MoCA) is a 30 point test used as a screening tool for cognitive impairment (see Figure 7).
- The Abbreviated Mental Test Score (AMTS) is a 10 point test which is a useful initial screen tool for acute or chronic confusion. The patient scores one point for each correct answer (see Figure 8).
- The Addenbrooke’s Cognitive Examination is an extended 100 point assessment that tests a broader range of cognitive domains in depth.
Figure 7 - the Montreal Cognitive Assessment (MOCA)
### Abbreviated Mental Test Score

<table>
<thead>
<tr>
<th>Item</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>1</td>
</tr>
<tr>
<td>Time (nearest hour)</td>
<td>1</td>
</tr>
<tr>
<td>Address (repeat now and at end of test)</td>
<td>1</td>
</tr>
<tr>
<td>Year</td>
<td>1</td>
</tr>
<tr>
<td>Name of this place</td>
<td>1</td>
</tr>
<tr>
<td>Identify 2 persons eg doctor, nurse</td>
<td>1</td>
</tr>
<tr>
<td>DOB</td>
<td>1</td>
</tr>
<tr>
<td>Date of first world war</td>
<td>1</td>
</tr>
<tr>
<td>Name of present monarch</td>
<td>1</td>
</tr>
<tr>
<td>Count backwards 20 to 1</td>
<td>1</td>
</tr>
</tbody>
</table>

**Figure 8 - Abbreviated Mental Test Score**

### Glasgow Coma Scale (GCS)

<table>
<thead>
<tr>
<th>Best eye response (E)</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spontaneous – open with blinking at baseline</td>
<td>4</td>
</tr>
<tr>
<td>Opens to verbal command, speech, or shout</td>
<td>3</td>
</tr>
<tr>
<td>Opens to pain, not applied to face</td>
<td>2</td>
</tr>
<tr>
<td>None</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Best verbal response (V)</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oriented</td>
<td>5</td>
</tr>
<tr>
<td>Confused conversation, but able to answer questions</td>
<td>4</td>
</tr>
<tr>
<td>Inappropriate responses, words discernible</td>
<td>3</td>
</tr>
<tr>
<td>Incomprehensible speech</td>
<td>2</td>
</tr>
<tr>
<td>None</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Best motor response (M)</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obeys commands for movement</td>
<td>6</td>
</tr>
<tr>
<td>Purposeful movement to painful stimulus</td>
<td>5</td>
</tr>
<tr>
<td>Withdraws from pain</td>
<td>4</td>
</tr>
<tr>
<td>Abnormal (spastic) flexion, decorticate posture</td>
<td>3</td>
</tr>
<tr>
<td>Extensor (rigid) response, decerebrate posture</td>
<td>2</td>
</tr>
<tr>
<td>None</td>
<td>1</td>
</tr>
</tbody>
</table>

**Figure 9 - Glasgow Coma Scale (GCS)**
FRONTAL RELEASE SIGNS

These are primitive reflexes and their presence is suggestive of pathology in the frontal lobes. However, a proportion of elderly patients will have positive frontal release signs without pathology. There are lots of these and their utility in daily clinical practice is debatable.

- Grasp reflex – to elicit, lightly stroke your hand across the patient’s palm. A positive response consists of involuntary grasping.
- Palmo-mental reflex – it is elicited by stroking the thenar eminence and a positive response consists of contraction of the ipsilateral chin muscles. Best conducted with patients eyes closed.
- Glabellar tap – With the patient sitting, tap gently and repetitively with index finger in the mid-line between eyebrows. Continued blinking after two or three taps is abnormal.

CONSCIOUSNESS

Patients can present with unconscious, diminished, or deranged consciousness as a result of a huge variety of neurological problems and it can be useful to classify their level of consciousness. This is often done using the Glasgow Coma Scale (GCS).

The GCS grades the level of consciousness between 3 and 15 according to the patient’s eye response, verbal response, and motor response (see Figure 9).
LOCALISING A LESION

The ability to localise a neurological lesion (i.e. work out which bit of the nervous system is causing the symptoms and signs a particular patient has) is the core key skill of a neurologist (there are of course others!). Not only does it make you look improbably clever when you request a scan, but it allows you to make a reasonable and rational differential diagnosis to guide further investigation. Furthermore, in cases where the diagnosis is clinical e.g. Parkinson’s disease, localising the lesion allows you to make the diagnosis without need for further testing - what could be more satisfying than that!

Localisation is a skill that requires practice to perfect, but with the framework below you’ll be doing a better job than most non-neurologists. See the neurology for dummies lecture more information (https://teesneuro.org/lectures/neurology-for-dummies/).

BASIC (HONESTLY!) NEUROANATOMY

Neuroanatomy can be very, very complicated or very, very simple and we definitely subscribe to the latter! Most neurologists don’t use a vast amount of neuroanatomy on a daily basis but a few basic principles are important to help you localise the lesion.

Firstly the nervous system is split into the central and peripheral nervous systems. For simplicity, each section has 5 bits and each of these bits is associated with certain symptoms/signs and diseases (see Figure 10). For weakness there is an even simpler division - upper motor neurone and lower motor neurone weakness.
By knowing which symptoms/signs are associated with which bit of the nervous system, you can make a reasonable guess as to where the lesion is and therefore what the underlying disease process is!

### CENTRAL NERVOUS SYSTEM

<table>
<thead>
<tr>
<th>Nervous System Component</th>
<th>Symptoms/Signs</th>
<th>Pathology (common examples)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cortex</td>
<td>Behaviour, cognition/memory, language, seizures</td>
<td>Stroke, tumours, epilepsy</td>
</tr>
<tr>
<td>2. Basal ganglia</td>
<td>Increased/decreased movement</td>
<td>Parkinson’s disease</td>
</tr>
<tr>
<td>3. Brainstem and cerebellum</td>
<td>Motor and sensory (inc face), ataxia</td>
<td>Stroke, MS</td>
</tr>
<tr>
<td>4. Spinal cord</td>
<td>Motor, sensory, bladder, bowel</td>
<td>MS, tumours, spondylotic disc disease</td>
</tr>
<tr>
<td>5. Cauda equina</td>
<td>Motor, sensory (lower limb), bladder, bowel</td>
<td>Tumours, spondylotic disc disease</td>
</tr>
</tbody>
</table>

### PERIPHERAL NERVOUS SYSTEM

<table>
<thead>
<tr>
<th>Nervous System Component</th>
<th>Symptoms/Signs</th>
<th>Pathology (common examples)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Anterior horn cells</td>
<td>Motor, fasciculation</td>
<td>Motor neurone disease</td>
</tr>
<tr>
<td>2. Nerve root</td>
<td>Motor, sensory, pain</td>
<td>Spondylotic disc disease</td>
</tr>
<tr>
<td>3. Peripheral nerve</td>
<td>Motor, sensory, decreased reflexes</td>
<td>Diabetes, Guillain–Barré syndrome</td>
</tr>
<tr>
<td>4. Neuromuscular junction</td>
<td>Fatigability</td>
<td>Myasthenia gravis</td>
</tr>
<tr>
<td>5. Muscle</td>
<td>Proximal weakness, wasting, normal sensation</td>
<td>Idiopathic inflammatory myopathies</td>
</tr>
</tbody>
</table>
Another important concept is the idea of upper (so-called pyramidal) and lower (so-called flaccid) motor neurone lesions (UMN and LMN). When you see a patient with weakness, classifying their symptoms/signs as either an upper or lower motor neurone pattern helps you quickly work out if the lesion is in the central or peripheral nervous system (or both!).

The upper motor neurone is principally inhibitory in function (things “increase” when it fails); whilst the lower motor neurone adds power and bulk! An easy way to remember this is using the table below (STORM is an acronym for the clinical features) and noting that everything goes down in LMN lesions.

<table>
<thead>
<tr>
<th>Clinical Feature</th>
<th>UMN</th>
<th>LMN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strength</strong></td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td><strong>Tone</strong></td>
<td>↑</td>
<td>↓</td>
</tr>
<tr>
<td><strong>Others</strong></td>
<td>Clonus</td>
<td>Fasciculation</td>
</tr>
<tr>
<td><strong>Reflexes</strong></td>
<td>↑</td>
<td>↓</td>
</tr>
<tr>
<td><strong>Muscle bulk</strong></td>
<td>-</td>
<td>↓</td>
</tr>
<tr>
<td><strong>Babinski’s</strong></td>
<td>↑</td>
<td>↓</td>
</tr>
</tbody>
</table>
Figure 10 - Basic Neuroanatomy
Once you’ve decided which bit of the nervous system is being affected, you need to decide what the underlying disease process is. Sometimes this may be relatively obvious but neurology is full of weird and wonderful diagnoses! One way of trying to systematically think through the possibilities is the use of a surgical sieve. There are numerous mnemonics but one we like is VITAMIN-DIC:

<table>
<thead>
<tr>
<th>V</th>
<th>I</th>
<th>T</th>
<th>A</th>
<th>M</th>
<th>I</th>
<th>N</th>
<th>D</th>
<th>I</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vascular</td>
<td>Inflammatory</td>
<td>Trauma</td>
<td>Autoimmune</td>
<td>Metabolic</td>
<td>Infection</td>
<td>Neoplastic</td>
<td>Degenerative</td>
<td>Iatrogenic</td>
<td>Congenital</td>
</tr>
</tbody>
</table>

Duration and tempo of onset of symptoms is vital in considering their cause. For example, vascular pathologies are usually sudden onset whereas this is less likely to be the case for neoplastic (slow or sub-acute in evolution) or congenital (often from birth) causes. Using some common sense reasoning will help you narrow down the possibilities and, in combination with your knowledge of basic neuroanatomy, should enable you to have a reasonable guess at the diagnosis.

Once you’ve seen a patient with a neurological presentation you’ll need to be able to summarise the clinical features, not only to be able to speak to the (hopefully) kindly neurologist on-call, but also to help draw out the
salient features so you can try and work out what is going on! In clinical reasoning terms this is a ‘problem representation’ – a succinct medical description of the clinical features of the case that should hopefully trigger a differential diagnoses from your mental store of illness scripts.

A simple way to describe the myriad of neurological symptoms and signs is to imagine descriptive neurological terms as fridge magnets – you can combine them in various ways to describe any condition. So, below are various categories of neuro-babble which can be combined in countless ways to describe neurological presentations and make it sound like you know what you’re talking about!

See Figure 11 for a suggested scheme for describing neurological presentations. You can then add descriptive terms relating to the lateralisation and symmetry. Finally, you can describe any specific neurological features e.g. sensory, motor, visual etc. An example might be:

“This is a 32 year old woman presenting with a **sub-acute resolving neurological disorder characterised by unilateral asymmetrical moderate weakness in the right leg with upper motor neurone signs**”.

There are also terms which describe different patterns of neuropathology, see the table on the next page for definitions and typical symptoms.

For a more in-depth look at neuro-babble see this online lecture ([https://teesneuro.org/lectures/how-to-think-and-speak-like-a-neurologist/](https://teesneuro.org/lectures/how-to-think-and-speak-like-a-neurologist/)).
<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Definition</th>
<th>Potential symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mening-</td>
<td>Related to the meninges</td>
<td>Headache, photophobia, neck stiffness</td>
</tr>
<tr>
<td>Enceph-</td>
<td>Related to the brain</td>
<td>Headache, cognitive change, fever, seizures</td>
</tr>
<tr>
<td>Myel-</td>
<td>Related to the spinal cord</td>
<td>Motor / sensory changes, bowel, bladder</td>
</tr>
<tr>
<td>Neur-</td>
<td>Related to the nerves</td>
<td>Motor / sensory changes, pain</td>
</tr>
<tr>
<td>Myo-</td>
<td>Related to the muscles</td>
<td>Weakness</td>
</tr>
<tr>
<td>Radicul-</td>
<td>Related to the nerve roots</td>
<td>Motor / sensory changes, pain</td>
</tr>
<tr>
<td>-itis</td>
<td>Inflammation</td>
<td></td>
</tr>
<tr>
<td>-opathy</td>
<td>Abnormality</td>
<td></td>
</tr>
</tbody>
</table>
Figure 11 - Neuro Fridge Magnets