Minnesota Handwriting Assessment Overview

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Introduction

This document contains a brief overview of information regarding the Minnesota Handwriting Assessment (MHA) and its potential suitability for children with autism spectrum disorder (ASD). It is intended to provide clinicians working with school-aged children with relevant background information about the purpose, psychometric properties and considerations for using the measure with their clients.

Summary

Purpose	Discrimination and/or Evaluation
Type of Measure	Norm-referenced
Perspective	Assessor
Population	Grade 1 & 2 students: 6-8 years
ICF Component[21]	Activity
ICF Attribute(s)[21]	Learning & applying knowledge (write, problem solve)

Context	School or clinic
Time to Complete	5 min; 3-7 min to score
Equipment Needed	Test sheets, pencil, manual, stop-watch, ruler, red pen
Cost	$127.00

How was the literature review completed?

An electronic search was performed in March 2015 of the following databases: MEDLINE, CINAHL, ERIC and EMBASE. Keywords used in the search included: 'Minnesota Handwriting Assessment', 'Child* or student, Autism or Autistic Disorder' and 'validity or reliability or psychometric.'

What is the Minnesota Handwriting Assessment?

The Minnesota Handwriting Assessment (MHA) is a norm-referenced test for first and second graders that can identify students with handwriting difficulties (discriminate) as well as evaluate treatment effectiveness (measure change over time).[1]

The MHA assesses legibility and speed of handwriting in near point copying. Administration is timed, and begins after directions are provided to the student. Students copy a standard sentence that contains all the letters of the alphabet. The test is timed for the first 2.5 minutes to establish a **rate score**. Then, if necessary, students are given additional time to produce a complete sample to enable scoring of the five **quality score** categories: legibility, form, alignment, size and spacing.[1]

The MHA is a clinician-rated instrument intended for administration by occupational therapists (OTs) with training as described in the manual.[2] The MHA has a clear, easy-to-understand manual including a self-guided tutorial of multiple handwriting samples for scoring practice.

Total test time administration time is approximately 5 minutes. Children therefore do not need to miss significant class time for testing and this reasonably lends the test to repeat administrations. Space requirements can usually be met in a school or clinic setting with use of a quiet room, desk and chair of the appropriate height.

When scoring, very specific criteria for each of the 5 quality categories are provided in the manual and a clear ruler is provided for measuring, which provides consistent objective ratings.

The rate and five legibility scores are point scores. Grade one and grade two **performance levels** can be derived from these point scores. Students that score in the "Performing Like Peers" level would fall in the top 75% of the final sample. Those who perform in the "Somewhat Below Peers" level match those students whose performance was within the bottom 5% to 25% of the final sample. Students who fall in the "Well Below Peers" level perform like students whose scores were in the bottom 5% of the sample. The manual states that the "Somewhat Below Peers" level students should be monitored and the "Well Below Peers" level student should be referred for OT assessment and intervention.[2]

The quality scores can be useful in revealing the source of illegible handwriting. Remediation can then be focused on the appropriate areas of challenge. A low score in any quality category should be examined but Legibility and Form would be high priorities for remediation.[2] When interpreting the results, OTs must look at the complete picture of a student's handwriting abilities. Typical classroom samples should be reviewed as well as engaging in consultation with the teacher and others involved with the student.

Change in MHA Total/Composite Test Scores (i.e., a composite score is the sum of legibility, form, alignment, size and spacing and rate) has been evaluated in group-research designs to measure improvements resulting from intervention. [3-5]

How was the Minnesota Handwriting Assessment standardized?

The developer of the MHA provides normative data for comparison of a student's score on individual subscales with the scores of a large sample (n = 2186) of typically developing children in grades one and two (ages 6 – 8 years; 78-103 months).[2] The sample of students was from 11 US states. An effort was made to obtain an ethnically diverse sample by soliciting a mix of students from both urban and rural school districts across several states. However, the sample does not reflect the ethnic composition of students in the general population. Special education students, mainstreamed into the regular classroom were included (4% of the total sample). Diagnostic information for special education students was not provided. Sample by gender was on average 49% female and 51% male.

What are the measurement properties of the Minnesota Handwriting Assessment?

Reliability

Inter-rater and intra-rater reliability for total MHA scores are reported to be excellent.[1] Test-retest reliability was assessed in a sample of 99 grade 2 students with testing re-administered after 5-7 days and found to range from poor to adequate for total rate scores.[1] Adequate intraclass correlation coefficients of test-retest reliability were also reported (see Table 1 for all values).

Validity

Face Validity: The MHA has good face validity as a measure of handwriting difficulties and directly assesses manuscript handwriting.[6] The MHA produces results that one would expect (i.e., grade 2 students score higher than grade 1 students).

Content Validity: The MHA is relevant to the purpose of assessing handwriting difficulties and is comprehensive for evaluation of all areas of legibility in near point copying. The context and setting of the sample provide a good match for school-based therapists. All components of this test are meaningful for primary school-aged children as handwriting is an important life skill developed during the primary school years [7] and is an occupation that comprises much of their day.[8] Handwriting comprises the main method

that elementary students use to demonstrate knowledge in all academic areas [9]; thus, being able to adequately handwrite is both meaningful and valuable to students.

Construct Validity: The MHA represents the construct under study, i.e., handwriting.[2, 10, 11] Evidence exists to confirm that the MHA validly and consistently measures handwriting in relation to other similar measures.

Cornhill and Case-Smith [12] found strong to moderate correlations when the MHA was compared to standardised handwriting performance indicators, such as scores on the Developmental Test of Visual Motor Integration (VMI), and the Motor Accuracy Test (MAC) for eye–hand coordination.

Reisman [2] reported moderate to strong correlations (see Table 1) when the MHA was compared to a visual motor measure (Test of Visual Motor Skills) for first grade, special education and OT placement categories.

Falk, Tamb, Schellnus and Chau [13] reported that with use of an instrumented utensil and digitizing tablet to objectively measure handwriting using the MHA, quality parameters of grip force, temporal and tablet measures correlated strongly with MHA subscale scores. In a case control study that evaluated use of the MHA in children with autism spectrum disorder (ASD), Fuentes, Mostofsky and Bastian [14] reported that the children with ASD showed poorer handwriting quality and significantly lower scores on the MHA relative to typically developing, age-matched controls.

Criterion-Related Validity: No literature was found regarding a gold standard to use as a comparison instrument for assessing concurrent validity of the MHA, nor have any predictive validity studies been published.

Known-Groups Validity: Reisman's [15] study of 565 students, including both typical students and those in special education, found that the MHA was able to discriminate between good and poor handwriters as compared to teacher categorization. Cornhill and Case Smith [12] reported comparable findings, in that the MHA could almost perfectly discriminate between good and poor handwriters, as rated by their teachers, in the general grade one population (48/49 categorized appropriately).

Measuring Change (Interpreting single point scores): The standard error of measurement (SEM) for the MHA has not been reported and therefore is not available for interpreting single point scores.

Indices of Individual Change: No studies were located that reported the minimal detectable change (MDC) for the MHA, which is not surprising as the MDC is derived from the SEM. Minimal clinically important detectable change (MCID) or responsiveness findings are limited to one study. MacKay, McCluskey & Mayes [16] quantified the MCID of the MHA as the ability to detect a difference in printing legibility errors. They determined a clinically significant improvement in handwriting legibility as 10% or more change on the MHA (a 3.4-point within-group change). This result was derived from a power calculation, in which the authors used the standard deviation (4.0) from a previous study[17] that used the MHA. Mackay et al.'s [16] study results included an improvement of 15% in legibility, which was considered clinically worthwhile. Changes in secondary outcomes (letter form, alignment, size, and space) were also >10% and were considered to be clinically worthwhile after an 8-week intervention program. Caution is advised in using the above calculations, as it is difficult to be confident in stating whether a change is considered important if one does not know whether or not it is detectable, i.e., not having computed an MDC.

Floor and Ceiling Effects:

The MHA was used as an outcome measure in Howe, Roston, Sheu, & Hinojosa's [18] pretest-posttest study of 72 grade 1 and 2 students with minor handwriting difficulties who were assigned to two different

interventions. Because approximately two-thirds of the students completed the MHA speed test within the allotted 2.5 minutes post-intervention, this aspect of the test (speed) showed a ceiling effect making it impossible for the authors to determine which intervention was more effective for improving speed of handwriting.

What other considerations and precautions should be noted when using or planning to use the Minnesota Handwriting Assessment?

- Steps must be taken to ensure that measurement error is accounted for and that the circumstances of assessment are as standardised as possible.
- Application of the MHA for evaluative purposes would require the following changes to practice:
    - Take the average of multiple measurements to reduce error in clinical research, especially in light of the ICC values for test-retest reliability.
    - Conduct only initial and end-of-school year assessments to decrease burden of administration
    - Use the same setting (quiet and distraction-free) and time of day for repeat assessments
- Use written mid-year and year-end goals, which are concrete, observable, contextualized and set for a given time frame [19], to review progress, complement re-assessment findings and decrease burden of repeated administration of the MHA.
- Use a patient-reported outcome, such as the Canadian Occupational Performance Measure (COPM), [20] with either client ratings or parent/teacher ratings by proxy.
- When conveying results in a child's report, the term "*cautious interpretation"* should be used, especially in low incidence populations, as these populations were not part of the normative sample.

Risks and Benefits:

Risks

- MHA has not been normed on low incidence populations, such as children with ASD
- Ceiling effects for speed have been noted
- Test- retest reliability coefficients ranged from poor to adequate
- SEM has not been reported
- Minimal findings regarding indices of individual change
- Caution required in using and interpreting MCID values

Benefits

- Comprehensive, relevant, and meaningful assessment for students
- Inexpensive and quick tool to administer and score
- Some good evidence of valid and reliable use in primary-aged students including good match for grade, setting and context
- This evidence along with added measures listed above increases confidence in reporting both discriminative findings and change over time (evaluative findings)
- The MHA guides intervention with use of subscale findings (e.g., size of letter vs alignment on the lines)
- Quantification of improvement (in the form of a test score) is very motivating to both school staff and the child (similar to grades on a report card)

Summary

Overall the benefits of using the MHA outweigh the risks. The MHA, with *cautious interpretation*, is an appropriate measure for discriminative and evaluative use, in the primary-aged school population, for measuring the observable construct of handwriting (legibility and speed). For use with populations other

than those included in the normed sample, such as those with ASD, added caution in interpretation would be advised.

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A copy of this document is available at: www.childdevelopment.ca

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Table 1: Reliability Study Results

Author (year)	Type of Reliability	Statistic Used	Value	Rating (Excellent, Adequate or Poor)
Reisman, 1993[1]	Inter-rater	Pearson correlation coefficients	Between experienced scorers *r* = 0.90 - 0.99 Between inexperienced scorer and author *r* = 0.87 - 0.98	Excellent Excellent
Reisman, 1993[1]	Intra-rater	Pearson correlation coefficients	Rate *r* = 1.00 Five quality categories *r* = 0.96 - 0.99	Excellent
Reisman, 1993[1]	Test-retest	Pearson correlation coefficients	Total accuracy scores *r* = 0.72 Rate *r* = 0.50 for total rate scores	Poor - Adequate
Peterson, 1999[22] *	Test-retest	Intraclass correlation coefficients	Rate = 0.62 Five quality categories = 0.60 - .089	Adequate

Rating [23, 24]

Excellent	Greater than 0.80
Adequate	.60 to .79
Poor	Less than 0.60.

*Unpublished doctoral dissertation

Table 2: Validity Study Results

Author (year)	Type of Validity	Statistic Used		Value
Cornhill & Case-Smith, 1996[12]	Construct validity	Pearson correlation coefficients	MHA and VMI MHA and MAC	*r* = 0.61 *r* = 0.59
Reisman, 1999[2]	Construct validity	Pearson correlation coefficients	MHA and TVMS (First Grade) MHA and TVMS (Second Grade) MHA and TVMS (Special Ed) MHA and TVMS (OT)	*r* = 0.61 *r* = 0.37 *r* = 0.76 *r* = 0.89
Falk, Tamb, Schellnus & Chau, 2011[13]	Construct validity	Pearson correlation coefficients	MHA and tablet	*r* = 0.68-0 88 *r* = -0.66 -0.89