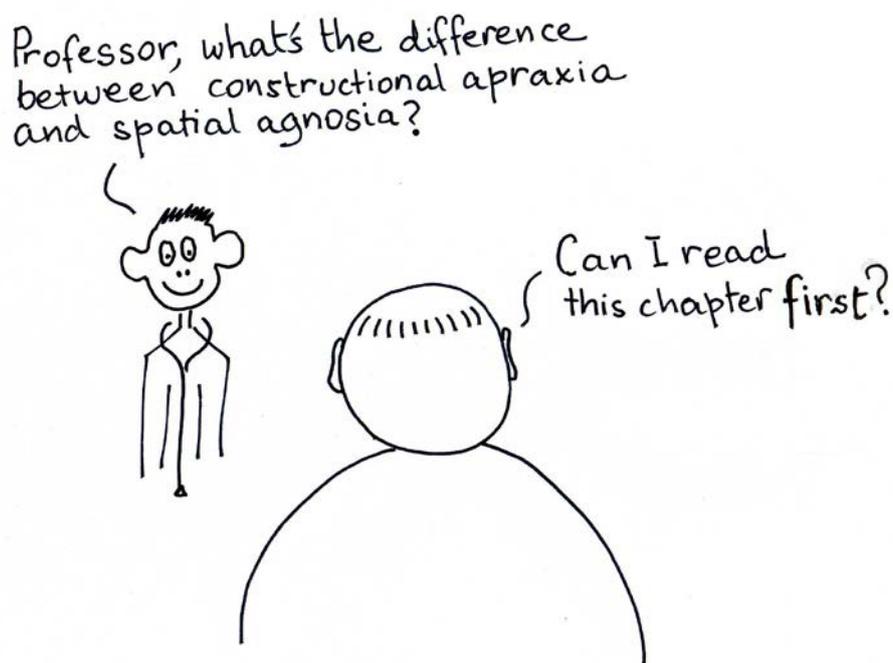


CHAPTER 26

HIGHER CORTICAL FUNCTIONS

Introduction



The HCFs are: 1) memory, 2) orientation, 3) concentration, 4) language, 5) performance of learned skilled movements (examined by tests for apraxia), and 6) recognition of stimuli (examined by tests for agnosia).

Only the first four (memory, orientation, concentration, language) are components of the regular psychiatric assessment. Language is a component in so far as we focus particular attention on the form of thought. It is also a focus of attention in the Mini Mental State Examination (MMSE; Folstein et al, 1975, see Chapter 20), the most widely used screening test for cognition/HCF. Some additional aspects of language are listed toward the end of this chapter for reference purposes.

Recognition of stimuli (gnosis) and performance of skilled movements (praxis) are not components of the regular psychiatric assessment; they are traditionally part of the neurological exam, and may be used in the examination of a psychiatric patient when a neurological or other medical condition is being excluded. That is, the HCFs are examined in detail when the clinical findings suggest an “organic” disorder.

The term organic disorder is problematic. It was coined at a time when investigative technologies were crude (compared to those of the early 21st century). At the time, it was assumed that if no organic basis could be demonstrated (with the technology of the day), none existed. Those conditions for which no physical explanation could be

found were termed “functional”, which implied that organs were healthy/intact, but not functioning properly.

With technological advances, the boundaries of “organic” should be moved. Schizophrenia, for example, was considered to be a functional disorder, but imaging and genetic studies have clearly demonstrated a physical basis. The same applies to many other psychiatric disorders.

The term organic, therefore, says more about the technology of the day than the existence of pathology. It can be argued that psychiatry is generally concerned with pathology at a molecular level (e.g., neurotransmitters) and other branches of medicine are concerned with supra-molecular pathology (e.g., abnormal cells, as in tumour), but this is an over-simplification. For example, the ‘neurological’ disorder, Parkinson’s disease, is a result of reduced availability of the neurotransmitter dopamine, in the nigrostriatal tract, while the ‘psychiatric’ disorder, schizophrenia appears, at least in part, to involve variations in the availability of dopamine in the mesolimbic tract.

Putting confusing terminology aside: HCF testing is a valuable means of detecting conditions which may present as psychiatric disorders but which require the services of other branches of medicine. For example, patients may present with a picture suggestive of schizophrenia or depression which is secondary to space occupying lesions, toxic, endocrine or metabolic abnormalities, and in such circumstances, HCF testing frequently reveals abnormalities.

In general, if memory, orientation, concentration and language are intact, the performance of learned skilled movements and recognition of stimuli will also be intact. Thus, the former may be regarded as a screening test, such that if they are intact, the latter need not be tested.

MMSE deserves special mention. This is a standardised, widely employed screening test of HCF. It examines orientation in some detail and then briefly touches on registration and recall, attention/concentration, language and constructional abilities. Brevity is its strength (allowing wide breadth examination) and its weakness (not providing a comprehensive assessment). This is a screening test which may be used to indicate whether more extensive (time consuming) examination is necessary.

Memory

Memory is the ability to revive past thoughts and sensory experiences. It includes three basic mental processes: registration (the ability to perceive, recognise, and establish information in the central nervous system), retention (the ability to retain registered information) and recall (the ability to retrieve stored information at will).

Short-term memory (which for this discussion includes what has been called immediate memory by others) has been defined as the recall of material within a period of up to 30 seconds after presentation. Intuitively, there is something different between short term and long term memory. At the library, there is something different

between the daily newspapers which are displayed on a table in the foyer, and those of last year which are stored out of sight in the basement.

Long term memory can be split into **recent memory** (events occurring during the past few hours to the past few months) and **remote memory** (events occurring in past years).

Memory can be influenced by many factors. In addition to physical lesions, intoxication, emotional arousal, psychomotor retardation, thought disorder and motivation must be considered.

Tests of memory

During the psychiatric interview good information about memory is available. Memory testing provides quantification (but this may not be necessary).

Three levels of memory are specifically tested.

There should be concern for the patient's comfort and dignity, but there should not be indecision or inappropriate apology. After some general conversation, the examiner may say something like, "Thank you Mr X, I understand what you have been saying. I now need to test your memory." Then proceed directly to, "I am going to give you three things which I want you to remember....." or similar words, according to the test the examiner wishes to apply.

When a patient who has been treated respectfully but makes excuses or refuses cognitive testing, there is probably cognitive impairment. [The impression is that at some level, the patient is aware of reduced ability, and refuses testing to avoid the experience of failure.]

History and conversation

The patient should be able to give a clear account of his/her life from the remote to the recent past.

The presenting complaint is important. Where memory function is the primary problem the patient may not be able to remember why he/she is present. The patient should be able to give details of who made the arrangements for the interview, how she/he was conveyed from home or work, at what time did he/she depart home or work, at what time did he/she arrive and how long the journey took. Thus, the history gives the opportunity for a real life test of the recent memory.

From the history, assessment of the remote memory may be difficult as the examiner does not have many (if any) of the facts of the patient's life. Internal consistency of the personal history, however, may give important information. That is, do the dates, ages and events match up, when patient describes her/his past life. The names and current ages of children and siblings are often useful questions. An alarm goes off if a 70 year old appears to have little idea of the age of her/his children.

Short-term (immediate) memory test

The most common test is to ask the patient to repeat sequences of digits. Three digits are given first and the patient is asked to repeat them. If this is performed

successfully, four digits are given and so on, until the patient makes mistakes. A healthy person of average intelligence is usually able to repeat seven digits correctly. (Strictly speaking, this is not memory, as this information is kept in mind and does not have to be retrieved.)

Recent memory test

A common testing method is to ask the patient to learn three or four unrelated words. The patient is advised that she/he will be given some words to remember, and that later in the interview she/he will be asked to recall them. The words are said (e.g., a car, a tree, a sock, a bucket) at the rate of about one second per second. The patient is asked to repeat each word after it has been said, to ensure that each has been registered properly. The interview then proceeds so that the patient is distracted. Some minutes later the patient is asked to recall the words. If any words cannot be recalled, the test can be re-administered using a different set of words. The score is kept, "the patient remembered two out of four items".

Remote memory test

The examiner usually does not have extensive knowledge of the patient's past life against which to check any answers. Individual differences in intelligence and education make it difficult to know what questions on past world events are reasonable to ask.

The date of birth is often available to the examiner. However, this is very highly learned material, it is among the last pieces of information to be lost and its retention does not exclude moderately severe memory problems.

The names and dates of birth of the patient's children may also be available, as might the patient's partner/spouse and mother's maiden names.

It is reasonable to ask the capital cities of Australia, England and USA, and perhaps the dates of the first and second world wars - taking care to consider intelligence and education levels.

It is reasonable to ask the name of the current Prime Minister or President. Often patients with memory problems give the name of a Prime Minister or President from the past – in this case, in clinical experience, the more remote in time the named person held office, the greater the memory problems.

Loss of memory/Amnesia - clinical pictures

Loss of memory of organic origin

Dementia

Dementia (see Chapter 20) is a global deterioration in intellectual functioning, a central feature of which is memory problems. It is usually of gradual onset, although it may follow sudden events such as head injury. In general, the more recently stored the more rapidly lost; memories stored long ago are lost last. However, this is a relative matter and the remote memory of patients with dementia is usually significantly impaired compared to that of non-demented persons or comparable age.

There is also impairment in abstract thinking, judgement, other cortical functions and personality change.

Amnestic disorder (Korsakoff's psychosis/syndrome)

Korsakoff's amnestic disorder is characterised by the inability to learn new information, while other HCFs are retained. Lack of motivation and flat affect are common. Patients frequently lack insight and deny difficulties. Confabulation (untrue experiences which the patient believes) may occur in the early stages but this curious sign usually declines over time. Confabulation is different in nature to delusion, the confabulation may change at every meeting, it is usually friendly and often claims a previous friendly acquaintance with the interviewer ("Yes, of course I remember you, we've played golf together for years"). The impression is that the ideas flood in to fill a memory vacuum.

The patient with Korsakoff's syndrome is severely disabled, and frequently incapable of independent living.

The most common cause of amnestic disorder is thiamine deficiency secondary to alcohol use - in which case onset may be gradual, or more apparently rapid if it arises in a setting of acute Wernicke's encephalopathy. Head injury, cerebral neoplasm, carbon monoxide poisoning and herpes simplex encephalitis are other causes.

Loss of memory of psychological origin

Psychogenic amnesia

In psychogenic amnesia the predominant disturbance is an episode of sudden inability to recall important personal information, which is not due to an organic mental disorder. (The usual presentation is distinct from Korsakoff's amnesia where the difficulty is in learning new information.) Onset is sudden and there is usually some precipitating emotional trauma. The psychogenic amnesias are reversible.

The clinical presentation is compounded by the combination of unconscious forgetting and active avoidance of painful material. The memories lost and the understanding of the patient of their condition usually varies with time and circumstances. Unlike organic amnesia, the ability to learn new material is usually retained. Malingering must be excluded.

Orientation

In the psychiatric examination, orientation means awareness of one's relationships and surroundings in time, place and person. Insofar as disorientated people are frequently given orienting information by other individuals, but remain disorientated, the condition has a memory component.

Orientation in time

Orientation in time is often the first dimension to be lost and the last to return. As with memory, it is the recent, more precise information, which is lost first. The patient is asked to give the year, month, day of the week and date.

Even more fine-grained information is the time of day. Clinical experience is that disorientated patients often give answers which are inconsistent with the evidence. They may contend it is evening even when the sun is blazing through the window, and may not change their answer when these inconsistencies are pointed out. When trying to help the patient with the time of day the examiner may ask which meals of the day the patient has eaten. This is a test of memory, but may be asked here - the patient may claim that it is late afternoon - but that breakfast has not yet been served.

Orientation in place

The MMSE contains some good orientation in place questions. At the “big picture” end, the questions are about identifying the city and the county. If a patient knows the city, knowing the county is a matter of memory, rather than orientation.

Going on from other questions the examiner can say something like, “Well, thank you for helping me with those questions, Mrs Z. Now, I would like to ask you, can you please tell me, the name of the city (or building) we are in?”

If the patient is not able to give the name of the building, or gives an incorrect answer it is important to determine whether she/he can benefit from the cues around them. If they answer that they are in their own home, it is reasonable to say something like, “I’m not sure this is your house. Is this your furniture? There seem to be other people walking around. Are you sure this is your home?”

If the patient says she/he does not know where she/he is, the same sort of questions as in the above paragraph should be asked. It is reasonable to say something like, “Mr Y, we are in a public building. It could be a police station, a railway station, a fire station or a hospital. Have a look around. Look at the beds and the people walking around. In which one of those places do you think we are?”

The patient gives the name of the facility/hospital correctly, she/he should then be asked to name the ward. If this cannot be given, the patient should be asked what type of cases are treated on this ward. If there are difficulties with this question, ask the patient to look around, “You are right about this being a ward of the Royal Hospital. But, what type of ward is this? Have a look around, the patients don’t seem to be in bed here. Do you think this is a surgical ward where people are recovering from operations?”

Orientation in person

Orientation in person requires various abilities, including the capacity to recognise faces (prosopagnosia being agnosia for faces) and memory. Thus, failure in orientation in person is a general rather than specific indicator of pathology.

Under this heading the examiner assesses the patient’s ability to identify her/himself, but more importantly, others. A common mistake is to report only on the patient’s ability to give her/his own name.

The patient may then be asked to identify the examiner, who will have introduced him/herself earlier (and may have been known from previous meetings) and to indicate the type of work the examiner performs. The patient may say that she/he has a poor head for names. In this case it is better to move to the examiners function, by

saying something like, “Yes, I’m not much good on names myself. But we’ve been talking about things for a few minutes, Mr X.....Can you tell me what sort of work I do?”

When testing orientation in person it is often worth asking the patient to identify by name and occupation, any available nursing staff who have had dealing with her/him and to identify any available relatives.

Attention (Concentration)

The term ‘concentration’ has traditionally been used in the standard psychiatric assessment. This is being replaced by the term “attention”.

Attention is a multifaceted mental function, but in general, it denotes the capacity of an individual to focus the mind on (pay attention to) some aspect of the environment or the contents of the mind itself (Cutting, 1992).

Tests of attention

History and conversation

Patients often lack insight into their difficulties with attention (as mentioned, they are usually more familiar with the word concentration). The experience of poor attention is often unpleasant. Where the symptom is suspected, it is reasonable to ask, “Mr X how is your concentration at the moment. Are you able to watch a show on TV and concentrate all the way through?” (Alternatively, “Are you able to concentrate on reading the newspaper?”)

Where there are marked difficulties with attention, this will be obvious during conversation. The patient will be unable to give a clear account of the reasons for presentation, will wander off the topic and will be distracted by the external environment and her/his own thoughts. It may, in the early stages, be difficult to distinguish the person with schizophrenia and severe formal thought disorder from the person with delirium.

Subtraction

A common test is to ask the patient to take seven from one hundred and keep subtracting seven from the answer. There is no accepted standard for the number of mistakes and the amount of time allowed. A written record of the performance is useful, particularly when a problem is suspected, as this allows the ability to be re-tested on a later occasion and comparisons to be made. Even without an agreed standard, it is often possible to identify impaired ability. The patient may not even get the first subtraction correct. Quite often an impaired patient will perform a number of subtractions (often with mistakes) and then start making additions.

If the patient has had little numerical education, it may be appropriate to give an easier task. Subtracting three from twenty down to zero is easier. Subtracting two from twenty is easier again. It is important only that the task taxes the patient so that her/his ability to sustain attention can be evaluated.

Reversing components

Reversing a series of numbers is a commonly used test of attention. The examiner reads the numbers to the patient slowly and clearly. Again, it is not clear what constitutes normal and pathological performances.

Reversing the letters of a “word” is stated to be an alternative to the 100 minus 7 test in the MMSE. However, in this test the patient should be comfortable with the forward arrangement of the letters. The examiner should first say the word, and have the patient spell the word forwards before attempting to reverse the letters.

Reversing the months of the year is another recommended test. A problem with this is test is that some students learn this task by rote at school, while others do not. For those without rote learning, reversing the months of the year can be quite difficult. An easier task is to reverse the days of the week. This may too easy - it can be made more taxing by asking the patient to reverse the days of the week for a fortnight. If the impaired patient makes a start on this test, they often fail to continue into a second week.

Other HCFs

Medical students and trainee psychiatrists should be competent in the above. The material from this point on, however, is more esoteric and forms part of a more comprehensive assessment, and is included for reference purposes only. Various experts may be involved in such an assessment: psychiatrist, neuropsychiatrist, neurologist, behavioural neurologist, neuropsychologist and speech pathologist.

Language

Language is assessed in the standard psychiatric assessment through attention to the form of thought, and is a significant component of the MMSE. Thus, language could be placed in the group above, but the aspects of language assessment are not part of the standard psychiatric assessment.

Aphasia

Aphasia is the loss or impairment of language caused by brain damage (Benson, 1992). The specific mention of the presence of brain damage prohibits the use of this term in the so-called ‘functional disorders’ (such as schizophrenia). Another definition is interesting: “a disorder of the symbolic functions of speech”. This would make aphasia indistinguishable from the formal thought disorder of schizophrenia – but let us not embroil ourselves in a pointless debate.

Broca's aphasia

In Broca's aphasia the output is sparse, effortful (the patient struggles), dysarthric, dysprosodic, short-phrased and agrammatic. There is disturbance in repetition and naming. Comprehension is relatively preserved. The patient may be aware of and frustrated by her/his expressive difficulties. This form is associated with damage to

the posterior inferior frontal gyrus (in the region of the operculum) of the dominant hemisphere.

Wernicke's aphasia

In Wernicke's aphasia there is fluent verbal output with normal word count and phrase length and no effort or articulatory problems, but there is difficulty in word finding and frequent paraphasia (unintentional syllables, words or phrases during speech). The patient may be unaware of her/his difficulties and frustrated by the failure of others to respond appropriately. This form is associated with lesions of the posterior superior temporal lobe of the dominant hemisphere.

Nominal aphasia

In anomic aphasia the primary problem is with word finding. There are frequent pauses and a stumbling output. There may be reading and writing disturbance. Output may be fluent and comprehension good, but with naming significantly disturbed. This is often the residuum when other aphasias have largely resolved.

Other forms of aphasia

Additional forms include conductional aphasia and transcortical aphasia.

Examining aphasia

Observations are made during introductory conversation and history gathering. If indicated, the following may be tested.

Dysarthria

Dysarthria (speech disorder due to organic disorders of the speech organs or nervous system) is a mechanical problem. It is not a form of aphasia, but as it frequently co-exists with aphasia. It is convenient to include it here. Dysarthria may coexist with Broca's aphasia, or alone, as in cerebellar damage or bulbar palsy.

The patient is asked to produce the vowel "ahhhhh..." steadily for as long as possible, and to produce a string of consonants ("puh-puh-puh..."). "Tongue twisters" may also be used. Any tongue twister will do, a traditional favourite of neurologists is, "Around the rugged rocks, the ragged rascals ran".

Comprehension

When testing comprehension, the examiner stays alert to the possibility that apraxia and agnosia may be complicating factors. The patient may be asked to, "Close your eyes", or be given some information such as a short story and asked to repeat it in her/his own words. Comprehension should be tested both verbally and in written language.

Repetition

The patient is asked to repeat verbatim, short passages of normal speech.

Naming

The patient is asked to name objects on the examiner's person or around the room, such as, watch, tie, pencil pillow and chair.

Writing ability

The patient is given equipment and asked to write a sentence (as in the MMSE). Educational background is taken into account.

Reading ability

The patient is asked to read a passage aloud.

Diagnostic implications of aphasia

Aphasia is rarely difficult to distinguish from schizophrenic thought disorder.

Aphasia, by definition, a symptom of organic disorder, is commonly found with vascular and space occupying lesions.

Other language disorders

The following are rare. They are included here for the sake of completeness and because of they illustrate the difficulties of the functional/organic distinction.

Amelodia (aprosodia)

Amelodia is characterised by flat, monotonous verbal output, decreased facial movement, and reduced use of gesture (Benson, 1992). It can be tested by having the patient hum a familiar tune such as Happy Birthday, a nursery rhyme, or the national anthem.

It has been described as the result of pathology of the right frontal opercular area. Depressive disorder and schizophrenia manifest similar symptoms.

Verbal dysdecorum

Verbal dysdecorum is not, in fact, a problem of the symbolic use of language, but a loss of control of the contents of verbal output. The patient speaks too freely, discusses improper topics, argues and is 'otherwise disagreeable' (Benson, 1992). There may or may not be physical impropriety.

Verbal dysdecorum is associated with pathology of the right frontal lobe. Hypomania has similar symptoms and would need to be considered.

Skilled movement (and apraxia)

Apraxia is a disorder of learned skilled movements, which is not due to elementary sensory or motor dysfunction. (Gr. *praxis*, "process")

Five types deserve mention: 1) ideational, 2) ideomotor, 3) kinetic limb, 4) dressing, and 5) constructional apraxia. However, there is much confusion, and a simplified approach is offered. Roper and Brown (2005), editors of the most recent "Adams and Victor's Principles of Neurology", state, "We have been unable to confidently separate ideomotor from ideational apraxia". On this basis, only ideational apraxia will be discussed in this chapter. Kinetic limb apraxia refers to clumsiness and Pryse-Phillips (2003) described this as "an entity of doubtful validity", and accordingly, it will not be described. Dressing and constructional apraxia are not apraxias in the strict sense of a loss of previously learned behaviour, but are instead, are symptoms of

gnosis (recognition of stimuli, see below (Roper and Brown, 2005). However, they will be discussed here, in accordance with tradition.

Ideomotor apraxia

Ideomotor apraxia is the inability to perform common actions. Such actions may be performed automatically, as with shaking hands on meeting friends. Thus, the inability may only be revealed if the patient is asked to demonstrate actions or to imitate the actions of the examiner. In the testing situation the patient may be asked to “wave good-bye”, “blow a kiss” or “show how to use a toothbrush”.

Ideomotor apraxia may result from disconnection of the language area from the motor area – the idea cannot be sent to the appropriate area – and is a feature of parietal lobe damage.

Dressing apraxia

Dressing apraxia is difficulty in orienting articles of clothing with reference to the body. The obvious test is to ask the patient to put on an article of clothing. This task is made more difficult by the examiner by turning one sleeve inside out.

It is seen in dementia and right parietal lobe lesions, and is common in confusional states.

Constructional apraxia

Unsurprisingly, constructional apraxia denotes difficulties with “constructions”. In the testing situation the patient is asked to copy a drawing on paper or an arrangement of blocks, or other physical objects. An example: the interlocking tetrahedrons of the MMSE.

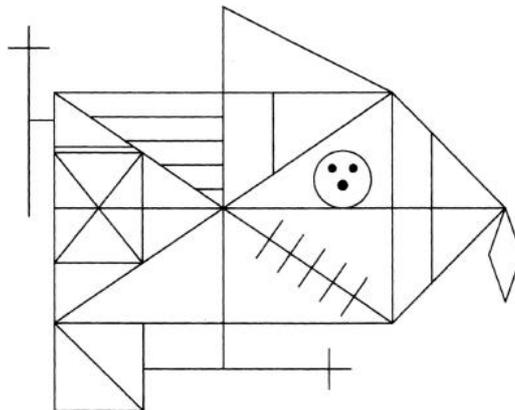


Illustration. A more difficult task is to ask the patient to copy the Rey-Osterrieth Complex Figure. (For those with extraordinary interest, Chapter 30 provides scoring details.)

It is seen in posterior lesions of left or right, or diffuse brain damage.

Interlocking finger test

The Interlocking Finger Test (IFT, Moo et al, 2003) is the first bed-side/office test of the parietal lobe to be described in many decades. It probably entails limb praxis, visual-spatial, and visuoconstructional skills, and poor performance is highly correlated with parietal lobe pathology.

The doctor sits facing the patient and demonstrates each of 4 IFT positions, maintaining each until the patient appears to have made her best attempt at duplication.

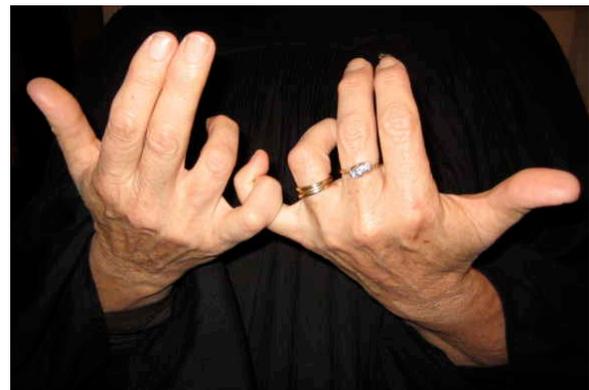
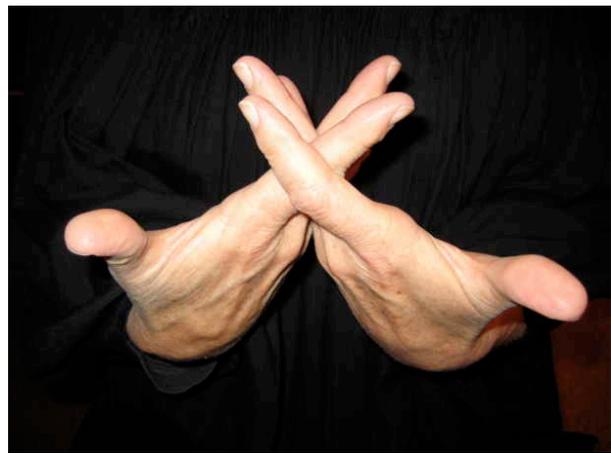
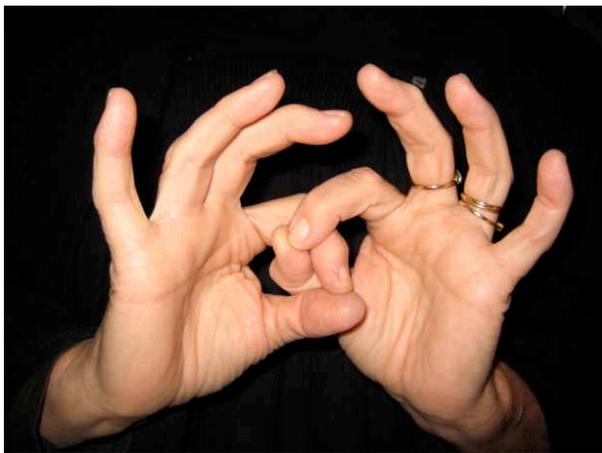


Illustration. The Interlocking Finger Test positions (Adapted from Moo et al, 2003)

Recognition of stimuli (and agnosia)

Gnosis (Gr. *gnosis* “knowledge”) refers to the higher synthesis of sensory impulses, resulting in the recognition of stimuli. Agnosia refers to the loss of the ability to know or recognize the meaning of stimuli, even though they have been perceived (Rosen, 1991; Campbell, 2005). It is most frequently specific to one modality.

Visual object agnosia

Visual object agnosia is the inability to recognise a familiar object which can be seen. In the test situation the patient is asked to identify objects which make no noise, such as a pen, a coin or a dressing.

It is seen in left occipital lobe lesions.

Agnosia for faces (prosopagnosia)

Prosopagnosia is the inability to recognise faces of people well known or newly introduced to the patient.

It is most frequently the result of bilateral lesions of the mesial cortex of occipital and temporal lobes.

Tactile agnosia

Tactile agnosia is the inability to recognise objects by touch. In the test situation the patient is asked to identify by touch, items such as a key, a coin, or a pen.

It results from unilateral or bilateral lesions of the postcentral gyrus.

Auditory agnosia

Auditory agnosia is the inability to recognise non-verbal acoustic stimuli. In the test situation the patient may be asked to identify the sound of keys jangling, water running from a tap, or the clapping of hands.

It is associated with unilateral or bilateral temporal lesions.

Spatial agnosia

Spatial agnosias include disorders of spatial perception and loss of topographical memory (Rosen, 1991). Some include spatial agnosia and constructional apraxia under "visuospatial function" (Ovsiew, 1992). In testing the patient may be asked to locate significant geographical locations on an unmarked map and orient him/herself in space using the available cues.

Spatial agnosia is associated with bilateral cortical lesions.

Corporal agnosia and anosognosia

Corporal agnosia is the inability to recognise parts of the body (one form of which is finger agnosia) or that a part of the body is affected by disease (anosognosia).

Agnosia limited to finger identification may be found in left parietal lesions (in right handed people), while anosognosia is associated with right parietal lesions.

Dressing and constructional apraxia

As mentioned above, these problems should perhaps be included under the heading of Agnosia.

References

- Benton A. Neuropsychiatric aspects of aphasia and related language impairments. In The American Psychiatric Press Textbook of Neuropsychiatry, Eds S Yudovsky, R Hales. Washington: American Psychiatric Press. 1992. pp. 311-328.
- Campbell W. DeJong's The Neurologic Examination, 6th Edition. Lippincott Williams and Wilkins: Philadelphia. 2005.

Cutting J. Neuropsychiatry aspects of attention and consciousness: stupor and coma. In, The American Psychiatric Press Textbook of Neuropsychiatry, Eds S Yudovsky, R Hales. Washington: American Psychiatric Press. 1992. pp. 227-290.

Folstein M, Folstein S, McHugh P. Mini-mental state: a practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research* 1975; 12:189-198.

Moo L, Slotnick S, Tesor M, Zee D, Hart S. Interlocking finger test: a bedside screen for parietal lobe dysfunction. *Journal of Neurology, Neurosurgery and Psychiatry* 2003; 74:530-532.

Ovsiew F. Bedside neuropsychiatry: eliciting the clinical phenomena in Neuropsychiatric illness. In, The American Psychiatric Press Textbook of Neuropsychiatry, Eds S Yudovsky, R Hales. Washington: American Psychiatric Press. 1992. pp. 89-126.

Pryse-Phillips W. *Companion to Clinical Neurology*. 2nd ed. Oxford: Oxford University Press, 2003.

Rosen W. Higher cortical processes. In, *Foundations of psychiatry*, Eds, K Davis, H Klar, J Coyle. Philadelphia: W B Saunders, pp. 199-207.