Introduction

There are twelve pairs of cranial nerves which supply the structures of the head and neck.

According to convention, their functions are examined in the approximate rostrocaudal order in which they exit from the brain (i.e., from I to XII). However, the oculomotor (III), trochlear (IV) and abducens (VI) nerves are usually examined together, as they collectively control eye movements and the glossopharyngeal nerve (IX) and vagus nerve (X) are also typically examined together.

This article should be read alongside The JCE’s Summary of the Examination of the Cranial Nerves [22].

Preparation

Start by washing your hands or using alcohol gel. Introduce yourself to the patient and confirm their identity, then obtain consent to examine them. Collect the necessary equipment, as detailed in Figure 1. The optimal position for examination of the cranial nerves is to have the patient seated in a chair, and then to seat yourself approximately 1-1.5m away and directly opposite. Ideally, your eyes should be at the same height as those of the patient.
Beginning

Begin the examination with an initial brief general inspection of the patient and their immediate environment (explain what you are doing so as not to cause embarrassment). Look for obvious signs of neurological disease in the territory of the cranial nerves and briefly look at the rest of the body. Also note any medical equipment such as ventilators or mobility aids such as walking sticks.

I. The Olfactory Nerve

The olfactory nerve is responsible for transmitting information about smell from the olfactory receptors in the nasal mucosa. Its function is not usually formally examined in a routine examination of the cranial nerves. Asking the patient if they have noticed any change in their sense of smell or taste (olfactory defects often present as ‘taste’ deficits) is the conventional method of assessing olfactory function [10,16].

If formal testing is required, it is possible to test olfaction more objectively by occluding one nostril at a time and asking the patient to identify a set of aromatic oils, e.g., peppermint. If such testing apparatus is unavailable, you can make use of common substances, such as coffee or flowers, as a readily available substitute. It should be noted that ammonia and other irritant chemicals are detected by trigeminal (V) nerve afferents, and not by the olfactory nerve, so these are unsuitable for testing.

II. The Optic Nerve

The optic nerve is purely sensory, mediating vision by relaying information from the retinal ganglion cells. There are four key aspects of optic nerve function which should be routinely tested when examining a patient’s cranial nerves (see Table 1).

| Equipment needed to conduct a cranial nerve examination. From Akhtar and Briley 2008. |
| Smelling salts | Snellen Chart |
| Pen torch | Ophthalmoscope |
| Red hat pin | Cotton wool |
| Orange stick | Neupins |
| Tongue depressor | 256Hz tuning fork |
| Small glass of water |

| Table 1  The four main components of optic nerve function tested during examination of the cranial nerves. |
| 1. Visual acuity |
| 2. Visual fields (including sensory neglect) |
| 3. Pupillary reflexes to light and accommodation |
| 4. Fundoscopy |

Acuity

When assessing visual acuity from the neurological perspective, the patient should wear glasses or contact lenses if he or she usually uses them to compensate for a pre-existing refractive error. Viewing the chart through a pinhole can also be used to correct for refractive errors. The examiner should measure acuity for each eye separately, with the other eye covered, using a Snellen chart, or a near-vision chart or other alternative. The chart is placed the correct distance from the patient (6m in the case of a standard Snellen chart). The patient is then asked to read the chart and the examiner notes the smallest size of print the patient is able to read. This process is repeated for the other eye. Visual acuity is recorded in the form of a fraction, with the numerator being the distance between the patient and the chart, i.e. 6m for a standard Snellen chart, and the denominator denoting the distance at which a normal person should be able to read that particular size of script. The latter number is usually found on the Snellen chart next to the line of letters in question. If formal charts for assessing acuity are unavailable, a newspaper can be used to make a rough assessment.[18]

If the patient is unable to read the chart, further tests need to be undertaken and the examiner should record, for each eye separately, whether the patient is able to count the number of fingers the examiner holds up in front of them, see hand movements, or perceive the light from a pen torch.

For further details about assessing visual acuity, readers are referred to The JCE’s Expert Review on Examination of Visual Acuity. [18]

Fields

The examiner should be seated at the same eye-level as the patient. The examiner looks first for sensory inattention (the inability to perceive a particular stimulus when presented with another stimulus at the same moment) by holding his or her hands outstretched, approximately 60cm apart.
wiggling the index and middle fingers of both hands at once. The patient is asked to report which hand moves, usually by pointing to avoid left-right confusion. A normal patient will inevitably report that both hands move at once.

Visual fields are then assessed using the confrontation technique, so-called because it allows comparison of the patient’s visual fields with those of the examiner sat directly opposite, making the assumption that those of the latter are normal. The patient is asked to cover one eye; let us suppose that he or she covers their left eye. The examiner then covers the corresponding eye, his or her right, using his or her right hand. The patient is asked to focus on the examiner’s uncovered eye. The examiner then uses their left hand to introduce a red pin into the upper and lower temporal quadrants of the patient’s visual field, in a line proceeding towards the midpoint between patient and examiner (i.e. from outside the visual field towards the middle), remaining equidistant between patient and examiner at all times. The patient is asked, for each quadrant, to notify the examiner when the pin is first seen. The examiner then swaps the hand covering his or her own eye so that his or her right hand is now free to test the upper and lower nasal quadrants of the visual field in the same manner. Finally, the patient is asked to cover the other eye, and the examiner does likewise, so that the process can be repeated to test the visual field of that eye. Figure 2 shows an example of confrontational field testing using a wiggling index finger, which can be used to give approximate visual fields if a red pin is unobtainable, though this is less sensitive and less accurate.[4,19]

**Reflexes**

The optic nerve forms the afferent part of the pupillary reflex responses to light and accommodation, while the oculomotor nerve provides the efferent innervation.

Before assessing the pupillary response to light the examiner should observe the pupils in ambient illumination and note their shape, size and symmetry. A pupil gauge (a card with black circles of different sizes used for comparison) or a clear plastic ruler can be used to measure pupil size if there is any suspicion of abnormality. The examiner then asks the patient to look straight ahead at a distant point while a pen torch is shone into his or her eyes one at a time. The pupil normally constricts in response to light and the examiner should note both the direct response (that of the eye into which the pen torch is being shone) and the consensual response (occurring simultaneously in the other eye), in each eye.

The examiner then assesses for a relative afferent pupillary defect (RAPD, sometimes referred to as Marcus Gunn pupil), again asking the patient to look straight ahead, then shining the pen torch first into one eye, then the other, in an alternating fashion at approximately one-second intervals. If an RAPD is present in one eye, the examiner will see the pupil of the affected eye dilate when the light returns to it, rather than constrict as expected normally.

To test accommodation, the patient should first be asked to fixate on a distant point, such as a clock at
the other side of the room, and then asked to fixate on the examiner’s finger or a red pin placed approximately 30cm from the patient. The normal response to this is pupillary constriction associated with the necessary convergence of the two eyes.

Ophthalmoscopy
The ophthalmoscope, in the context of a neurological examination, is principally required to perform fundoscopy, i.e. to observe the optic nerve head (fundus). For detailed instructions on fundoscopy, readers are directed to The JCE’s Expert Review on Examination of the Fundus [20] (or a brief account in given in The JCE’s Expert Review on Examination of the Cranial Nerves [1]).

Before performing fundoscopy, the examiner should ensure that the room is darkened and, if possible, the patient’s pupils have been dilated using appropriate pharmacological methods, as these steps make the examination process much easier. The examiner should then use his or her right eye to examine the patient’s right eye, and vice versa.

III, IV and VI. The Oculomotor, Trochlear and Abducens Nerves.
These cranial nerves all play key roles in motor functions concerned with the control of eye movements and are, therefore, usually examined together. There are six extracocular muscles, of which four are controlled by the oculomotor nerve, namely the medial rectus, superior rectus, inferior rectus and inferior oblique. The superior oblique muscle, which moves the eye downwards and medially (i.e., adducts the eye) is innervated by the trochlear nerve, while the lateral rectus, which moves the eye laterally (i.e., abducts the eye), is innervated by the abducens nerve.

The oculomotor nerve is also responsible for eye opening, as it innervates the levator palpebrae superioris muscle of the eyelid, in addition to providing the parasympathetic innervation responsible for the efferent limb of the pupillary light reflex.

To examine the functioning of these cranial nerves, begin by noting the alignment of the eyes in the neutral position (i.e. at rest). Any drooping of the eyelid causing either partial or complete closure of the eye should be noted, as this represents ‘ptosis’.

Extraocular muscle function can be tested by asking the patient to keep their head still whilst following an object, such as a pen-top or finger, with their eyes, reporting any diplopia (double vision) that ensues. Some patients find it difficult to maintain a static head position while moving their eyes, in which case the examiner can gently hold the chin to serve as a reminder to the patient to keep their head stationary.

The object should be held at least 45-50 cm away from the patient and moved slowly and smoothly to form the shape of an ‘H’, as shown in Figure 3. The examiner should observe the ability of the patient to make the eye movements themselves, and also note any nystagmus (rapid involuntary oscillating movements of the eye). If any nystagmus is seen, the examiner should note the direction of gaze in which it is most prominent, and the direction of any fast component. Many normal people have a few beats of nystagmus at the extremes of lateral gaze.

Figure 3  To test eye movements, the examiner traces the shape of an ‘H’ with a stimulus such as a red pin or a pen held at least 45-50cm away from the patient’s face. From Akhtar and Briley 2008.

If the patient reports double vision, this should be further characterised by establishing whether the images appear to be either side by side or above and below one another, and whether one of the images is tilted with respect to the other.
The cover test should then be performed to identify any strabismus (squint). To perform a cover test, ask the patient to fixate on an object, then cover one eye and note any movement of the uncovered eye to take up fixation. This should then be repeated for the other eye.

Saccadic eye movements, which are quick and simultaneous in nature, should then be tested. To create saccades for the purposes of cranial nerve examination, ask the patient firstly to look at the examiner’s hand, made into a fist, then to look at the examiner’s other hand, palm open, using a phrase such as ‘Look at my fist…now look at my palm’ to ensure that the movement is sufficiently rapid. The examiner’s hands should be held approximately 60cm apart.

V. The Trigeminal Nerve
The trigeminal nerve has both sensory and motor functions, providing cutaneous sensation to the face and motor innervation to the muscles of mastication, including masseter and temporalis.

There are three sensory divisions of the trigeminal nerve; the ophthalmic, maxillary and mandibular divisions (Figure 4). It is therefore important to routinely test sensation in all three divisions. To do this, the examiner, using light touch as a screening tool, first provides a reference point by ensuring the patient can feel a light touch of the examiner’s index finger applied to the sternum or the neck. Then the patient is asked to say ‘Yes’ whenever they feel the examiner touching their face, before the examiner lightly touches one point in each of the three divisions on each side of the face with their index finger. As sensation is subjective and paraesthesia (altered, abnormal sensation) is also an important finding, the patient should be asked whether they felt the same sensation in all parts of their face, and whether that sensation was the same as that which was felt when the reference point was tested. This process can then be repeated using a disposable pin (Neurotip) to test for pain, and a vibrating tuning fork applied to a bony prominence to test for vibration sense, as these sensations are conveyed by different types of nerve fibres. In a routine examination, assessment of light touch using the finger tip usually suffices without the need for a neurotip and a tuning fork.

To assess the motor component of the trigeminal nerve, observe for any weakness of the muscles of mastication, as evidenced by wasting of the masseter or deviation of the jaw to one side when the patient is asked to open their mouth. To further assess the muscles of mastication, ask the patient to clench their teeth and assess the bulk and contraction of the masseters and temporalis by palpation. Simultaneous bilateral palpation of masseter and temporalis muscles is preferable as this allows comparison between the two sides.

Figure 4  This image shows the areas of the face innervated by the three sensory divisions of the trigeminal nerve. The upper area is innervated by the ophthalmic division, the middle part is innervated by the maxillary division, and the lower part by the mandibular division. The more posterior parts of the head and neck are supplied by cervical nerves.

A jaw jerk can be used to distinguish whether any signs of trigeminal nerve palsy are due to an upper or a lower motor neuron lesion, though it need not be routinely performed as part of a cranial nerve examination. Therefore, readers are referred to The JCE’s Expert Review on Examination of the Cranial Nerves for further information on this sign.[1]

VII. The Facial Nerve
The facial nerve also has both motor and sensory components. It supplies the motor innervation to the muscles of facial expression, and its sensory component consists of taste fibres from the anterior two-thirds of the tongue. In addition, the facial nerve is responsible for lacrimation and the reflex contraction of the stapedius muscle in response to loud noise.
To assess facial nerve function, begin by observing the patient’s face in the neutral position (at rest). Note any asymmetry of facial expression or wrinkles, and look specifically for dribbling associated with unilateral drooping of the mouth. It is also helpful to note spontaneous emotional facial expressions occurring at other points in the examination or while taking the history. The motor function of the facial nerve can be specifically tested by asking the patient to raise their eyebrows (frontalis muscle), close their eyes (orbicularis oculi), puff out their cheeks (buccinator), whistle, and either smile or bear their teeth (orbicularis oris). The combination of movements used depends on personal preference and varies between one textbook and another.[3,5,11,12] Assessment of the power of the muscles innervated by the facial nerve can be achieved by asking the patient to close their eyes tight and keep them shut, while the examiner provides resistance by trying to open them. With an intact facial nerve, the examiner would not normally expect to be able to open the patient’s eyes. In suspected facial nerve palsy, any sparing of the frontalis muscle of the forehead should be specifically noted, clinically manifesting as the ability to raise their eyebrows symmetrically in the presence of other signs of unilateral facial nerve dysfunction, as this indicates the presence of an upper motor neuron lesion.

The corneal reflex can also be tested at this point, or alternatively as part of the examination of the trigeminal nerve, though this should not be undertaken routinely as it is very uncomfortable and unpleasant for the patient and, as such, to subject all patients to this would breach the fundamental principle of clinical examination which states one should not cause harm.[17] This reflex involves trigeminal afferent fibres from the cornea and efferent facial nerve fibres. To test the corneal reflex, take a piece of cotton wool and either pull off a wisp, or roll a small piece between finger and thumb to create a tip, then ask the patient to look up and lightly touch the edge of the cornea (not the sclera) with the tip of the cotton wool. Bring in the cotton wool from one side to ensure the patient doesn’t see it before you have chance to apply the stimulus. The normal result is bilateral blinking, as a reflex response.

Taste sensation and the other functions of the facial nerve are not routinely tested, though altered taste, hyperacusis, lacrimation, and salivation can all be asked about while taking the history. For instructions on formal taste testing, readers are directed to Ross’ textbook.[12]

VIII. The Acoustic (Vestibulocochlear) Nerve.
The acoustic, or vestibulocochlear, nerve comprises two major divisions, the cochlear nerve and the vestibular nerve, both of which contain purely sensory fibres conveying information about sense of hearing and sense of balance, respectively.

The cochlear nerve is routinely tested as part of the cranial nerve examination using the whispered-voice test.[1] The whispered-voice test is conducted by whispering numbers into one of the patient’s ears, while concomitantly creating a masking sound by the rubbing together of fingers at the external auditory meatus of the other ear. This test should then be repeated to assess the hearing in the other ear. The whispered-voice test forms a screening tool, which can be combined with the tuning fork tests, Rinné’s and Weber’s tests, to identify various hearing deficits.

Rinné’s test is performed by placing a vibrating tuning fork on the patient’s mastoid process, posterior to the ear being tested. The patient is then asked to report when they can no longer hear the tuning fork, at which point, the examiner transfers the still-vibrating tuning fork to just outside the external auditory meatus of that ear. A patient with normal hearing (and most patients with sensorineural hearing loss) will still be able to hear the tuning fork at the external auditory meatus at this point, even though they could no longer hear it when it was resting on the mastoid process; this indicates a positive result from Rinné’s test, as air conduction is more efficient than bone conduction. In conductive hearing loss, bone conduction is greater, resulting in a negative Rinné’s test.

Weber’s test can be used to lateralise any abnormality noted in the whispered-voice test or Rinné’s test. Weber’s test consists of placing a vibrating tuning fork in the midline of the patient’s forehead, and then asking the patient to report in which ear the sound is heard loudest. Normally, the sound is experienced by the patient as being equally loud in both ears. For further information on the tuning fork tests, and particularly their interpretation, readers are referred The JCE’s Expert Review on Examination of the Ear using Tuning Fork Tests.[21]
Vestibular nerve function is not routinely tested, but if indicated, Hallpike’s manoeuvre or specialist caloric tests can be undertaken.[1,6]

IX and X. The Glossopharyngeal and Vagus Nerves.
The glossopharyngeal nerve provides sensory innervation to the nasopharynx, pharynx, and the middle and inner ear, as well as conveying taste sensation from the posterior third of the tongue. Meanwhile, the vagus nerve, as well as being responsible for a myriad of parasympathetic functions, provides sensory fibres from the larynx and pharynx, as well as providing motor innervation to the muscles of these structures and the palate.

To test the function of these two nerves, the examiner begins by asking the patient to open their mouth wide, and say ‘Ah’, while observing with the aid of a pen-torch. In a patient with normal vagus nerve function, the examiner observes symmetrical elevation of the soft palate, with the uvula remaining central. In some patients it is impossible to see the palate and uvula without the aid of a tongue depressor, the flat surface of which is used to gently press down on the tongue. Deviation of the uvula towards one side and failure of palatal elevation should be noted, as they imply that a vagal nerve palsy is present.

The gag reflex is not routinely tested, even though it relies on both the glossopharyngeal nerve for the afferent limb and the vagus nerve for the efferent limb, as it is not always reliable and is extremely unpleasant for the patient. To elicit the gag reflex when necessary, the examiner should touch the posterior pharynx (not the palate) with a wooden spatula, causing the patient to gag. Talley and O’Conner suggest that touching the posterior pharynx, observing for palatal contraction and then asking the patient whether they were able to feel the stimulus, is a better alternative.[4]

The swallowing reflex is also mediated by the glossopharyngeal and vagus nerves, and should be assessed by asking the patient to take a small sip of water, while the examiner notes any coughing, spluttering or regurgitation that occurs during swallowing. If any of these are observed, the patient should be made nil by mouth pending a full swallowing assessment.

Finally, the examiner should ask the patient to cough and then to speak in order to assess the functioning of the recurrent laryngeal portion of the vagus nerve. Speech can be further assessed by asking to make sounds such as ‘Ka’, ‘Ma’ and ‘La’, which respectively assess palatal (vagal), facial nerve, and hypoglossal nerve functioning.

XI. The Accessory Nerve.
Only the spinal portion of this cranial nerve is tested, which provides motor innervation to the sternocleidomastoid and trapezius muscles of the neck, as the cranial portion joins the vagus nerve. Assessment of spinal accessory nerve function should begin with inspection of the muscle bulk of trapezius, noting any asymmetry, as well as looking for any sag of the scapula or shoulder.

To test trapezius function specifically, ask the patient to shrug their shoulders upwards against resistance in the form of the examiner’s hands pressing down on the patient’s shoulders. Sternocleidomastoid function can be more specifically examined by asking the patient to turn their head to one side, while the examiner’s hand on the same side of the patient’s jaw provides manual resistance. It is important to remember that the right sternocleidomastoid contracts to turn the head towards the patient’s left, and vice versa.

XII. The Hypoglossal Nerve.
The hypoglossal nerve provides motor innervation to the intrinsic and extrinsic muscles of the tongue. The examiner begins by asking the patient to open their mouth and inspecting the tongue for wasting and fasciculations (rippling, involuntary movements of a muscle at rest) while it is at rest in the floor of the mouth: a pen-torch is helpful at this point. Then the patient is asked to stick out their tongue directly forwards, and the examiner should note any deviation of the tongue from the midline. The patient is finally asked to move their tongue from side to side. If any abnormalities are found, power may be tested by asking the patient to push their tongue against the inside of their cheek, first on one side, then the other, while the examiner pushes against the outside of cheek to oppose the tongue muscles.

To Complete the Examination
The examiner should end the examination by thanking the patient and returning them to a comfortable posture. The examiner then washes their hands.

Conflicts of interest
None.
Acknowledgements
None.

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