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Information/Education Page

Rapid Yet Thorough Bedside Assessment of Eye-Hand Coordination

Eye-hand coordination (EHC) is critical for activities of daily living. EHC is dependent on the integrity of multiple brain systems and therefore is often disrupted by central nervous system pathology. Impairments can occur in ocular motor, manual motor, or ocular-manual motor control, that is, eye, hand, or EHC. Impaired EHC affects visually guided actions, such as reaching, grasping, wielding tools, and manipulating objects. This is true in acute pathologies, such as stroke and neurotrauma, as well as more chronic neurodegenerative conditions, such as Parkinson disease.[1-5] Despite its clinical relevance, EHC is not often systematically assessed. Using 3 simple measures (fig 1), health care providers may rapidly identify and characterize deficits in EHC while also assessing visual function and eye and limb movement.

Figure 1 is a flow diagram for rapid EHC assessment. The patient performs 3 assessments: finger-to-nose, finger-to-knee, and finger chase. The patient performs finger-to-nose with a target in both central and peripheral vision; if deficits are noted, tests are repeated by providing proprioceptive ± audio feedback.

General Examination Instructions for all assessments:

- Sit in front of patient's midline about 1 arm's length away
- Have patient sit comfortably. If necessary, support feet and trunk (head/body aligned in a forward/central position)
- Patient performs 5 trials for each assessment, emphasizing both speed and accuracy.
- Test both arms whenever possible, score each side separately; test the less affected arm first to ensure task comprehension.
- Start the task with hand/arm resting on the knee of to be tested side and arm/shoulder both mildly flexed
- One trial (cycle) starts when the hand moves from the knee and ends when back on the knee
- Reach distance should be ~50% of the patient's arm span

I. Finger-to-nose[1-4] (fig 2.I, below)

Significance

Finger-to-nose (FtN) has 2 defined steps.

Step 1. The patient brings their finger to their nose.

Step 2. The patient brings their finger from their nose to examiner finger and then returns their finger to their nose and subsequently back to their knee. This completes a cycle. The patient performs 5 cycles.

Nose-to-finger (examiner) movements require visual guidance and test for optic ataxia but are also influenced by primary motor system deficits (eg, tremor, akinesia, chorea, clumsiness). Patients with optic ataxia are inaccurate when reaching to a visualized target. The FtN movement provide a relatively pure measure of motor dysfunction. Note, patients with cerebellar ataxia may overshoot the target when moving rapidly and display a characteristic tremor that worsens as the limb approaches the target; in this case, pay close attention to the finger chase, in which these deficits should be more apparent. Note discrepancies between the nose-to-finger or FtN segments of the task (inaccuracy and/or tremor) to inform your clinical decision making.

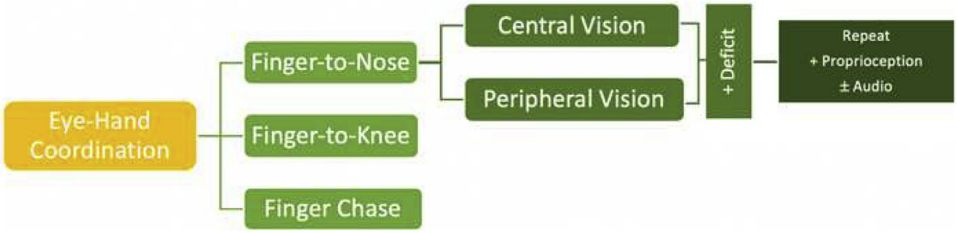

Fig 1 Flow diagram for rapid eye-hand coordination assessment. Examiner performs three assessments finger-to-nose, finger-to-knee, and finger chase. Finger-to-nose is performed with targets in both central and peripheral vision; if deficits are noted, tests are repeated by providing proprioceptive ± audio feedback.

A1. FtN → central vision

Instructions: "Lift your hand from your knee and touch your finger to your nose. Then touch the tip of my finger. Then return to touching your nose. Finally, return your hand to your knee. Try to do all of this as fast and accurately as possible for each of the target positions that I indicate. You can move your eyes and follow your hand with your eyes while keeping your head still."

Examiner instructions (fig 3):

- Use your index finger as a target for patient's index finger.
- Place your finger at 5 locations in random order.

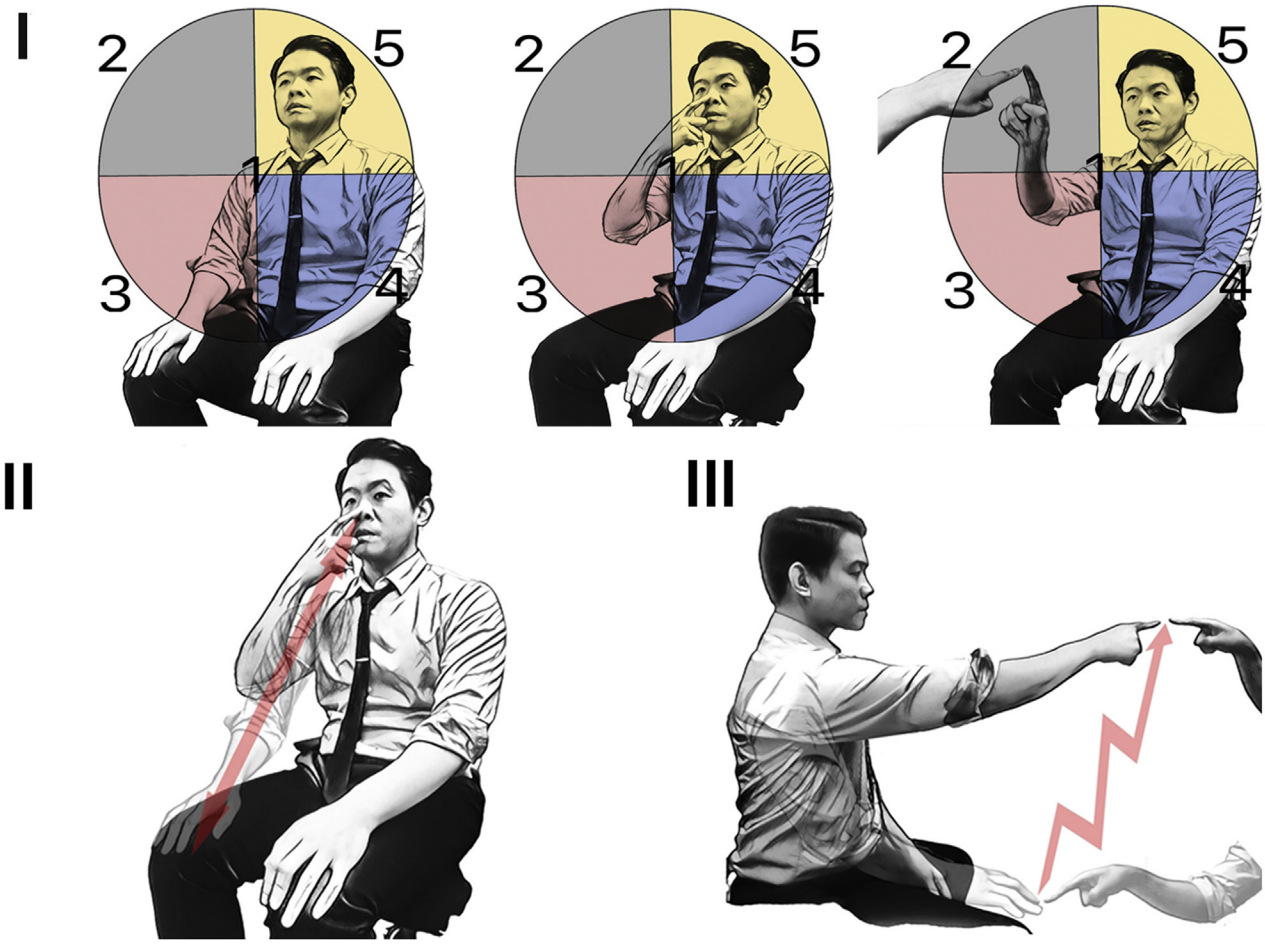

Fig 2 Finger-to-Nose: (left, upper and lower) Rapid and accurate movements are completed between two targets: 1) an egocentric (nose) and 2) an allocentric object (examiner's finger); (right) trials are completed in 5 cardinal positions: 1) central, 2) upper right, 3) lower right, 4) lower left, and 5) upper left, covering all spatial quadrants.

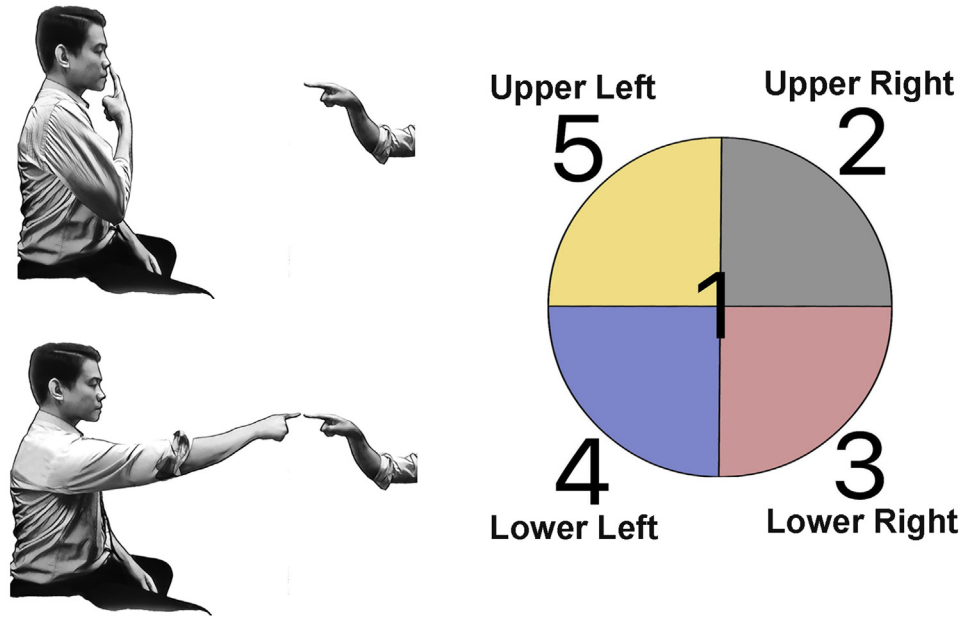

Fig 3 Assessment Battery: I) Finger-to-Nose: rapid and accurate movements between nose (egocentric) and finger (allocentric). II) Finger-to-Knee: rapid and accurate movements between knee (allocentric) and nose (allocentric). III) Finger Chase: follow the finger (allocentric) as fast and as accurately as possible, in between step-like target shifts.

Outcome measures:

- Time to completion: record total time to completion (from time hand leaves the nose to the time it returns) using a stopwatch.
  - Fatigue: note any prolongation of completion time over the trials
- Reach accuracy: quantify degree of error (0-5, see below) and type (over-/undershoot)
  - 0 = No error
  - 1 = Mild error (<5cm)
  - 2 = Moderate error (<15cm)
  - 3 = Severe error (>15cm)
  - 4 = Unable to perform 5 pointing movements
- Tremor: record the presence and degree of any tremor noted during movement (0-3, see below for scale):
  0 = Normal
  1 = Slight
  2 = Moderate
  3 = Severe
- Types of tremors (optional): fine, coarse, high-amplitude, high-frequency, resting, intention
- Miscellaneous: record the presence of any other neurologic abnormalities incidentally noted (impairment of eye movements, impairments of somatosensory or somatomotor function, etc).

A2. FtN → central vision ± guided tactile/proprioceptive feedback.

If the patient has trouble performing the FtN tasks, repeat the trial but manually guide the patient's hand to the target. Patients with optic ataxia may improve with proprioceptive information about target location. In contrast, as with misreaching due to motor deficits, supplemental proprioceptive information will not help.

Instructions: "Lift your hand from your knee and touch your finger to your nose, then touch the tip of my finger. Then touch your nose. Finally, return your hand to your knee. If you miss any of the targets, I will help you by moving your hand to touch my finger and have you repeat the task."

Examiner instructions:

- Follow A1 instructions.
- If the patient misses your finger, guide them to the target and repeat the trial.
- Document the outcome measures.

B1. FtN → peripheral vision

Reaching for targets in the peripheral visual engages a wider network of neural systems and may

reveal deficits not observed in reaching to foveated targets. Hemispatial neglect, subtle visual field deficits or impairment in translating between eye and hand-based spatial coordinate systems, and impairment in working memory may all worsen performance in reaching to targets in peripheral vision (when they are not looking at target)

Examiner instructions: Same as A1, except ask the patient to look at your nose at all the times.

Instructions: "Lift your hand from your knee and touch your finger to your nose. You are then going to touch the tip of my finger, then touch your nose, and ultimately return your hand to your knee as fast and accurately as possible. Look at my nose at all times and do not move your eyes and head."

Outcome measures: Same as A1.

*If the patient is noted to have difficulty in performing B1, perform B2:

B2. FtN → peripheral vision ± guided tactile/proprioceptive feedback

Examiner instructions: If the patient misses your finger, guide them to the target and ask to them to repeat the trial.

Instructions: "You are going to touch the tip of my finger first, then touch your nose, and then return your hand to your knee as fast and accurately as possible. Look at my nose the whole time and don't look to my finger. If you missed my finger, I will help you by moving your hand to touch my finger and have you repeat the task."

Outcome measures: Same as B1 (see fig 2).

II. Finger-to-knee (rapid movements)[5,6] (see fig 2.II)

Significance: To distinguish between visuomotor and motor deficits contrast performance on the finger-to-knee, which entails reaching to a target defined by body schema and proprioception, and FtN, which requires reaching to a visualized target (especially, nose-to-finger (examiner).

Instructions: "Start by lifting your hand from your knee and touch your finger to your nose.

Then touch your knee. Repeat this for a total of 5 times, as fast and as accurately as possible."

"Now close your eyes and repeat the same task, repeat it for a total of 5 times, as fast and as accurately as possible."

Examiner instructions:

- Ask the patient to perform 5 trials with eyes open and then ask them to perform the same with eyes closed.

Outcome measures: Same as part I

III. Finger chase[2] (fig 2.III)

Significance: Patients with cerebellar ataxia overshoot with the affected extremity when rapidly and continuously following a moving target. Cerebellar tremors (an uncontrolled oscillation of the limb perpendicular to the axis of the movement that becomes worse as the limb approaches the target) may become exaggerated when reaching to moving targets.

Instructions: "Using your index finger, follow my finger as I move it, as fast and precisely as possible."

Examiner instructions:

- Use your index finger as a target and ask the patient to follow/chase your finger as you move it.
- Make 5 sudden and fast arm movements in different random locations.
- Movements should be about 30 cm (~12 in) and a frequency of 1 movement every 2 s.

Outcome measures: Same as part I.

Conclusions

The 3 tests described herein, when combined, provide a systematic and reproducible assessment of eye-hand coordination. While any abnormal finding from the battery will assist in triggering appropriate referrals to experienced neurologists and/or physiatrists, granular details generated, following the characterization of the impairment, will help downstream clinicians, such as physical and occupational therapists, tailor rehabilitative therapeutics, stage prognosis, and, ultimately, stimulate novel directions in care approaches for eye-hand dyscoordination.

Authorship

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Disclaimer

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