Short-term sensorimotor-based intervention for handwriting performance in elementary school children

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Handwriting

Handwriting is an academic skill that allows individuals to express their thoughts and feelings and communicate with others. It is a “brain-based skill, not merely a mechanical or motor skill(Richards 2011).

The skill of handwriting is also referred to as a “graphomotor” skill, including visual–perceptual, orthographic coding, motor planning and execution, kinesthetic feedback and visual–motor coordination.

Why hand writing is important?

Children spend 31–60% of their classroom time performing handwriting and other fine motor tasks- Difficulty in handwriting can therefore influence academic achievement, which in turn affects self-esteem

An estimate of 25–33% of students are struggling to achieve competency in this skill

Handwriting-forgotten skill

The traditional art of letter writing is declining

Psychologists and neuroscientists say it is far too soon to declare handwriting a relic of yesteryear (Medwell J 2008).

New evidence suggests that the links between handwriting and broader educational development run deep(Berninger 2009)

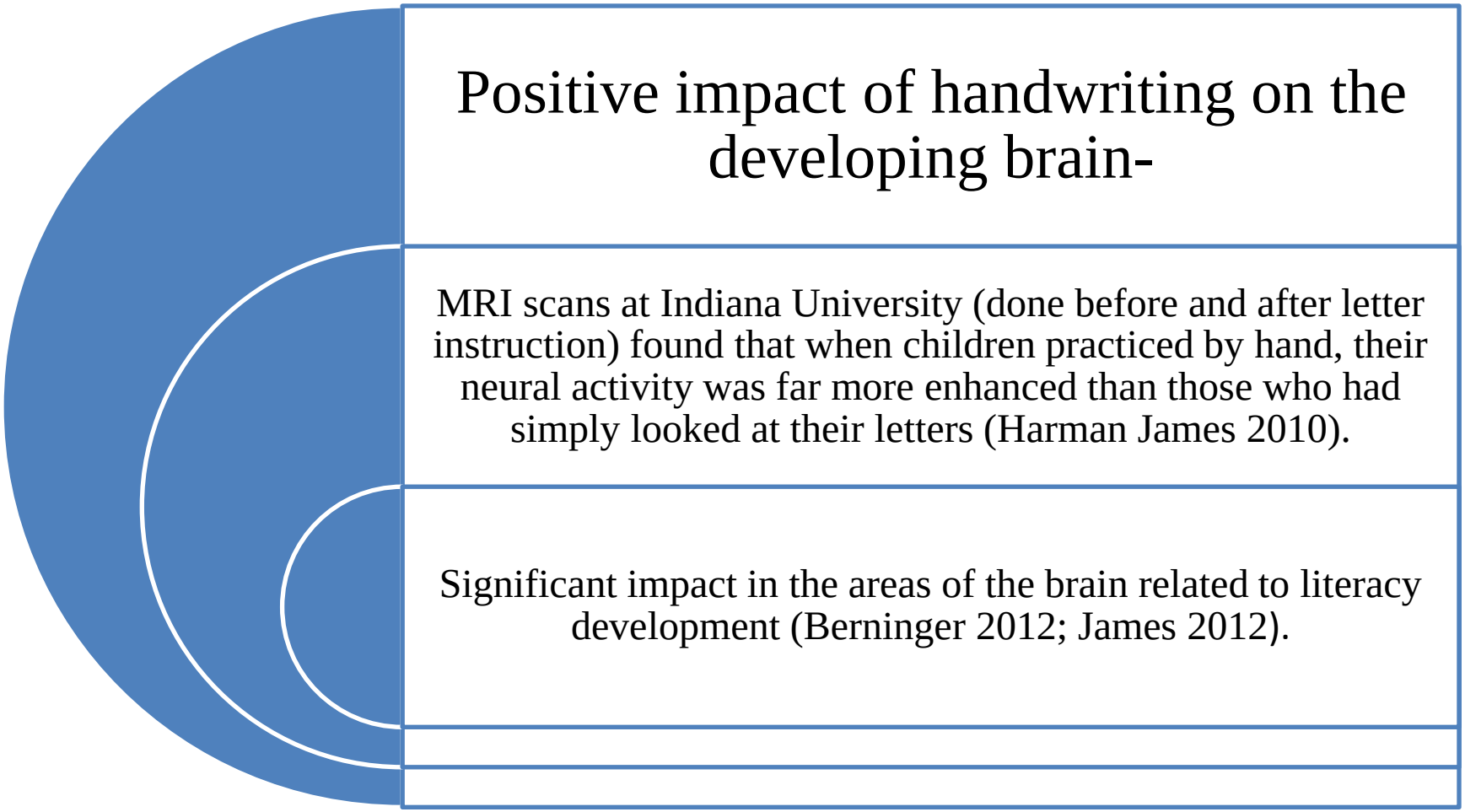
Developmental Sequence of Handwriting

Research states that learning how to write by hand is a necessary early motor exercise for other cognitive and physical skills.

It helps develop eye-hand coordination skills and boosts brain development(Saperstein Associates 2012; James and Gauthier 2006; James 2012; Berninger 2012).

Handwriting is a foundation skill that needs to be developed early as it affects students' reading, writing, language use, and critical thinking.

Handwriting and the Brain



Handwriting mastery builds Academic success in all Subjects

Children with writing disorders have a tendency towards

Lower mathematics achievement

Low verbal IQ

Increased attention difficulties and consistently achieve lower marks compared with peers.

Remediation of handwriting problems

It is common for elementary-school children with handwriting difficulties to receive remedial education from their teacher or be referred to occupational therapy for evaluation and intervention.

Purpose of the study

Identify students in school with poor handwriting

To evaluate the additive effects of sensorimotor intervention(SM) intervention on the child’s handwriting..

Research questions?

What are the possible effects of the intervention on specific qualities of handwriting (legibility, form, alignment, size, and spacing) and on speed

What would be the possible effect of training in teacher assessment using the Hand writing proficiency screening questionnaire(HPSQ) and grip strength

Methods

- ***Research design***: prospective, one-group, pretest–post-test experimental design
- ***Sample:*** Students in two first grade classes(British International School, Riyadh, Saudi Arabia) for whom English was their first language, but who had no identified educational need, were selected to participate in the study.
- Excluded from the study- direct intervention for handwriting problems prior to the study, and who missed more than two intervention sessions.

Screening and recruitment of children

Thirty-one(31) students (16 boys, 15 girls)- screened using the Minnesota Handwriting Assessment (MHA)

Twenty students(21) fulfilled the inclusion criteria for performing somewhat below peers or performing well below peers in at least two components of the MHA.

Thirteen(13) students- agreed to participate later two students left the school, and one student left the study before the actual intervention.

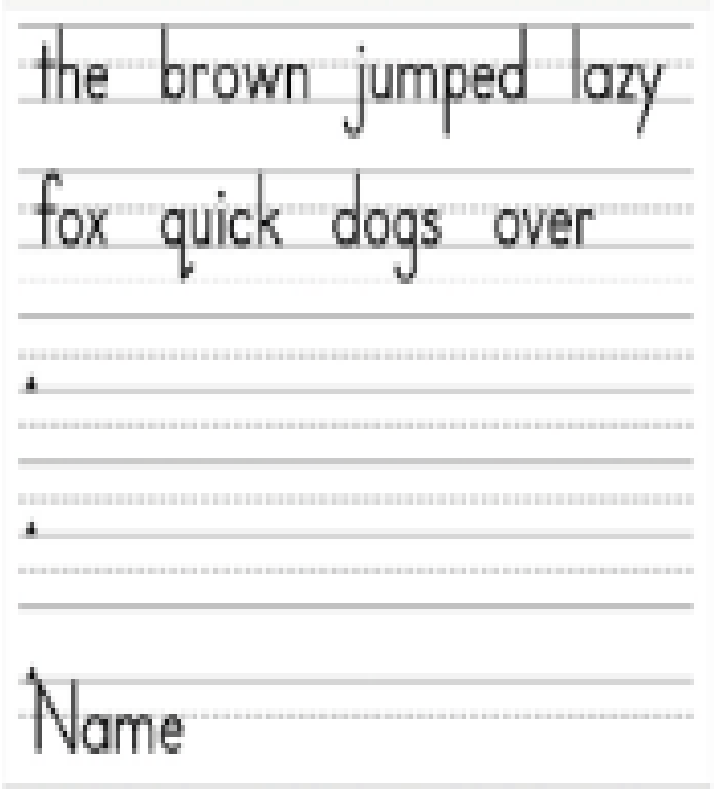
Finally, 10 students (seven boys, three girls) aged 6–8years (mean age, 77.1 ± 1.45 months) participated in the intervention program

Assessment tools and Instruments

Minnesota Handwriting Assessment(MHA)

- It was used both as a screening tool and an outcome measure
- The near-point copy assessment analyzes Rate, Legibility, Form, Alignment, Size, and Spacing.
- Performance is then judged and classified as:
  - ✓ performing like peers (upper 75th percentile);
  - ✓ performing below peers (bottom5–25th percentile);
  - ✓ performing well-below their peers(bottom 5th percentile).

Minnesota Handwriting Assessment(MHA)- Manuscript & D'Nealian style



The handwriting sample was scored based on specific directions for each category (legibility, form, alignment, size, and spacing) and rate.

Each category was scored based on the error rate with a maximum potential score of 34. Rate or speed was scored by counting the number of letters completed in 2.5 minutes

Handwriting Proficiency Screening Questionnaire (HPSQ)

- HPSQ was used to identify handwriting deficiency among school-aged children and is appropriate for varied academic and clinical purposes.
- Non-proficient handwriters were classified
  - ➢score ≥14- non-proficient hand writers
  - ➢score <14-proficient handwriters

Grip strength

- A calibrated hydraulic hand-held dynamometer (Jamar hand-held dynamometer), was used to measure isometric grip strength for both the dominant and non-dominant hand.

Procedure

- Baseline measures:

HPSQ, MHA and grip strength

The same group of students acted as their own controls

Pre and post intervention assessment was done.

- The Sensori motor (SM)-based intervention group- twice weekly for 5 weeks during school hours
- Each session lasted for 40 min;

    -10 min of gross and fine motor warm-up activities

    -followed by 30 min of SM component activities

Contd…

- Therapists were supplied with a toolbox of games, activity worksheets, equipment.
- Therapists and teachers were assigned to the stations

  To monitor students and provide specific feedback, support and instruction as needed. The students rotated through the stations in random order to perform the list of sensorimotor activities

Sensori motor intervention activities

- **Gross Motor Warm-up Activities (5 minutes)**
  - Do jumping jacks
  - Do crab walk
  - Perform pushups on floor
  - Chair push-ups
  - Seated student places hands on either side of chair next to thighs.
  - Straightens arms and lifts bottom off the chair
  - Balance on one leg with eyes closed
  - Walk toe-to-heel on a masking tape line on the floor

- **Fine Motor Warm-up Activities (5 minutes)**
  - Rub hands together
  - Squeeze tennis balls
  - Rub hands in circles on the carpet
  - Play with Wikki Stix
  - Build with small Lego blocks
  - String small beads
  - Roll clay between fingers
  - "Walk" fingers up and down the pencil

Visual Perception Activities

- **Activities included visual-closure; visual memory, figure ground and spatial relationships work sheets**
- **Visual perceptual workbook**
- **Visual perceptual games**
- **Give the child a drinking straw in one hand and a strand of uncooked spaghetti in the other. Tell the child to look straight ahead, as he brings his hands up in front of his face and slowly slides the spaghetti into the straw.**
- **Play balloon tennis, either with rackets or hands**
- **Blow some bubbles. Have the child chase and pop them**
- **Play concentration, where the child has to turn over cards and find matches**
- **Play "What's different?" Put 3 things on the table, have the child close his eyes, and then change one. Have the child tell you, which one is different. Use more objects as he gets more skilled**
- **Place a covered tray with a dozen or so objects on a table, let the child look at it for 30 seconds, cover the tray, and have the child write down or tell you everything that he remembers**
- **Nesting and stacking toys promote pattern recognition, which is critical for learning shapes of letters**
- **Mazes, dot to dot, and tracing activities**
- **Hide objects in an indoor sandbox: fill a large container full of beans, rice, packing pellets, etc. Hide little toys for the child to find.**

Visual-Motor Integration

- **Activities included:**
- **Drawing within a large space, such as on a wall chalkboard, dry erase board or easel, helps children learn about the movement involved in the shapes and strokes they are learning.**

- **Draw shapes within square boxes for using the attributes of a square as landmarks. For example, cut the box in half by drawing a vertical line through the middle of it, then a horizontal line to make a cross.**

- **Drawing diagonals is the most challenging to learn. Play games that involve diagonal relationships such as checkers, Chinese checkers, Tic-Tac-Toe or Connect Four, as examples.**

- **Make shapes with sticks (toothpicks, popsicle sticks, Wikki Stix, etc.) for child to trace beside**

- **Stringing beads: copy bead patterns or create repeating patterns**

- **Dress up dolls**

- **Bean bag toss: Make a circle on the floor and ask them to toss the bean bags into the circle. Gradually increase the distance**

- **Origami design**

Kinesthesia/Proprioception

Activities included:

- **Weight bearing**
- **Pushing heavy objects (boxes, chairs, benches etc.)**
- **Pulling (tug of war)**
- **Pressing different parts of hand into clay**
- **Pushing fingers into clay or therapy putty**
- **Pushing shapes out of perforated cardboard**
- **Tearing package or boxes open**
- **Playing clapping games**
- **Air writing**
- **Mystery writing etc**

In-Hand Manipulation

Activities included:

- **Making ball by crumpling paper**
- **Rolling and moving the clay/putty from fingers to palm/making balls**
- **Moving coins from coin box to palm**
- **Getting a coin of a change purse**
- **Hiding a penny in the hand (magic trick)**
- **Picking up and bringing a small piece of food into the palm**
- **Getting two or more coins out of a change purse, one at a time**
- **Taking two or more chips off a magnetic wand, one at a time**
- **Playing with marbles**

Results

Subject characteristics

Characteristic	Group
Mean age (months) (N=10)	77.1±1.45
Hand dominance	Right-8 Left- 2
Gender	Male-7 Female -3
Ethnicity	Arabic 8 British- 2

MHA scores for within-subjects factors (Manuscript)

Manuscript (n=10)	Time	M± SD	F	(p≤0. 05)
Rate	Baseline Pre-intervention Post-intervention	20 ±7.77 21.3±3.31 27.4±7.94	3.886	.080**
Legibility	Baseline Pre-intervention Post-intervention	21±8.52 26.5±7.42 33.7±0.68	22.965	.001*
Form	Baseline Pre-intervention Post-intervention	17.50±5.29 20.80±5.54 30.80±2.15	61.682	.000*
Alignment	Baseline Pre-intervention Post-intervention	5.80±6.85 18.00±4.85 30.90±4.31	72.610	.000*
Size	Baseline Pre-intervention Post-intervention	8.20±8.35 20.20±4.49 32.20±2.74	66.122	.000*
Spacing	Baseline Pre-intervention Post-intervention	20.50±8.18 23.00±5.85 30.90±3.57	13.183	.005*

MHA scores for within-subjects factors (D'Nealian)

Manuscript (n=10)	Time	M± SD	F	(p≤0. 05)
Rate	Baseline Pre-intervention Post-intervention	20.60±6.68 25.0±7.71 33.6±1.27	31.954	.000*
Legibility	Baseline Pre-intervention Post-intervention	26.7±5.58 27.0±6.18 33.8±0.42	15.281	.004*
Form	Baseline Pre-intervention Post-intervention	22.00±5.01 23.20±4.98 30.60±1.65	25.175	.001*
Alignment	Baseline Pre-intervention Post-intervention	8.60±7.98 20.00±8.69 29.80±4.94	58.827	.000*
Size	Baseline Pre-intervention Post-intervention	11.30±8.76 22.20±9.17 32.40±1.51	57.168	.000*
Spacing	Baseline Pre-intervention Post-intervention	25.50±6.67 25.70±5.36 31.00±1.76	8.288	.018*

Post intervention changes in MHA for Manuscript & D'Nealian style

Manuscript (n=10)	t	(p≤0. 05)
Rate	-2.141	.061**
Legibility	-2.951	.016*
Form	-5.752	.000*
Alignment	-8.310	.000*
Size	-10.757	.000*
Spacing	-4.570	.001*
D'Nealian (n=10)		
Rate	-3.459	.007**
Legibility	-3.374	.008*
Form	-3.805	.004*
Alignment	-4.889	.001*
Size	-10.757	.000*
Spacing	-2.994	.015*

Paired Samples Test (HPSQ) and Grip strength

Characteristics	Pre	Post	(p≤0. 05)
HPSQ			
Legibility domain	5.80±3.58	2.90±2.52	.020*
Time performance	6.00±3.24	4.00±2.49	.019*
Physical & emotion wellbeing	8.50±6.02	3.10±2.81	.012*
Total	19.90±9.66	10.00±6.47	.002*
Grip strength			
DOM_GRIP	17.50±5.89	20.50±5.51	.024*
NDOM_GRIP	14.00±6.99	18.00±4.22	.022*

Discussion

- The results of the study showed that short-term training had beneficial effects on MHA scores of rate, legibility, form, alignment, size and spacing in both the manuscript and D'Nealian scripts.
- The teacher perception of student handwriting assessed by Handwriting proficiency screening questionnaire (HPSQ) showed a significant difference in all the domains, i.e., Legibility, performance time, physical and emotional components after the intervention.
- Apart from the sensorimotor approaches, the additional findings observed such as paper position, writing surfaces, grip strength, and posture were considered.
- Limitations: convenience sample and size of sample is small, and design is quasi experimental.

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