

Chapter 2: Bedside Cognitive Testing in Neuropsychiatry

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Approach

There are different ways to approach Bedside Cognitive Testing. These include the Functional Neuro-anatomical approach proposed by John Hodges (Hodges, 2017); a domain-based approach; or a battery-based approach.

In clinical neuropsychiatric practice, bedside testing usually follows at least some clinical interview and assessment, and so you are able to develop some idea as to what the disorder might be, and which tests might be most useful.

1. The Functional Neuro-anatomical approach:

1.1. General observations are made. If the patient is intrusive, overfamiliar or abnormally jocular this may point to frontal lobe pathology. If the patient is distractible, hypervigilant or displays increased psychomotor activity, this may indicate impairment in the domains of attention and concentration. Psychomotor activity (May be decreased/slowed with white matter pathology). Alertness (Is the patient drowsy or awake and fully alert to surroundings).

1.2. Distributed Cognitive Functions are assessed. The anatomical substrate of these cognitive functions is not localized to specific brain areas. These include: *Attention, Concentration and Memory*

1.3. We then attempt to localise the pathology by assessing the cognitive functions specific to either the left or right hemisphere of the brain. This includes assessing specific lobes in each hemisphere.

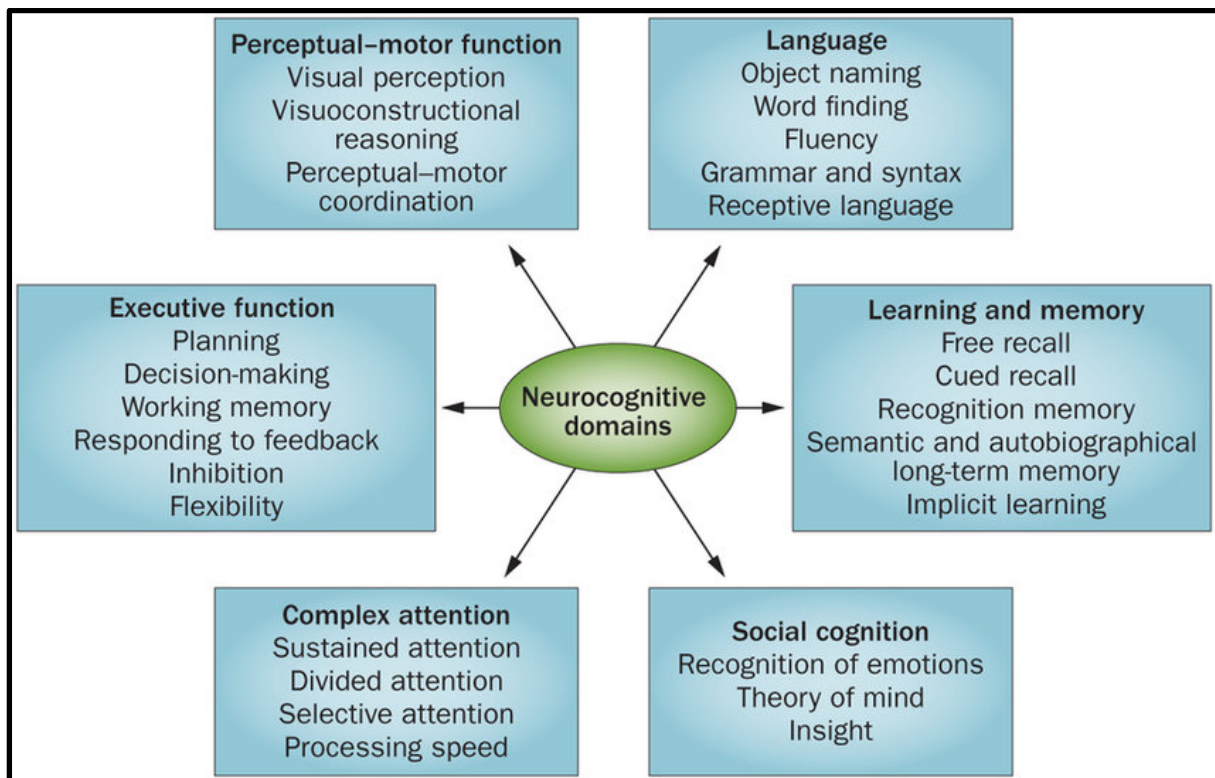
2. The Domain-based approach:

2.1. In this way, the patient is assessed according to specific cognitive domains namely attention/concentration, memory, language, visuo-spatial, processing speed, and executive functions.

2.2. If this is applied to the DSM5, then often Social Cognition is added. (see Figure 1)

2.2.1. This is often more useful when trying to distinguish between different types of neurocognitive disorders, because in theory, different domains are associated with different regions of the brain affected by different pathologies.

Figure 1: Sachdev et al. Classifying neurocognitive disorders(Sachdev et al., 2014)



3. The battery-based approach:

3.1. In clinical practice, it is useful to have a few simple bedside tests on hand for each cognitive domain.

3.2. These tests will use simple bedside ways to assess domains, with some being better than others. For example, the MMSE is better for attention/concentration and language, while the MOCA is better for executive function.

3.3. If pathology is detected, you should know which formal neurocognitive tests you would recommend to further elucidate the underlying pathology.

4. Standardized bedside tests you should be very comfortable administering

- 4.1. Mini Mental State Examination (MMSE)
- 4.2. Montreal Cognitive Assessment (MOCA)
- 4.3. Frontal Assessment Battery (FAB)
- 4.4. International HIV Dementia Scale (IHDS)

Figure 2 below illustrates the typical domains using the DSM5 approach, and which of the above tests can be used to tap impairment in them.

Table 1: Bedside Neurocognitive Screening tools

	MMSE	MOCA	Other Bedside	Formal
Attention	Orientation, registration, serial sevens/world back	Digits forwards / back, letter "A" tap, serial sevens, orientation		Digit span forwards / back
Executive	-	Mini trails B, cube draw, clock-draw, abstraction	Recursive figures / loops, Luria hand sequence, go-no-go, similarities	Wisconsin Card Sorting test, stroop colour word, Tower of Hanoi
Learning and memory	3 word recall	5 word recall	Figure recall, story recall, memory of recent or past events	Rey Complex figure, HVLT or RVL T
Language	Reading, writing, repetition, naming, 3 stage command	Repetition, verbal fluency		Category and phonemic fluency, Boston naming test
Perceptual motor / visuospatial	Interlocking pentagons, 3 stage command	Cube draw, clock draw	Show me how you salute, use scissors, line bisection	Rey figure
Social cognition	-	-	Observed, collateral, "tests of judgement"	Various tasks of emotion recognition and theory of mind.

5. Domain-based approach to Bedside Cognitive Testing

What follows is a brief description of the application and approach to using brief bedside tests to measure function across the key DSM5 domains.

Distributed domains / functions:

5.1. Orientation

This is not a cognitive domain per se but represents the general functioning of multiple domains and is therefore a good starting point.

- Time: Day of week, date, month, season, year. Questions like; How long have you been in hospital. Disorientation to Time is commonly impaired in delirium (Which can be described as a disorder of Attention). Disorientation is not typically found in mild neurocognitive disorders but can occur in more severe stages.
- Place
- Person

5.2. Attention and Concentration

Bedside tests that we can use include;

- Serial 7s or spelling WORLD/HERFS (Afrikaans) backwards. This can be problematic in certain circumstances as spelling and counting is influenced by education.
- Months of the year said backwards is more reliable as it is an over-learned sequence and a patient with normal Attention should have no difficulty completing this task.
- Digit span is a measure of Attentional processing. It requires intact Attention but also employs the domain of Working Memory. Therefore, digit span (especially backwards) will be impaired in delirium but may also be impaired in frontal lobe pathology. As digit span does not require encoding or retrieval, it should be normal in conditions such as Korsakoff dementia, semantic dementia and Alzheimer's dementia. A forward digit span of 6+-1 is considered normal.

5.3. Memory: Classification

- *Episodic memory* refers to the ability to acquire new information (anterograde) or to recall previously learned information (retrograde) regarding *personally experienced events*. The neural substrate for this is the hippocampus (medial temporal lobe) and the diencephalic system (including the mammillary bodies and medial thalamus).

Episodic memory is measured by assessing the ability to encode new information. The bedside tests that we can use to assess episodic memory consist mainly of verbal recall

exercises such as: 3 word recall on MMSE (after distracting with other tasks); 5 word recall MOCA. Here we have the advantage of testing response to cueing; True amnesic disorders (encoding pathology) e.g. AD will not benefit from cueing. If there is marked improvement with cueing, this indicates abnormal retrieval functioning which is indicative of cortico-subcortical circuit pathology, for example in Vascular Dementia.

- *Semantic memory* refers to recall of *word meaning and general knowledge*, and the neural substrate is the anterior temporal lobe.

The underlying neural substrate for semantic memory is widely distributed but can be simplified as a function of the anterior temporal lobe. A pure semantic dementia, which is a form of frontotemporal dementia, is rare. Semantic memory deficits do frequently occur in Alzheimer's, as the disease progresses. Category fluency is useful test and might be sensitive but not specific for semantic memory- but it also assesses executive functioning to an extent

- *Working memory* refers to the ability to retain, manipulate and process information over a short period and neural substrate is the dorsolateral prefrontal cortex (DLPC).

Working memory is not an encoding/recall function. It is dependent on intact attention and executive functioning. The bedside test that can be used to assess working memory assess immediate recall. This includes digit span testing (primarily the backwards type) and spelling WORLD backwards on the MMSE. Digit span involves asking the patient to repeat increasingly longer strings of single digits (either repeated forwards or backwards) to the point where errors are made.

5.4. Executive functions

Executive functioning can be described as the ability to plan, sequence, switch and monitor cognitive tasks. The neural substrate for executive functions consists of the dorsolateral prefrontal cortex (DLPC) and the cortico-striatal circuits. The MMSE lacks sensitivity for identifying executive dysfunction. The MOCA is a more useful screening tool in this regard.

It is imperative to gather a comprehensive history from collateral sources. Any reported disinhibited behaviour should be considered as possible evidence of impaired executive functioning. Executive functioning can be assessed under the following sub categories; Verbal fluency, abstraction, response inhibition, set shifting and complex motor sequencing.

- Verbal Fluency: Category fluency is less specific to the frontal lobe and may indicate anterior temporal lobe pathology (semantic memory). Across cultures, animal fluency is best. Letter fluency is more specific to the frontal lobe. *Instruct a patient to name as many words as they can, beginning with the letter F, A or S in 1 min.* A healthy young adult should comfortably manage a minimum of 20 words. 15 words is considered the lower limit of normal. The elderly should be able to generate at least 12 words. Different tools prescribe different cut-offs. Also note perseveration or intrusions.
- Abstraction. This can be tested by asking the meaning of proverbs, however, keep in mind that this is influenced by educational and cultural background. Similarities; Start with simple concepts such as the similarity between an apple and banana progress to more abstract pairs such as a poem and statue. Cognitive estimates is another way to test abstraction but may also be culturally insensitive. This may include questions like; How far is CPT from JHB? How fast does a horse run? Patients with frontal lobe pathology will often give bizarre, unrealistic estimates.
- Response inhibition, Set shifting. Response inhibition is the ability to inhibit inappropriate responses while set shifting is the ability to shift from one cognitive set to another. The Trials B in the MOCA is a good measure of processing speed and set shifting while the Go-No-Go measures response inhibition. This can be assessed using a “tap once when I tap once, and DON’T tap when I tap twice” task instruction.
- Alternating sequence tasks. The patient is asked to copy a segment with alternating shapes. With frontal lobe pathology a patient will often perseverate and repeat the same shape. Luria’s three step motor program is a sequential performance of three movements, usually fist-edge-palm. It is important to demonstrate the sequence to the patient without verbal cues.

Figure 2. Localization in Neurologic Diagnosis, A presentation by D. Joanne Lynn

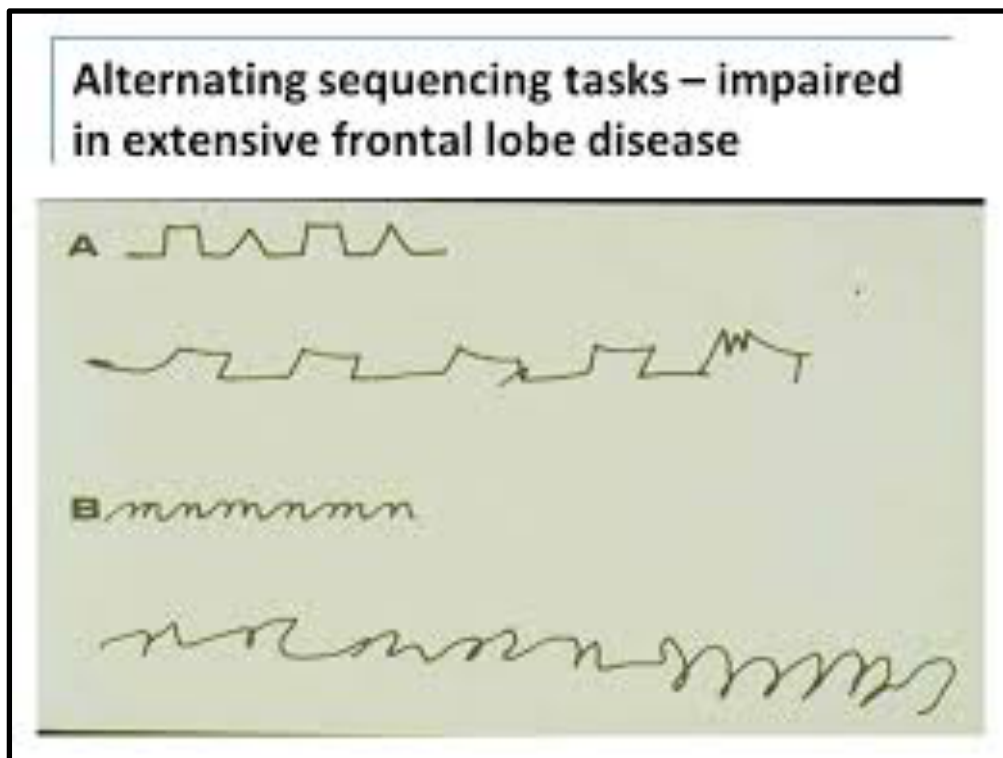
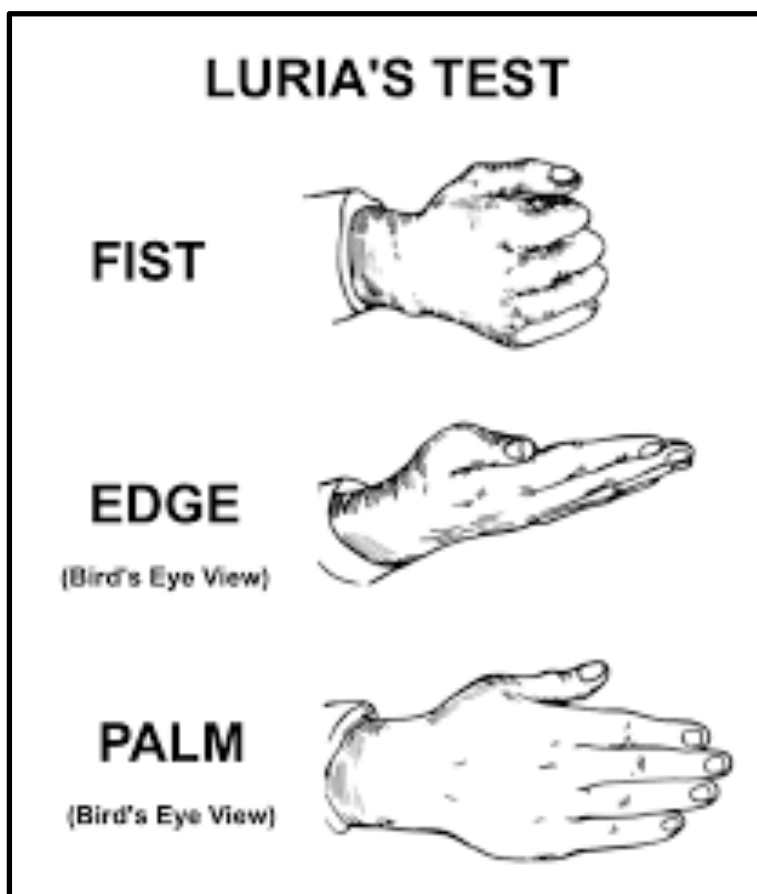


Figure 3: The Luria 3-stage hand test (Luria, 2012)



Lateralised domains / functions

Dominant hemisphere (Left)	Non-Dominant Hemisphere (Right)
The dominant hemisphere controls Language, Calculation and, to an extent, Praxis	The non-dominant hemisphere controls Visuospatial and constructional abilities. Lateralising signs also include hemi-neglect

Dominant hemisphere (Left)

6. Language

Language deficits can be seen with unilateral focal pathology (such as strokes, space occupying lesions) as well as diffuse pathology (such as neurodegenerative disorders). The terminology used to describe language deficits can be summarised as follows;

- Dysphonia: Abnormal sound production (hoarse voice).
- Dysarthria: Abnormal motor speech production.
- Dysphasia/Aphasia: Disorder of language due to cortical damage.
- To assess language as a cortical domain one should test the following components thereof;
- Fluency, naming, comprehension, repetition, reading and writing.

Table 2. Language functions, localisation and tests

Aphasia	Site	Fluency	Repetition	Comprehension	Naming	Reading	Writing
Global	Extensive	↓	↓	↓	↓	↓	↓
Broca's (motor)	Inferior frontal convexity	↓	↓	N	↓	N	↓
Wernicke's (sensory)	Wernicke's/temporal	N	↓	↓	↓	↓	
Conduction	Arcuate fasciculus	N	↓	N	↓	N	↓ or N
Anomic	Various and common in stroke; angular gyrus	N	N	N	↓	N	↓
Transcortical: motor	Dominant anterior cerebral artery	↓	N	N	↓	N	↓
Transcortical: sensory	Advanced diffuse disease	N	N	↓	↓	↓	N
Tests		Spontaneous speech, animal or category fluency	MMSE sentence, "british constitution" or other words	Must have NORMAL hearing; point to items, then commands (e.g. 3- stage command), or "what bird flies at night and hoots?"	Naming of objects	"Close your eyes"; various types of dyslexia occur e.g. pure (read letters), neglect (sees half)	"Write a sentence"; writing dyspraxia=poorly formed letters

- Fluency / Speech: This can be assessed throughout the interview. Take note of the rate, fluency and articulation.
- Naming: Naming is impaired in all aphasias. To test naming, start with high frequency items such as pen, watch and progress to lower frequency items such as buckle and nib. The nature of the naming abnormality is helpful. A Broca's anomia is characterised by slow, effortful speech and the patient can usually produce the first sound of the word. With Wernicke's aphasia, a patient will make semantic/concept errors when naming. Apple for orange, musical thingy for guitar
- Comprehension. Start with single words. Ask the patient to point to a chair, pen, bed. Then move on to syntactic comprehension. Ask the patient to put the watch on the table, touch the keys and then the pen or to follow a three step command such as demonstrated in the MMSE.
- Repetition. Test with series of words and sentences of increasing complexity.
- Reading. Ability to read aloud combined with reading comprehension. E.g. **Close your eyes** on MMSE).

7. Visuo-spatial functions

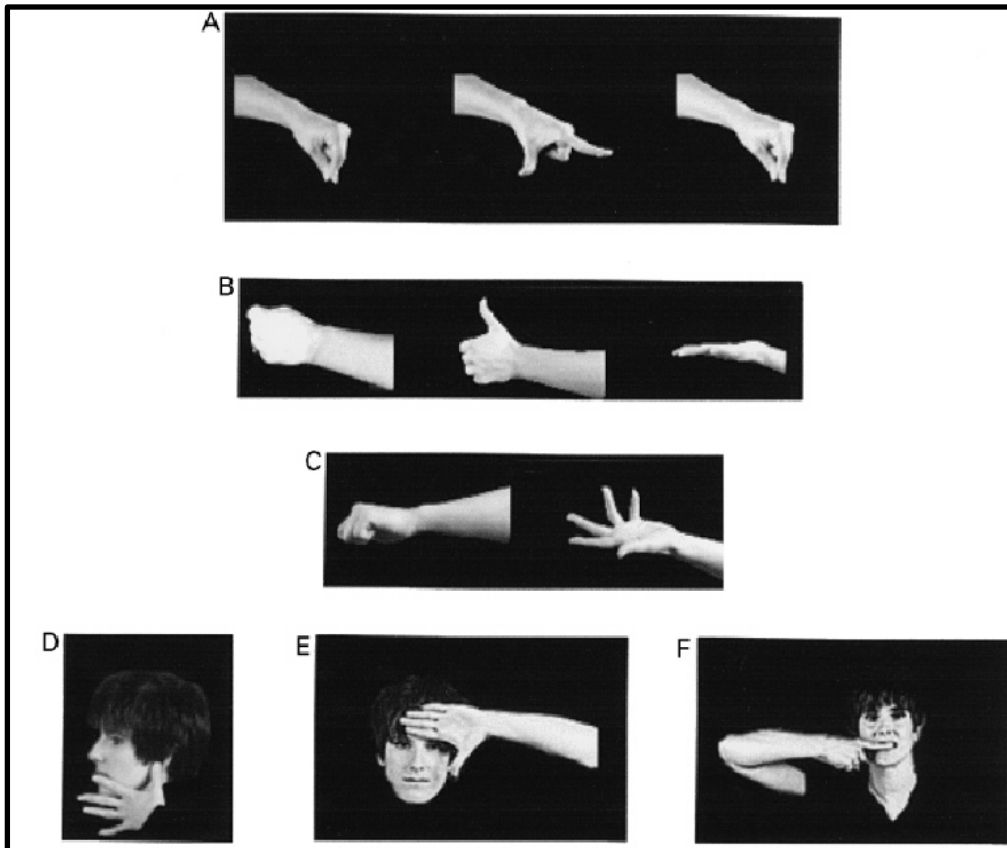
7.1. Praxis

Praxis is the higher, integrative cognitive functioning that facilitates the ability to perform complex motor tasks. Praxis is not often included in commonly used bedside cognitive tests. Praxis is often described as a left inferior parietal lobe function but the left supplementary motor cortex is also involved. Therefore, left frontal lesions can also result in apraxia.

The following tests for praxis can be utilised at the bedside:

- Limb apraxia: Copy meaningless hand/finger positions
- Ideomotor praxis: Say to patient: "Demonstrate to me how you would comb your hair" or "brush your teeth".
- Ideational praxis: This consists of a sequenced motor task. Say to the patient: "I'd like you to imagine that you have a tray with a cup, kettle, tea bag, spoon, milk and sugar. Show me how you would make a cup of tea from start to end". Ideational praxis can be localised to the left, inferior temporal lobe.

Figure 4. Examples of Apraxia using the hands (Haaland, Harrington, & Knight, 2000)



Non-Dominant Hemisphere (Right)

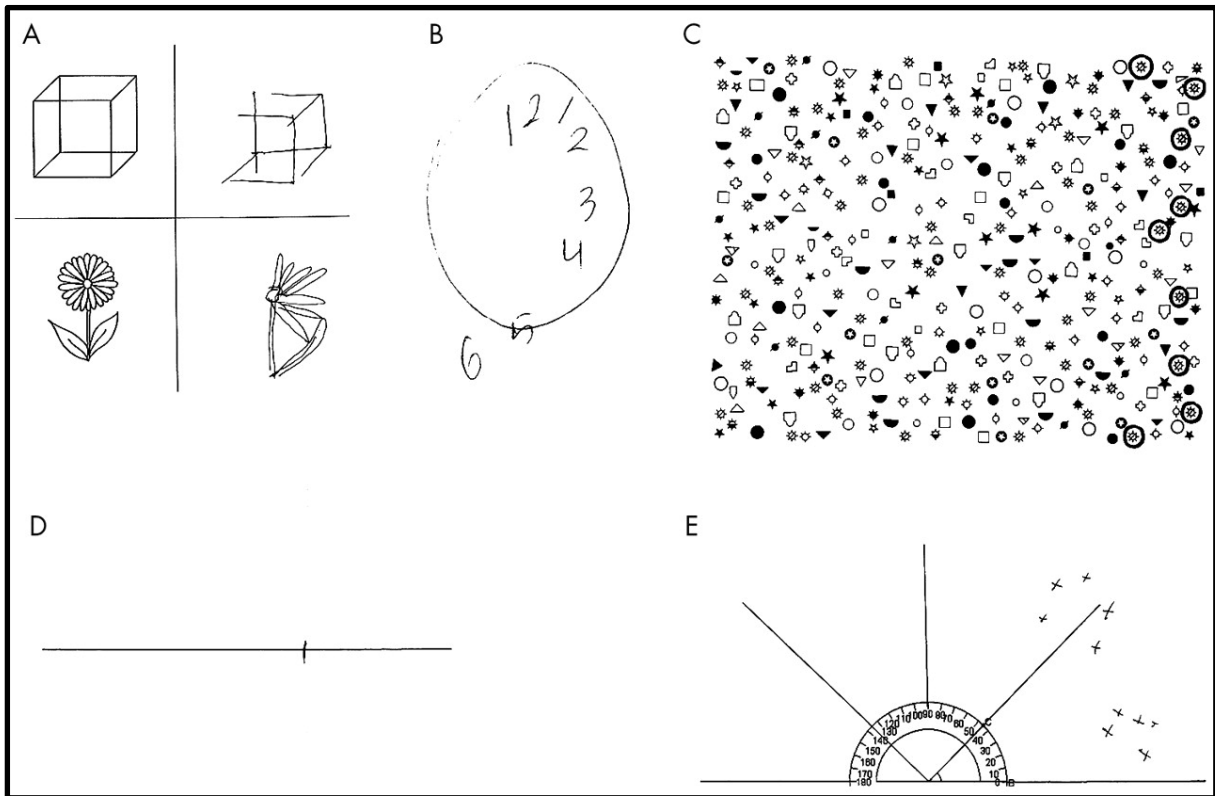
8. Neglect

Neglect indicates right frontoparietal pathology. The patient typically neglects the left side.

Tests include:

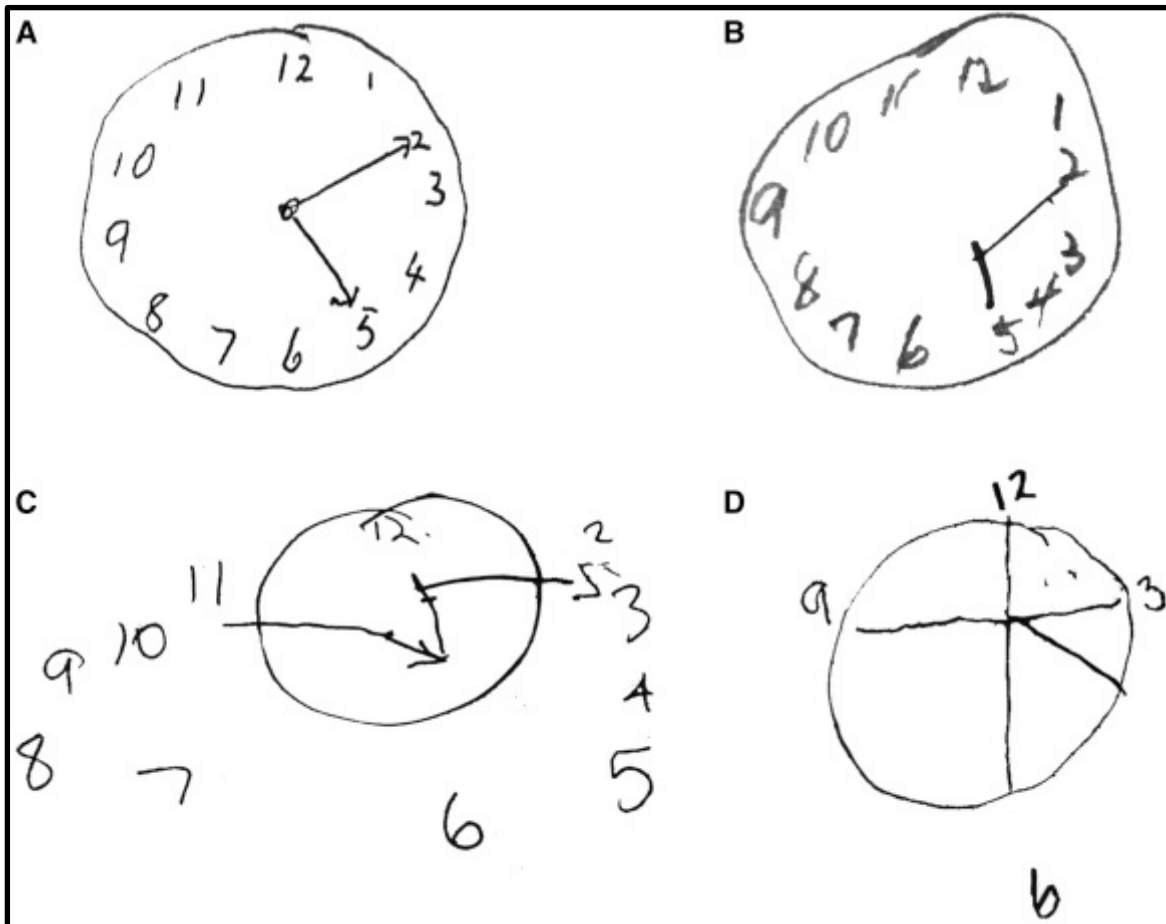
- Line bisection task-ask patient to indicate the midpoint of a line. The patient bisects to the right of the midpoint (diagram D). Ask the patient to copy symmetrical, two-dimensional images (clock, 2 headed daisy).
- Visual search tasks (explain what that is?)

Figure 5. Examples of visual neglect problems (Parton et al (Parton, Malhotra, & Husain, 2004)



- Dressing apraxia: Dressing apraxia is a misnomer as it is not an apraxia per se as it is not an abnormality of learned motor tasks but rather of spatial orientation of limbs and garments in space.
- Visuo-spatial and Constructional domain: Substrate: Right parietal lobe. Visuo-spatial deficits are more often seen in the context of global dysfunction such as neurodegenerative disorders. Tests include: Ask the patient to copy interlocking pentagons (MMSE) and Ask the patient to copy a clock drawing.

Figure 6: Examples of Clock Drawing



Key points:

- Whether the clinician applies a functional anatomical approach, or a domain-based approach, or a battery-based approach or a combination, it is key to obtain careful clinical history and conduct an examination, as this will guide you as to the tests you should be using at the bedside.
- A clear knowledge of the common bedside screening tools, and how their respective sub-tests can be applied to various aspects of cognitive function is essential to interpreting the findings.
- At the same time, awareness of the patient's educational and cultural background are also critical to interpreting performance on bedside tests.
- Bedside tests should be used as a guide, and not as diagnostic instruments

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