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Evaluating Visual-Motor Integration as Part of the Handwriting Assessment Process



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What is VMI?

- Visual motor integration is defined as:
 - The degree to which visual perception and finger-hand movements are well coordinated.
- Many different parts of the brain need to work together for efficient visual-motor integration to occur so there are many factors that could cause delay or impairment.

The Visual System


- The eye must first register the visual input (reminder: the right half of each retina is connected to the right hemisphere of the brain and the left half of each retina is connected to the left hemisphere).
- The brain must interpret all of the attributes of what it sees (light/dark, size, shape, pattern, part/whole, orientation). Visual perception is the intermediate step between simple visual sensation and cognition.

The Motor System

- Motor development tends to follow a path from mass action to refined specific activity. It also follows a path from proximal control to distal control.
- As such, finger activity (including control & manipulation) are the last refinement of the shoulder/arm/hand.
- In addition to the motor cortex, the cerebellum is required for smooth, coordinated movements


Visual-motor Integration

- This requires an interaction between the sensory system (visual processing and visual perception) and the coordinated response from the motor system.
- It also requires a feedback loop for self-monitoring and self-correction
- A deficit in either component part is likely to impact VMI
- The separate parts of visual perception and motor coordination may function well independently but not in combination




Why is VMI Important?

- In addition to the obvious correlation between visual-motor integration skills and handwriting skills, impairments in VMI has been correlated with difficulties in academic achievement including:
 - Reading
 - Spelling
 - Math
- VMI skills are required for success in non-academic areas as well, including sports and self-care
- Difficulties with visual-motor integration is common in many diagnoses including
 - Specific learning disabilities
 - ADHD
 - Brain injury
 - DCD
 - ID
 - Visual impairment
 - Low birth-weight and prematurity
 - ASD
 - Spina bifida
 - Iron deficiency
 - Lead toxicity
 - Cognitive decline due to ageing
 - Dementia



Why is copying a good measure of VMI?

- Copying a geometric shape requires the individual to first visually capture the information then coordinate a motor output that mirrors what the eye has captured.
- Children might scribble horizontal, vertical and circular lines before being able to imitate them as this spontaneous movement does not require coordination of visual perception + motor.
- Children can usually imitate a drawing before doing direct copy because in watching somebody else model the drawing they get a chance to rehearse the eye movements and form the pattern prior to requiring the motor output.
- Copying geometric shapes (as opposed to alphanumeric shapes) decreases cultural bias

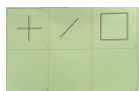


Three Options for Assessing VMI

Beery-Buktenica Developmental Test of Visual Motor Integration 6th Edition (Beery-VMI)	Developmental Test of Visual Perception - Third Edition (DTP-3)	Wide Range Assessment of Visual Motor Abilities (WRAMA)
<ul style="list-style-type: none"> Published 2010 Age range 2 – Adult Administration time: 10-15 minutes per subtest Includes Visual-Motor Integration, Visual Perception & Motor Coordination subtests 	<ul style="list-style-type: none"> Published 2013 Age range 4 – 12:11 Administration time 30 -45 minutes for complete assessment Includes eye-hand coordination, copying, figure-ground, visual closure & form constancy subtests 	<ul style="list-style-type: none"> Published 1995 Age range 3-17 Administration time 4-10 minutes per subtest Includes visual-motor, visual-spatial and fine motor subtests

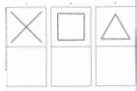
All Three Assessments Have Copying Tasks

- All three are developmentally sequenced
- All three include geometric shapes that have curved lines and angles
- All three provide norm-referenced scores and percentiles



Beery VMI

- Starts with scribbling & imitation for youngest children
- 24 copied items of increasing complexity
- Specific scoring instructions for each item with pass/fail structure



DTVP-3

- 18 copied items of increasing complexity
- Possible scores of 0, 1, 2, or 3
- General scoring criteria (scoring overlay) with some specifics for particular items



WRAVMA

- Different starting points based on age
- Youngest children start by imitating line to complete a drawing
- 21 copied items of increasing complexity
- Specific scoring criteria for each item with pass/fail structure

All Three Assessments have good reliability

	Beery	DTVP	WRAVMA
Internal Consistency	.81-.89	.80-.95	.81-.84
Test-Retest	.84-.88	.70-.90	.82-.89
Inter-scoring	.93-.98	.94-.99	.96-.97

Validity

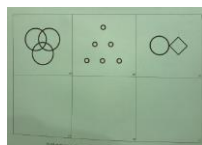
	Concurrent	Construct
Beery	VMI:WRAVMA VM = .52 VMI:DTVP2 Copying = .75 VP:DTVP2 P.I.S. = .62 MC:DTVP2 E.H.C. = .65	High correlation to chronological age. Subtests are related but measure different constructs. The VMI subtest is harder than MC or VP. Moderate correlation to nonverbal IQ. Moderate correlation to academic achievement. VMI results are lower in specific diagnostic groups.
DTVP	VMI Index:VMI5 = .81 MRVP Index:TVPS3 = .81 GVP Index:VMI5 = .74 GVP Index:TVPS3 = .78	High correlation to chronological age. Subtests are related but measure different constructs. No bias based on gender, ethnicity, race or handedness. DTVP results are lower in diagnostic groups with known VP difficulties. Moderate correlation between MRVP composite and academic achievement. High correlation between VMI composite and academic achievement.
WRAVMA	VS Subtest:MVPT = .54 VMI:VMI = .76	High correlation to chronological age. Subtests are related but measure different constructs. Moderate correlation to IQ with matching highest. Moderately high correlation to academic achievement. WRAVMA subtests provide substantial additional meaning to intelligence & achievement tests.

What Differentiates the Beery VMI?

- Quick administration
- No kit/manipulatives required
- The primary focus is VMI
- Norms from age 2 – 99 years
- Test scores have remained stable over time (Standardised 6 times between 1964-2010 on more than 13,000 children and more than 1,000 adults)
- Because the other subtests use the same stimuli, can consider scores in light of one another e.g.
 - VMI score lower than each of the Supplementary test scores – difficulty may be with integrating information
 - Visual Perception score low – is this due to discrimination issues, poor searching skills, slow processing speed, impulsivity?
 - Motor Coordination score low – may be poor pencil control or difficulty matching speed/force to task (calibration – cognitive skill)
- Supplementary parent checklist and teaching materials that support intervention
- If you are already doing a comprehensive motor assessment, this is a good supplement

Administration & Scoring Notes for VMI Subtest of Beery

- If child is under 5 (chronologically or functionally) begin with Task 4 (page 2) – imitation items. If the child is not able to do any of the three imitation items, go back to scribbling.
- If child is functioning over age 5 start on page 4, Task 7 (first copying tasks). If the child successfully completes first three copying items, give them credit for previous 6 items. If they don't complete all 3 successfully, go back to imitation items.
- Allow only 1 try per task – no erasing.
- You can end after 3 consecutive failures but if you aren't sure if the child will receive credit for an item, continue. Also, it's often informative to see child approach more challenging items, but no credit is given beyond ceiling of 3 consecutive failures.
- Do not trace the sample shape with a finger or pencil and do not allow the child to trace as that gives them patterning that will impact their performance.
- Avoid calling the form by its name and instead say "make one like this" pointing to the stimulus shape.
- It's helpful to have a ruler/protractor for scoring.
- When in doubt give them credit.



Administration – 'Testing the limits'

- After administering items using standardised procedure you can gain excellent qualitative information by returning to certain items.
- Return to the first VMI item the child did not receive credit for. Ask child if he thinks his incorrectly drawn shape looks the same as the stimulus. Does he recognise his mistake? Can he describe the differences?
 - No – could be visual perceptual issue
 - Yes – if he can re-draw it correctly, may have been lacking attention / concentration - if he can't re-draw might be planning issue
- If child has failed an item that should be developmentally within reach, try teaching the task by
 - asking him to trace the stimulus form then try drawing it
 - demonstrating how to draw it
 - use hand-over-hand assistance to help the child draw the shape then let them try again unassisted
 - verbalising the important features while you model drawing it then ask child to copy
 - asking the child to verbalise what you are doing as you model drawing the shape, then ask the child to try drawing it while he verbalises the actions.
- This information will help you identify potential for learning and retention as well as useful strategies that the child responds well to.

Additional Beery VMI Subtests

- These additional subtests are optional
- If administering the additional subtests, you must follow the proper order of administration:
 - VMI
 - Visual Perception
 - Motor Coordination

Visual Perceptual Subtest

- For children under 5, start with task 1 (pointing to own body parts, then outline pictures then picture of doll's body parts)
- For children over 5 start with task 4. Teach the first three items regardless of response, explaining why the other options are incorrect.
- Have them continue for 3 minutes.
- Ceiling of 3 consecutive incorrect items.

Motor Coordination Subtest

- Items 1-3 are observed (climbing into chair, pencil grasp and paper stabilisation)
- Regardless of age model drawing 4A, 5A, 6A
- Have them continue for 5 minutes
- Score all items (no ceiling)

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What Differentiates the DTVP-3?

- More comprehensive visual perceptual assessment
- Includes motor-reduced and visual-motor items
- Provides both subtest scaled scores (eye-hand coordination, copying, figure-ground, visual closure and form constancy) and composite standard scores (visual-motor integration, motor-reduced visual perception and general visual perception).
- Provides more detailed information about the nature of visual perceptual impairment. If a child comes out as below average on the visual perceptual subtest of the Beery, this would be a good follow-up.
- It's comprehensive nature also allows you to rule out visual perceptual difficulties. If a child has high scores on the MRVP index but low scores on the VMI index you have evidence that the difficulties with VMI are not due to VP.

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Administration & Scoring Notes for Copying Subtest of the DTVP-3

- There are no teaching or imitation items in this subtest of the DTVP-3
- A ceiling is reached when 3 consecutive "0" scores are given but since a child can receive a 0, 1, 2 or 3 it is difficult to ascertain during the assessment if a child has clearly received a 0 so continue administering if there is any doubt.
- General scoring criteria (utilise a scoring transparency & Appendix D)

To Achieve a Score of 3:

- Straight lines should be straight
- Lines of the same length should be within 1/16th inch
- Each segment of circular shapes should be smooth arcs
- Overlaps and gaps between lines should be less than 1/16th inch
- Angles should be within 2 degrees of stimulus

To Achieve a Score of 2:

- The shape is generally a good reproduction but fails to meet any of the previous criteria or meet the previous criteria but:
 - There is an additional line
 - There are overstrikes (numerous lines or sketches)
 - Drawings touch or extend beyond the boundaries of the box.

To Achieve a Score of 1:

- The drawing has the gestalt of the stimulus but the drawing is inferior
- There is always a description corresponding to a "1" score in Appendix

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Additional DTVP-3 Subtests

Eye-Hand Coordination

- Administer all 5 items (no ceiling)
- Child is not allowed to lift pencil during tracing tasks (can correct them on first item but not on subsequent items).
- Each segment is scored from 0-4 depending on how far they deviate from the middle.
- If they lift the pencil they get a 0

Figure-Ground

- Uses picture stimulus book. Child must identify all shapes used in the stimulus shape from a selection of shapes below.
- 2 examples
- 23 items, max of 4 shapes within stimulus shape
- The child receives 1 point for each correctly identified shape.
- The child receives a score of 0 if an incorrect shape is identified
- The ceiling is achieved at three consecutive 0s
- Do not indicate how many shapes are in the stimulus shape

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Additional DTVP-3 Subtests

Visual Closure


- Uses picture stimulus book. Child identifies which drawing would look like the stimulus shape if completed.
- 2 examples
- 26 items
- The child receives a score of 1 for every each correct answer.
- The ceiling is achieved at three consecutive 0s

Form Constancy

- Uses picture stimulus book. Child must identify all of the shapes that contain the stimulus shape. They might be bigger/smaller, darker/lighter, in a different orientation or part of a drawing. There can be more than one that matches the stimulus.
- 2 examples
- 24 items, max of 3 shapes that contain stimulus shape
- The child receives 1 point for each correctly identified shape.
- The child receives a score of 0 if an incorrect shape is identified
- The ceiling is achieved at three consecutive 0s

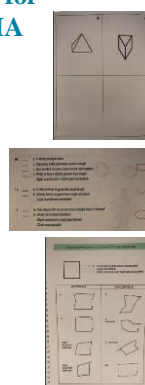
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What Differentiates the WRAVMA?




- Includes fine motor and visual spatial subtests that are unique to the visual motor task.
- Tasks tend to be engaging for children and are designed to limit impact of attention deficit on performance.
- Quick administration.
- Includes visual perceptual tasks that require more mental manipulation than the Beery but does not differentiate them into component skills/scores like the DTVP-3 does.
- Includes a strictly fine motor task (peg board) that does not require pencil control.
- If not doing any other fine motor assessment allows for at least a quick screen of fine motor via pegboard which allows you to observe in-hand manipulation, grasp, crossing midline, control/modulation and depth perception (as the board is textured).

Administration & Scoring Notes for Drawing Subtest of the WRAVMA




- Different start points depending on age.
- The youngest age group (3-5) start by completing a drawing and includes the therapist modelling.
- The remainder of the items are copying.
- No erasing – only score child's first attempt.
- Discourage sketching.
- Avoid outlining the shape with your finger or pencil or doing any gesturing, only point to the stimulus.
- Each shape has specific criteria that need to be met.
- Basic criteria are included on the score sheet with more specific criteria and examples in the manual.
- The child can receive a score of 1 or 0 for each item depending on whether or not all of the criteria have been met.
- A ceiling is achieved at 3 consecutive 0 scores.
- When in doubt, give the child credit.
- In scoring criteria the word "clearly" is used when a more exacting judgement should be employed. The words "generally" and "mostly" are used when a more liberal judgement can be applied.



Additional WRAVMA Subtests


Visual Spatial (Matching)


- Different start points based on age.
- Child is asked to identify which of four options "goes best" with the stimulus.
- If the child gets the first few incorrect, tell them it's incorrect and point out the correct one but don't explain why an option is correct/incorrect.
- Some stimuli are rotated, some are from a different orientation, some are identifying a puzzle piece that would fit, etc.
- 46 total items.
- 1 point is awarded for each correct match.
- Ceiling is achieved when 6 of 8 consecutive items score "0".
- Intentionally only 4 options and varied presentation to limit impact of attention.



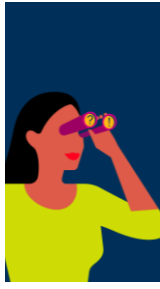
Fine Motor (Peg Board)

- Task is to put as many pegs as possible in 90 seconds.
- Dominant hand is tested first (this is what is scored). Child is encouraged to put "resting hand" in lap.
- Non-dominant hand tested second (doesn't contribute to score but there are norms available).
- Can only pick up one peg at a time.
- Must not skip any holes.
- Task is modelled by therapist and then the child gets to practice.
- Board is textured for increased challenge.
- If child is seeking out one colour of peg tell them to use all colours.
- Raw score is total number of pegs placed in 90 seconds.






Using a visual-motor integration assessment to it's max potential – Other things to look for




- Pencil grasp
- Bilateral hand use (holding page)
- Posture while seated
- Attention to detail
- Self-monitoring
- Perseverance when challenged
- Calibration of movement (e.g. going slower for more intricate forms)
- Search / locate skills
- Ability to process multiple info on page
- Part-whole awareness
- Impulsivity



So Which One Should I Use?

All three will provide you a reliable, valid measure of visual-motor integration...

Beery	DTVP-3	WRAVMA
<ul style="list-style-type: none"> I need a quick screen specifically to assess VMI I have limited budget and need something I can easily transport. I want something that is "tried and true". Something that has been around a long time, has large norm samples and has been used extensively in research. 	<ul style="list-style-type: none"> I suspect the child has difficulties with visual perception that are impacting their visual-motor integration I've done the Beery and the child came out low on visual perception I've already done a comprehensive motor assessment so don't want to overlap on assessing 	<ul style="list-style-type: none"> I want something that will be quick but will still allow me to have a good screen for visual spatial and fine motor skills in addition to visual-motor integration I work with children who are difficult to engage or have limited attention and need something quick that is more stimulating/game-like



Thanks for your attention!

Any questions?



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