Within general medical practice, neurological examinations are mostly limited to the investigation of the most important muscle reflexes, pupillary reactions and the nerve exit points. The patient’s facial expression, body posture, body-tension and also their motoric skills are observed concomitantly. When it comes to diagnosing patients with illnesses such as diabetes, or patients with anamnestic indications of neurological disorders, every physician should master the neurological diagnosis of the cranial nerves, before he refers the patient to a neurologist. In this article you will find a detailed overview of the options relating to neurological examination of the twelve pairs of cranial nerves. The most important diseases of all cranial nerves can be found in this chapter.

Examination of the 12 pairs of cranial nerves

The examination equipment required for a simple neurological diagnostic – without seeking any clarification of causes by means of EEG, CT or MRT scans – is clear, manageable and inexpensive.

It consists of a light source, a neurological reflex hammer, a tuning fork and resources such as brushes, cotton swabs, and blunt pins with which a patient’s sensitivity can be examined. Test tubes filled with cold and warm water can be used to determine a patient’s sensation of cold and warm temperatures.
Creating a case history, or anamnesis, is an essential part of any suspected diagnosis, especially in neurology. By means of specifically targeted questions, the physician aims to guide the patient in a direction that will establish a solid medical foundation, upon which a further case history and subsequent examination can be based.

Examination of the n. Olfactorius

The olfactory nerve (n. olfactorius) is responsible for the sense of smell and is a complete sensory nerve.

For the olfactory test each nostril should be examined individually and the patient’s eyes should be closed. It is necessary because olfactory memory can lead to recognition of odors. Using scented sticks containing characteristic odours such as coffee, cinnamon, or aniseed, the patient is asked to smell and identify them one at a time, using each nostril.

According to the patient’s age and the number of odours detected, a distinction is drawn between anosmia, hyposmia and normosmia. Loss of smell (anosmia) may have numerous causes such as:

- severe cranial cerebral trauma caused by an accident
- damage of the sensory perception
- infections
- tumours – particularly olfactory meningioma
- inflammation of the nasopharyngeal space, with infection of the olfactory mucosa

Note: In order to distinguish sensitive and sensory disorders, especially when simulating an olfactory dysfunction, testing with acetic acid or ammonia as a pure trigeminal irritant can prove useful especially for anosmia of organic cause, as, even with a loss of olfactory ability, these materials are perceived as a nasal irritation. A psychogenic disorder or simulation is present if the patient shows no reaction.
When it comes to **gustatory sensation** (lat. gustare = taste), especially where there is suspicion of simulation, the patient is explicitly requested to taste pure olfactory irritants (e.g. cinnamon) or mixed irritants containing smell and taste components (e.g. cocoa with nuts). If the patient suspects that he should recognise the taste, he will however name the odour component. Then the simulation is obvious.

**Examination of the n. Opticus**

The optic nerve (**n.opticus**) is the second cranial nerve, which transmits visual information to the occipital visual cortex, and which is a complete sensory nerve. Visual acuity and visual fields are important aspects of the optic nerve.

There are numerous possibilities for neurological examination of the optic nerve:

- indicative examination of visual acuity
- indicative examination of visual fields by confrontation (perimetry)
- simultaneous examination of the visual fields
- inspection of the pupils and examination of the pupil size

**Indicative examination of visual acuity**

The visual acuity testing forms an integral part of any ophthalmological examination in determining the best possible visual acuity.

Visual acuity test provides general idea of optical integrity of the eyes, healthy condition of the retina and healthy interpretation of images by brain.

Basically, the test is carried out monocularly from about a 5 m distance whereby the unexamined eye is fully but loosely covered. On the vision reading charts are various eye test characters (optotypes) such as numbers, letters, children’s images, landolt rings and e-hooks (for patients where verbal communication is not possible). This process is repeated for both the eyes, with and without distance glasses. Another vision reading chart to determine visual acuity is the “Snellen Chart”: 
The visual acuity for proximity is tested with reading samples in a reading distance of about 30 cm.
Indicative examination of visual fields by confrontation (perimetry)

The patient covers one eye while fixing their gaze on the opposite eye of the examiner with the other eye. The examiner moves an extended forefinger in from different directions, moving it from the periphery and into the patient’s visual field. Once the patient has detected the examiner’s finger, he signals this.

**The examiner should note:** the examiner’s own field of vision should be used for comparison. Peripheral Visual fields of each eye is tested individually.

Simultaneous examination of the visual fields

The patient looks at the examiner with both eyes, without covering an eye. The examiner holds his hands in the periphery of the right and left visual field and moves his fingers randomly on one side, or simultaneously on both sides. The patient then indicates on which side, or which sides, the fingers were moved.

Inspection of the pupils and examination of the pupil size

Before examining pupillary constriction, the examiner should inspect and evaluate the function of the *musculus sphincter pupillae*. The examiner also tests the sympathetic fibres, which innervate the *musculus dilator pupillae* and the afferent (lat. affere = to bring, to lead) pathways relating to pupillary function, the retina, the optic nerve and the optic tract (*tractus opticus*).

When examining pupil size, pupillary constriction is tested under direct lighting using a small light source. This test helps to determine the shape, symmetry and reactivity of the pupils beside its size. Using a semi-darkened room, the patient must look into the distance, thereby avoiding initiation of a short-range adaptation miosis (Greek miosis = reduction).

The examiner then separates the eyes from each other by placing a flat hand on the bridge of the nose, and he/she then illuminates one eye with bright light at a time from a position below the pupil. The reaction of the illuminated eye is initially observed, followed by the reaction of the non-illuminated eye.

A normal result with respect to the pupil relates to symmetrical size and shape and prompt constriction of the pupil in response to light without any side-related difference.
Examination of the n.Oculomotorius, n.Trochlearis and n. Abducens

The oculomotor (n.Oculomotorius), trochlear (n.Trochlearis) and abducens (n.Abducens) nerves are cranial nerves with predominantly motor function which coordinate movement of the eyeball by the control of external ocular muscles. The position of the eyeball allows the examiner to determine which nerve may be damaged.

Each eye has six external ocular muscles that control the full range of movement of the eyeball.

The nervus oculomotorius

The oculomotor nerve is the nerve which controls the movement of the eye and innervates the musculus rectus superior (superior rectus muscle), the musculus rectus medialis (medial rectus muscle), the musculus rectus inferior (inferior rectus muscle), and the musculus obliquus inferior (inferior oblique muscle).

To test the eye movement, the patient focuses and follows the examiner’s fingers while keeping the head stationary in dark room, then bright and then dim light to study sympathetic or parasympathetic tone.

**Normal finding:** The patient is easily able to follow the examiner’s fingers in six directions, with respect to all three nerves without the eyeball lagging behind. Moreover, the patient must be able to lift their eyelids and have the ability to change the ocular lens such that things that are close in front of the eye (approx. 20-30 cm) can be seen in sharp focus (visual accommodation).

Nervus trochlearis
The trochlear nerve is responsible for rotation of the eye; it supplies the superior oblique muscle and can be checked by convergence or tested using a “squint test.” The patient is asked to fix their gaze on the index finger of the examiner while he/she moves their finger from a position (approx. 30-50 cm) below the patient’s face, towards the tip of the patient’s nose.

**Normal finding:** There should not be any side-related differences with respect to the pupils.

**Nervus abducens**

The abducens nerve (**n. abducens**) supplies the lateral rectus muscle. The patient is asked to follow an object or a lamp.

**Normal finding:** The patient is able to follow the object or the lamp medially or laterally, with both eyes pointing in the same direction.

**Examination of the n. trigeminus**

The trigeminal nerve (**n. trigeminus**) is the largest cranial nerve, and has both sensory and motor functions. It provides sensory innervation to the skin of the face, to the facial mucosa, including the teeth, and also to the dura mater (part of the hard cerebral membrane). It also provides motor control to the muscles of mastication (chewing).

Examination of the trigeminal nerve can be performed by the following tests:

- testing sensory functions
- examination of the nerve exit points
- the corneal reflex
- the masseter reflex

**Testing sensory functions**

The skin on the patient’s face is touched gently, using a wisp of cotton wool, to test the **sense of touch,** and the **sense of pain** is tested with the help of a blunt object (e.g. a wooden stick). Normal findings are symmetrical touch, and sensation of pain.

**Examination of the nerve exit points**

The rough tenderness of the three peripheral branches of the nerves can be assessed at their exit points: the supraorbital foramen, the infraorbital foramen and the mental foramen. The examiner presses the foramen using the thumb or middle finger. A normal finding would be represented by only slight tenderness.

**The corneal reflex**

The cornea is touched on one side, using a cotton swab. A normal finding would be
represented by normal closing of the eyelid (the blink reflex), with respect to each eye. It determines the sensation nerve V and VII.

The masseter reflex

The examiner places the index finger across a slightly open lower jaw, and taps it with a tendon hammer. This should cause bilateral contraction of the jaw by contracting temporalis, which can be felt as an upward phasic movement of the lower jaw by pterygoids.

Examination of the n. facialis

The facial nerve (n. facialis) is a mixed cranial nerve. It is responsible for the movement of most of the muscles of the face, excepting the masticatory muscles, and also for the movement of the platysma and the stapedius muscle in the middle ear.

Examination of the seventh cranial nerve is derived from the patient’s facial expression; attention is paid to whether the nasolabial grooves have equal depth on both sides, whether the eyelids are symmetrical in width, and whether the furrows of the forehead are equally pronounced. In addition, the patient is asked to activate the facial muscles innervated by the facial nerve, for example by means of:

- a frown,
- puffing out the cheeks,
- closing the eyes, against resistance,
- firmly shutting of the eyes,
- revealing the teeth or
- whistling

Note: Take particular note of any difference that is visible in terms of unilateral paresis (paralysis), any arbitrary innervation, and any involuntary movements relating to emotional expression (e.g. laughing). This happens due to lesion in lower motor neuron or upper motor neuron. These are not normal findings.
Examination of the n. vestibulocochlearis

The vestibulocochlear nerve (n. vestibulocochlearis) is a cranial nerve with a mainly sensory function, and is split into two parts: the vestibular nerve and the cochlear nerve. The vestibular nerve is responsible for innervation of the organ of equilibrium (balance) and the cochlear nerve is responsible for hearing (audition).

Indicative hearing examination

With decreasing distance, and starting at six meters, words or numbers of four syllables are directed at the patient while alternatively using natural speech and then whispered speech. The ear being tested is inclined towards the examiner during the examination.

Normal finding: Natural language and whispering from six metres away is audible. 
Note: whispering or high frequency tuning fork can be used in this test. Se of tuning fork can determine the nerve deafness and conductive deafness.

Examination of balance

When examining the vestibular nerve, Romberg’s Test and Unterberger’s Stepping Test are two important options for examination. However, when it comes to testing the auditory nerve, a variety tuning fork tests are used.

With Romberg’s test, the patient stands with their feet together, their arms stretched forwards and their eyes closed. One vestibular disease is represented by the reproducible tendency to fall to one side. However, a tendency for the patient to fall towards the front, towards the back or to both sides would testify against a neurological cause of loss of motor coordination.

Unterberger’s stepping test is similar to Romberg’s test, only differing in that the patient is additionally asked to walk on the spot with eyes closed. A vestibular disorder is present if the patient reproducibly turns more than 60 degrees to one side. This test determines peripheral labyrinthine dysfunction.

At the same time as coordination of movement is being examined, the examiner tests whether nystagmus (eye movement) is present.

Examination of the n. glossopharyngeus and the n. vagus

The glossopharyngeal nerve (n. glossopharyngeus) is a mixed cranial nerve containing both sensory and motor components. It provides sensitivity-related and sensory innervation to the palate and the throat, and also to the back of the tongue – particularly with respect to the sensation of bitter tastes.

Examination

When examining the ninth cranial nerve, attention must be paid to any hoarseness on the part of the patient, and the soft palate and the uvula must be inspected. The examiner checks that the soft palate has uniform height and the uvula appears in the midline.

When clear phonation is used – ask the patient to say “Aaah” – and the finding is normal,
the soft palate will elevate symmetrically, and the uvula will remain in the midline.

**The pharyngeal Reflex (the gag reflex)**

The swallowing reflex is initiated through the respective motor fibres. Using the tip of a cotton swab or a sharp object usually a tongue depressor, the sense of touch is examined, and reflexive elevation of the soft palate, or the gag reflex, is triggered.

The vagus nerve (**n. vagus**) provides autonomous parasympathetic innervation of the internal organs, and innervates the muscles of the larynx and the upper digestive tract in its role as an executive contributor to the swallow or gag reflex.

If the reflex fails, then both the ninth and the tenth cranial nerve may be damaged, as both cerebral nerves are involved in the gag reflex. The examiner should look for any indications of swallowing disorders or cardiac arrhythmias during examination of the pharyngeal reflex.

**Examination of the n. accessorius**

The accessory nerve (**n. accessories**) is a cranial nerve with predominantly motor function, and it innervates the sternocleidomastoid and the trapezius muscle.

**Testing function of the two muscles**

This examination tests the strength of the two muscles, on separate sides. The sternocleidomastoid muscle is checked by asking the patient to rotate their head to the side, against resistance, or by asking them to raise or shrug their shoulders against resistance, provided by pressing on the trapezius, using the hands.

**Normal finding**: Symmetrical, full strength in innervated muscle. Lower motor nerves cause weakness in both the muscles and upper motor nerve lesion cause ipsilateral weakness in sternomastoid and contralateral weakness in trapezius muscle.

**Examination of the n. hypoglossus**

The hypoglossal nerve (**n. hypoglossus**) is a cranial nerve with motor function, which innervates the tongue.

While examining the tongue, the examiner should pay attention to the following:

- the symmetry of the protruded tongue
- any deviation from the paralyzed side
- any atrophy
The patient is also asked to move their protruded tongue back and forth quickly and to lick their lips.

Alternatively, the examiner can ask the patient to press their tongue against the inside of their cheek with all their strength, with the examiner providing counter-pressure from the outside, so that the degree of force can be then assessed on both sides.

In this test, if the protruded tongue gets deviated to one side, it indicates towards hypoglossal lesions.

**Popular exam questions on paired nerves**

The answers are found below the references.

1. **Which three cranial nerves are responsible for the movement of the eyeball?**
   
   A. N. oculomotorius, n. fascialis, n. abducens
   B. N. oculomotorius, n. trochlearis, n. abducens
   C. N. oculomotorius, n. trochlearis, n. accessorius
   D. N. olfactorius, n. trochlearis, n. abducens
   E. N. oculomotorius, n.trigeminus, n. abducens

2. **Which statement is correct in relation to the optic nerve?**

   A. The optic nerve is a sensory nerve that transmits olfactory information to the occipital cortex.
   B. A test involving acetic acid or ammonia as pure trigeminal irritants can be useful when it comes to simulating optic nerve-related olfactory dysfunction.
   C. A normal finding with respect to the pupil would be: symmetrical size and shape, plus delayed narrowing of the pupil in response to light, with a side-related difference.
   D. When the patient’s visual fields are being simultaneously examined, the patient looks at the examiner and covers one eye.
   E. When it comes to indicative examination of visual fields by confrontation (perimetry), the examiner should use his own field of vision for comparison.

3. **Which of the following has been assigned incorrectly?**
A. N. vestibulocochlearis = Examination of hearing and the vestibular organ
B. N. hypoglossus = Examination of the motor functions of the tongue
C. N. oculomotorius = Innervation of the facial muscles
D. N. accessorius = Innervation of the sternocleidomastoid and trapezius muscles
E. N. trigeminus = Innervation of the skin and the mucous membrane of the face incl. the teeth and muscles of mastication

References

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Correct answers: 1B, 2E, 3C

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