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Effects of Training for In-Hand Manipulation on Legibility of Urdu Handwriting

Hafiz Tahir Jameel[1]

Tanzila Nabeel[2]

Muhammad Yaseen[3]

Abstract

This research studied the effectiveness of training of In-Hand Manipulation on typically developing children to study the improvement in Urdu handwriting legibility of students of grade 4 and 5. Thirty nine participants with poor handwriting were taken from the general education schools. Pretest-Posttest Two Group Design was used in the study. Nineteen participants of experimental group were given training for the improvement of In-Hand Manipulation and 20 students from control group performed only routine school activities with no extra treatment. The results showed that overall legibility of experimental group was improved significantly as compared to control group ($t = 5.49$, $p < 0.05$). Overall readability (from -0.6 to 0.5), use of margin (from 0.5 to 0.8), shape of words (from 0.5 to 0.7), were improved components of legibility in experimental group. This study may be taken as a first step in the development of a tool for assessment of Urdu legibility in school setting.

***Keywords**:* Assessment, In-Hand manipulation, legibility, Urdu handwriting

[1] Ph. D Scholar, AIOU, Islamabad. hafiz_physio@yahoo.com

[2] Associate Professor, AIOU, Islamabad. tanzilanabeel@gmail.com

[3] Assistant Professor, University of Agriculture, Faisalabad. myaseen208@gmail.com

Introduction

Most of the school work of children is Writing. Written work is a potential tool for the mastering performance of comprehending the syllabus. As the content of courses, children spend 30-60 % of their time in handwriting and related activities (Bumin & Kavak, 2008; McHale & Cermak, 1992). In typically developing children, handwriting is developed from grade one to five. Improvement process of handwriting continues throughout the life of the elementary school. In 1st grade handwriting develops typically, in 2nd grade it develops slowly and in grade 3rd it develops relatively faster and become reflexive (Karlsdottir & Stefansson, 2002). Although, it is influenced by number of environmental and biological factors (Feder & Majnemer, 2007) including age, intellectual capacities, instructional strategies, practice and many more.

School professionals adopted different sensory motor, cognitive, therapeutic and psychological approaches to assess the handwriting problems and provided comprehensive plans to overcome these problems (Rosenblum, 2008). Teachers are involved in development of instructional strategies for the improvement of handwriting. Modeling, guidance and cognitive strategies instruction may be involved with this training. Therapists are involved in assessment of sensory, motor or cognitive problem of children. They provide inclusive plans to deal with these problems (Cheung, 2007). Effectiveness of any intervention applied to improve handwriting depends upon nature, duration and methodology of the study conducted by the experts (Howe, Roston, Sheu, & Hinojosa, 2013).

In-hand Manipulation (IHM) is an important sensory motor component of handwriting (Denton, Cope, & Moser, 2006). It is the handling of an object after grasping in hand. It is the ability of one hand to move and adjust an object within it without using the other. IHM comprises of three skilled movements related to handwriting 1) translation (transfer of an item from palm to fingers and fingers to palm) i.e. picking of a pencil in fingers and grip it in palm, 2) shifting (movement of a utensil on fingertips in a linear mode) i.e. movement of fingertips from eraser to tip of pencil and 3) rotation (turning of object around an axis using finger pads) i.e. rotation of a pencil around an axis (Exner, 1989). Manual Dexterity (skillful use of hand) is related to development of handwriting and its speed (Bumin & Kavak, 2008; Weintraub & Graham, 2000). IHM is seen as an important component of

complex handwriting activity (Brossard-Racine, Majnemer, Shevell, Snider, & Bélanger, 2011). Development of IHM skills is considered essential for handwriting development (Cornhill & Case-Smith, 1996; Kaiser, Albaret, & Doudin, 2009).

Most of researches were conducted with atypical and English speaking children in developing countries. Unfortunately, there is no research work documented to assess handwriting capabilities of school going children in Urdu language. Even typically developing children were less studied although they come across many problems during development of these skills (Overvelde & Hulstijn, 2011). In lack of guidance, 10-30% of typical children showed poor handwriting performance in their whole academic life (Karlsdottir & Stefansson, 2002). It was assumed for this study that typically developing children may go through delayed of the developmental skills which impacts on development. This study may help to measure the effects of IHM on handwriting of primary school children. It may help the teachers to have knowledge of beneficial exercises and activities for handwriting improvement of students. Class teachers may find new avenues in the form of exercises to enhance handwriting abilities of students. This may be positive addition in regular and special handwriting classes of students. It may provide a direction to therapist to help the children with poor IHM and Urdu legibility.

Main purpose of this study was to observe the effects of improvement of IHM on Urdu legibility. This study intended to achieve following objectives: 1) to explore the effects of training for the IHM on translation, rotation and shift capacities of typically developing children and 2) To identify components of handwriting legibility, influenced by IHM training of children studying at elementary level.

Methodology

Pre-test post-test design was functioned for two groups in this experimental study. One was experimental and the other was control group.

Participants: 40 participants were selected by convenient sampling. To keep the uniformity in the entire sample, three experienced elementary school teachers were requested to select the students with poor handwriting from 4^{th} and 5^{th} grade of five selected schools of general education system of the district. Poor letter formation, roundness, slant, spacing and size of the words were recommended parameters for

the study. Teachers selected the students by using similar parameters in previous researches (Case-Smith, 2002; Tseng & Murray, 1994). It was ensured by parents and teachers that the students did not have any medical, educational or cognitive issue. Students with any extra medical or educational need were excluded. Purpose, procedure and design of study were briefed to students and their parents. After their consent, a session was arranged with selected participants to develop their rapport with the research team. The students were randomly allotted to experimental and control groups. Each participant was requested to pick a card from a box with cards mentioned with group 1 and group 2. Those having the cards of group 1 were assigned to experimental group while students with the brand of group 2 would be allocated into control group. One student from experimental group did not continue study due to illness. Finally, 39 students completed the study. Experimental group had 19 students, including 7 girls and 12 boys, with 9 to 13 years of age ($M = 11.05$, $SD = 1.51$). While control group contained 20 participants, including 12 girls and 8 boys, with 9 to 13 years of age ($M = 10.90$, $SD = 1.52$). To keep the study in its natural flow, the researcher did not make conscious attempt to balance both groups by gender, as done in a similar research previously (Denton et al., 2006).

Instruments: Handwriting and IHM were assessed as explained under:

Measurement of In-Hand Manipulation: Three components (translation, rotation and shift) of IHM were measured with help of 9-Hole Peg apparatus. Child was asked to sit in the chair in front of a table. A pegboard board was placed in front of the child. The child was asked to put small pegs in the pegboard one by one by using translation, rotation and shift patterns. This was repeated with all 9 pegs twice. Time was noted and score were awarded according to the prescribed criteria. Student's score was matched with standardized scores of that age group.

Evaluation of Handwriting: Students were asked to copy an Urdu paragraph of 160-170 words. This paragraph has enough length to check the legibility of handwriting. Handwriting of children was evaluated on the basis of speed and legibility. Global legibility (overall readability of handwriting) was measured for presenting research. It is an appropriate method to assess functional handwriting of children in classroom site (Sudsawad, Trombly, Henderson, & Tickle-Degnen, 2001). The parameters of legibility of handwriting were identified from the literature reviews, consulting with occupational therapists, senior teachers of

elementary level and psychologists. A questionnaire was used to evaluate legibility of Urdu handwriting on the basis of indicators of good and bad handwriting. 11 basic indicators including overall readability (Readability), use of appropriate margins (Margin), similarity among writing (Similarity), use of lines (Line), use of space (Space), size of words (Size), shapes of words (Shape), roundness of words (Roundness), slant of words (Slant), alignment of words (Alignment), recognition of words (Recognition). Questionnaire assessed Urdu legibility on 5-Point Likert scale. 1 score was awarded to poor and 5 to excellent legibility. Evaluation of handwriting legibility was accomplished independent experienced raters of handwriting. Uniformity in evaluation was assured by reassessment. Raters were unaware about participants of experiment and control group. Reliability of instrument was established by Cronbach's alpha for pre intervention 0.77 and post intervention 0.87.

Intervention: The intervention consisted on the activities to improve the IHM. It was provided for 45 minutes per day for 5 days a week for 3 weeks to 19 participants of experimental group only. Total 15 sessions were provided. The strategies consisted of activities and exercises were conducted individually and in groups. Intervention covered the three parameters of IHM.

Treatment Plan 1: It was designed to enhance translation ability of students. Some interactive activities were i) Picking a small coin by fingertips (hide it in the palm) and bring a coin from palm to finger tips, ii) Beat the drum with fingers and palm in a rhythmic manner, iii) Place many coins in palm and put them in the money box, iv) Hold several beads in palm and bead them into a wire (Buckner, 2012), v) Roll and spread blanket (Razi, 2011).

Treatment Plan 2: It was planned to improve rotation capability. Few of them were i) Open and close lids of bottles, ii) Flip a coin with all fingers, iii) Turn dices and see all directions, iv) Rotate pencil within fingertips through 180^0 and twist a top (Razi, 2011).

Treatment Plan 3: It was scheduled to increase shifting skills of hands. Following were some of the activities, i) Flip a pencil from eraser to the top, ii) Pulling a toy attached with other end of string, iii) Ask the children to hide whole sting in the palm iv) Removing stickers (Weichman, 2012).

Data Analysis: After treatment of three weeks, IHM and handwriting assessment was conducted again. Statistical Package of Social Sciences (SPSS) 16 and R 3.2.0 were used for data analysis. Independent and paired sample t test for overall difference on translation, rotation and shift and legibility and speed of handwriting were used.

Principal Component Analysis (PCA) and Path diagram were conceded for explanation of role of individual components on Urdu legibility.

Results

To see the effects of training on components of IHM (translation, rotation and shift) a standardized tool 9-Peg Hole was used. Legibility was measured by using researcher's made questionnaire on 5-Ponit Likert scale. And speed of Urdu handwriting was measured by total number of words/minute. To see the pre-experimental abilities of the participants, independent sample t-test was applied on pre-test scores of translation, rotation, shift abilities and legibility handwriting of the typically developing children. No significance difference was there between two groups before treatment (Table 1).

Table 1
Comparison of Pre-Experimental Scores IHM and Handwriting

	Mean (Standard Deviation)		t value
	Experimental	Control	
Translation	37.21 (4.92)	37.20 (5.81)	0.01
Rotation	37.42 (4.78)	38.20 (7.79)	-0.37
Shift	5.21 (1.08)	5.45 (1.43)	-0.59
Legibility	32.47 (1.74)	32.00 (3.37)	0.55

Note: df = 37, $p > 0.05$

It displayed that children had almost similar characteristics before application of intervention.

To see the effects of training, pre and post experimental score were compared by using independent sample t-test in experimental and control group (Table 2)

Table 2
Comparison of Pre and Post-Experimental Scores IHM and Handwriting

	Mean (Standard Deviation)		t value	r
	Experimental	Control		
Translation	29.58 (0.90)	34.60 (1.17)	-3.38	0.49
Rotation	30.26 (0.88)	36.96 (1.47)	-3.85	0.45
Shift	5.20 (0.32)	4.00 (0.26)	-2.87	
Legibility	41.00 (0.88)	34.45 (0.81)	5.49	0.67

Note: df = 37, $p < 0.05$

There was a significant difference in the experimental group (M = 29.58, SE = 0.90) than control group (M = 34.60, SE = 1.17) with t = -3.38 and good effect size = 0.49 for translation. There was a significant decrease in the performance score of the experimental group (M = 30.26, SE = 0.88) than control group (M = 36.96, SE = 1.47) with t = -3.85 and good effect size = 0.45 for rotation component. There was a significant less time in the performance score of the experimental group (M=5.20, SE=0.32) than control group (M = 4.00, SE = 0.26) with t = -2.87 for shift. There was a significant improvement in the legibility score of the experimental group (M = 41.00, SE = 0.88) than control group (M = 34.45, SE = 0.81) with t = 5.46 and good effect size = 0.67 of Urdu handwriting.

Effects of training on individual components were by seeing by correlation matrix of Urdu legibility components of both groups (Table 3).

Table 3
Correlation Matrix for Experimental (E) and Control (C) Group

		Read	Margin	Similar	Line	Space	Size	Shape	Round	Slant	Align
Margin	E	0.22									
	C	0.20									
Similar	E	0.12	-0.05								
	C	0.16	0.24								
Line	E	0.42	0.27	0.15							
	C	-0.27	-0.05	0.36							
Space	E	0.41	0.07	0.33	0.32						
	C	0.27	0.22	0.23	0.40						
Size	E	0.32	-0.01	-0.03	0.20	0.57					
	C	-0.29	-0.17	-0.18	0.52	0.00					
Shape	E	0.44	0.51	0.08	0.35	0.36	0.37				
	C	0.14	0.17	0.06	0.07	0.00	-0.11				
Round	E	0.02	-0.18	0.15	-0.46	-0.25	-0.25	0.16			
	C	0.10	0.07	-0.01	0.02	0.23	-0.18	-0.06			
Slant	E	0.31	0.21	0.16	0.16	0.13	0.13	0.32	-0.27		
	C	0.05	0.35	0.12	0.32	0.44	0.00	0.11	0.29		
Align	E	0.24	0.40	0.14	0.09	0.12	0.12	0.38	0.09	0.17	
	C	0.16	0.03	0.12	-0.12	0.23	0.06	0.06	0.21	-0.08	
Recog	E	0.22	0.01	0.15	-0.01	0.34	0.34	0.17	0.13	0.33	0.33
	C	0.14	0.10	-0.10	0.02	0.00	0.08	0.44	0.16	-0.16	0.57

Note: C = Control group, E = Experimental group, Recog = Recognition

In addition PCA with varimax rotation in comparison of experimental and control group was functioned separately on 11 items of Urdu handwriting legibility and 3 factors were extracted on conceptual basis. 58% of total variance in experimental group and 54% in the control group was explained by the 3 factors were supporting the conceptual approach for the formation of 3 factor for this study (Table 4).

Table 4
Components of Legibility by Principal Component Analysis with Varimax Rotation

	Experimental Group			Control Group		
	1	2	3	1	2	3
Readability	0.46	0.26	0.46	0.28	-0.58	0.22
Margin	-0.18	0.22	0.79	0.53	-0.32	0.06
Similarity	0.33	-0.05	0.10	0.52	-0.01	0.07
Line	0.16	0.75	0.29	0.48	0.80	0.07
Space	0.73	0.39	0.08	0.77	0.08	0.11
Size	0.84	0.11	0.01	-0.09	0.84	-0.11
Shape	0.33	0.07	0.75	0.09	-0.03	-0.01
Roundness	0.14	-0.87	0.07	0.37	-0.19	0.53
Slant	0.20	0.26	0.42	0.76	0.07	0.18
Alignment	0.12	-0.22	0.73	0.10	-0.13	0.75
Recognition	0.76	0.21	0.15	-0.08	0.05	0.93
SS Loading	2.38	1.77	2.23	2.21	1.84	1.85
Proportion	0.22	0.16	0.20	0.20	0.17	0.17

A path diagram was made to see the causation of the individual components of the legibility in Figure 1.

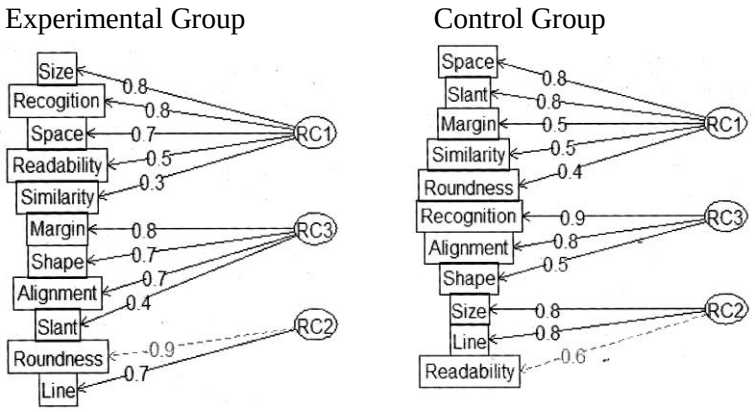

Figure 1: Path Diagram of Urdu Legibility Components of Experimental and Control Group

It exposed increase in causation of readability from -0.6 to 0.5, use of appropriate margins 0.5 to 0.8, shape of words 0.5 to 0.7 as a result of training provided for the improvement of IHM.

Discussion

This study was deliberated to see the effects of IHM training on Urdu legibility and its components. It was reported that the therapists used apposite patterns to enhance the IHM. They implemented motor and behavioral techniques to ensure truthfulness in the exercise patterns and encouraged the students to perform activities in a competitive environment. Any variation in the post-experimental scores may be considered a result of intervention in the absence of any extraneous variable due to similarity in groups before intervention.

Effects of Intervention on IHM Ability of Children: Pretest and post test score (paired sample t-test) of the experimental group also indicated similar results with rotation component improved very much with good effects size (r = 0.82) suggesting that the training was very effective for the improvement of translation, rotation and shift. Previous studies reported similar improvement in IHM of children (Volman, van Schendel, & Jongmans, 2006; Weintraub & Graham, 2000) facing difficulties in motor coordination and/or handwriting difficulties. So this study endorsed the similar pattern in typically developing children. This improvement revealed efficacy of treatment given to students for the improvement of IHM. Translation, rotation and shift showed almost similar improvement when compared with control group.

Effects of Intervention on legibility of Urdu Handwriting: Result of post experimental assessment indicated that students of experimental group displayed significant improvement in overall legibility scores. Similar results are reported in a previous study, in which student's functional handwriting were significantly improved as a reflection of training provided for improvement IHM (Case-Smith, 2002). 11 components were considered as constituents of legibility for Urdu and 3 conceptual factors were developed. Increase of total variance from control (54%) to experimental (58%) group may strengthen the conceptual pattern of 3 factors for this study (Table 3 & 4). It was revealed that improvement of use of readability, appropriate margins, and shapes of words in Urdu handwriting of children as a result of IHM training provided to students (Figure 1). It was suggested in a previous

research that due to its dynamic grasp pattern, IHM is believed to contribute in small letter formation and results appeared in the form of improvement of legibility (Cornhill & Case-Smith, 1996).

Conclusion

The training was useful for the improvement of translation, rotation, shift, legibility and Speed of Urdu handwriting. Readability, use of appropriate margins and shapes of the words of Urdu handwriting were seen related with IHM training. This study is significant to practice the improvement Urdu handwriting of typically developing children in the general education system.

References

Brossard-Racine, M., Majnemer, A., Shevell, M., Snider, L., & Bélanger, S. A. (2011). Handwriting capacity in children newly diagnosed with attention deficit hyperactivity disorder. *Research in Developmental Disabilities, 32*(6), 2927-2934.

Buckner, M. K. (2012). Therapy Street for Kids. Retrieved from http://therapystreetforkids.com/aboutus.html

Bumin, G., & Kavak, S. T. (2008). An investigation of the factors affecting handwriting performance in children with hemiplegic cerebral palsy. *Disability & Rehabilitation, 30*(18), 1374-1385.

Case-Smith, J. (2002). Effectiveness of school-based occupational therapy intervention on handwriting. *American Journal of Occupational Therapy, 56*(1), 17-25.

Cheung, W.-s. C. (2007). *Factors affecting the Chinese handwriting performance of children in Hong Kong.* The Hong Kong Polytechnic University.

Cornhill, H., & Case-Smith, J. (1996). Factors that relate to good and poor handwriting. *American Journal of Occupational Therapy, 50*(9), 732-739.

Denton, P. L., Cope, S., & Moser, C. (2006). The effects of sensorimotor-based intervention versus therapeutic practice on improving handwriting performance in 6-to 11-year-old children. *American Journal of Occupational Therapy, 60*(1), 16-27.

Exner, C. (1989). Development of hand functions. *Occupational Therapy for Cchildren*, 235-259.

Feder, K. P., & Majnemer, A. (2007). Handwriting development, competency, and intervention. *Developmental Medicine & Child Neurology, 49*(4), 312-317.

Howe, T.-H., Roston, K. L., Sheu, C.-F., & Hinojosa, J. (2013). Assessing handwriting intervention effectiveness in elementary

school students: A two-group controlled study. *American Journal of Occupational Therapy, 67*(1), 19-26.

Kaiser, M.-L., Albaret, J.-M., & Doudin, P.-A. (2009). Relationship between visual-motor integration, eye-hand coordination, and quality of handwriting. *Journal of Occupational Therapy, Schools, & Early Intervention, 2*(2), 87-95.

Karlsdottir, R., & Stefansson, T. (2002). Problems in developing functional handwriting (monograph supplement 1-V94). *Perceptual and Motor Skills, 94*(2), 623-662.

McHale, K., & Cermak, S. A. (1992). Fine motor activities in elementary school: Preliminary findings and provisional implications for children with fine motor problems. *American Journal of Occupational Therapy, 46*(10), 898-903.

Overvelde, A., & Hulstijn, W. (2011). Handwriting development in grade 2 and grade 3 primary school children with normal, at risk, or dysgraphic characteristics. *Research in Developmental Ddisabilities, 32*(2), 540-548.

Razi, S. A. (2011). *Exercises for Practical life: Elementary Exercises Module 2*. Karachi, Pakistan: Montessori Pakistan.

Rosenblum, S. (2008). Development, reliability, and validity of the Handwriting Proficiency Screening Questionnaire (HPSQ). *American Journal of Occupational Therapy, 62*(3), 298-307.

Sudsawad, P., Trombly, C. A., Henderson, A., & Tickle-Degnen, L. (2001). The relationship between the Evaluation Tool of Children's Handwriting and teachers' perceptions of handwriting legibility. *American Journal of Occupational Therapy, 55*(5), 518-523.

Tseng, M. H., & Murray, E. A. (1994). Differences in perceptual-motor measures in children with good and poor handwriting. *OTJR: Occupation, Participation and Health, 14*(1), 19-36.

Volman, M., van Schendel, B. M., & Jongmans, M. J. (2006). Handwriting difficulties in primary school children: A search for

underlying mechanisms. *American Journal of Occupational Therapy, 60*(4), 451-460.

Weichman, L. (2012). In-Hand Manipulation Skills: Why they are? Retrieved from http://nspt4kids.com/parenting/in-hand-manipulation-skills-what-are-they/

Weintraub, N., & Graham, S. (2000). The contribution of gender, orthographic, finger function, and visual-motor processes to the prediction of handwriting status. *OTJR: Occupation, Participation and Health, 20*(2), 121-140.

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