

PATHWAYS CENTER  
FINAL STATISTICAL ANALYSIS

Interactive Metronome, Inc.

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**Introduction**

Below is the final analysis of Pathways Center data sent to Interactive Metronome. The data was obtained from 13 clients of Pathways Center.

The study design was a pre-post one-group design. Three pre-tests were performed for each subject to assess pre IM training capacities followed by IM training and then followed by three assessments: an immediate posttest and then reassessment at three and six months. This design allows for the assessment of immediate changes due to IM training and then an assessment of how long the IM training impact remains at the three and six month periods.

Since the design does not include a comparison group receiving no training, the ability to assess whether observed changes in the IM group are specifically due to IM training, maturation changes or other factors is a limitation of this design.

A total of eight instruments were administered by Pathways' staff, including the following:

1. CLEF-3: Clinical Evaluation of Language Fundamentals, Third Edition.
2. Bruininks-Oseretsky Test of Motor Proficiency.
3. Sensory Profile – Care Giver Questionnaire.
4. Interactive Metronome Parent Questionnaire.
5. Self Perception Survey.
6. Handwriting Evaluation Tool.
7. The Listening Test

## 8. Draw A Person.

### **Results of Analysis**

Attached to this report are relevant statistics used to assess the results of IM training. To determine whether statistically significant changes occurred between the pretest and the three post testing periods, paired-samples t-tests were conducted for each of the subtests within each instrument. P values of 0.05 or lower were used as a rejection criterion for all t-test comparisons. The table presents the means for each of the four assessment periods. The pre-test mean was computed using the means of three pretest assessments (Test 1, Test 2 and Test 3). This established a pre-IM training base performance level for each subtest. The Posttest (Test 4) was given immediately after completing IM training while the 3-month (Test 5) and 6-month (Test 6) were given at three-month intervals.

The table also presents the paired differences standard error and the t-test p values for each comparison of the pretest mean with each of the three-posttest assessments. These statistics establish the level of statistical effects produced over the study duration.

#### *Clinical Evaluation of Language Fundamentals (CLEF-3)*

CLEF-3 assesses the relationships among semantics, syntax/morphology, and pragmatics (form, content and use) and the interrelated domains of receptive and expressive language. It is authored by Eleanor Semel, Ed. E., Elizabeth H. Wiig, Ph.D. and Wayne A. Secord, published by The Psychological Corporation and is a nationally normed test.

The Concepts and Directions and the Word Classes subtests of the CLEF were administered. Inspections of the table shows little significant IM training impact. Though the Concepts and Directions subtest showed a statistically significant difference between the pretest mean and the 3-month mean ( $p = .040$ ) as did the Word Classes between the pretest and 6-month means ( $p = .028$ ), there is

little consistency in IM influences over the span of the study. IM training apparently did not have affect on these two language fundamentals. For both subtests, the means increase over the four assessment periods but more likely reflect normal maturation affects.

### *Bruininks-Oseretsky Test of Motor Proficiency (B-O)*

The Bruinicks – Oseretsky Test is an individually administered test assessing the motor functioning of children from 4.5 to 14 years of age. It is comprised of eight subtests and provides a comprehensive index of motor proficiency as well as providing separate measures of both gross and fine motor skills. It is published by the American Guidance Service and is a nationally normed test.

For this study, five subtests of the B-O were used: Balance, Bilateral Coordination, Upper-Limb Coordination, Response Speed and Upper-Limb Speed and Dexterity. Two of these five subtests produced significant differences. The Balance subtest produced p values of .037, .023 and .004 when comparing the pretest mean of 17.27 to the means of the three posttest periods. Similarly, the Bilateral Coordination subtest showed pre vs. posttest statistically significant differences with p values of .027, .046 and .001. This suggests that IM training produced immediate posttest effects and that these effects remained during the ensuing 3 and 6-month periods. For both subtests, the 6-month means continued to improve, perhaps reflecting a continued improvement due to the IM training and/or reflecting normal maturation not related to IM affects.

The performance improvements in Balance and Bilateral Coordination are consistent with the numerous IM training exercises which emphasize these two subtest skills; however, Upper-Limb Coordination and Speed and Dexterity are not emphasized in IM training exercises. The Response Speed subtest measures quick reaction times to a falling stimulus whereas IM training emphasizes long term repetitive and consistent estimation of a timing interval, not the ability to quickly respond to a stimulus. Thus, it is not surprising that these three subtests show no IM affects.

## *Sensory Profile – Care Giver Questionnaire*

This instrument asks a caregiver of the client (usually a parent) to assess the subject's performance on 23 subscales (See table). It is a normed instrument developed by Winnie Dunn, Ph.D. and published by the Psychological Corporation. These subscales are divided into four general categories: Sensory Processing, Modulation, Behavior and Emotional Responses and Factor Clusters.

Ten subscales showed similar statistically significant patterns of increase over the pre-post assessment periods. These subscales included:

- \* Sensory Processing
  1. Auditory Processing.
  2. Touch Processing.
  3. Multisensory Processing.
  
- \* Behavior and Emotional Responses
  4. Behavior Outcomes.
  
- \* Modulation
  5. Endurance/Tone.
  6. Body Position and Movement.
  
- \* Factor Clusters
  7. Low endurance.
  8. Inattention/Distractibility.
  9. Poor Registration.
  10. Sensory Sensitivity.

For all ten subscales, the general pattern shows the pretest means compared to the immediate posttest means to be statistically significantly different, showing an increase in performance. These performance increases are maintained after 3-months. At 6-months, all ten subscales show increases in performance above the 3-month means. These increases could be either IM affects and/or normal maturation. See the table to inspect the means and p values for each subscale.

The improvement in the sensory processing category suggests that IM training is perceived by caregivers as lowering subject sensitivity and distractibility to auditory and touch stimuli and improving their capacity to integrate multiple sensory inputs into more coherent patterns. The Behavior Outcomes subtest of the Behavioral and Emotional Responses category suggests IM training may have improved subject capacities to be more self directed and efficient and more tolerant of environmental changes and disruptions. The two modulation subtests of Endurance/Tone and Body Position and Movement point to possible IM training affects improving physical strength/endurance, capacity to physically move and coordinate body movements while reducing accident proneness and improving physical balance and stability. The four Factor Clusters reinforce the improvement in Endurance (Low Endurance), and in capacity for Registration and improved Sensory Sensitivity. Of great interest are the perceived improvements in Inattention/Distractibility, improvements duplicated by earlier IM research with ADHD boys.

Two additional subscales from the Sensory Processing and Modulation categories show possible IM affects: Vestibular Processing and Visual Input Affecting Emotional Responses and Activity Levels. Both subscales produced significant but gradual increases in mean performance from pretests through the 6-month assessments. This points to improved balance, stability and spatial orientation and/or less seeking of exaggerated movement experiences and improvements in appropriate eye contact with other people. This suggests IM training may be having a gradual affect; however, normal maturation affects could also produce similar performance increases.

Four subscales did not show any statistically significant improvements from the pretest through the immediate posttest and 3-month assessments; however, significant 6-month increases were observed. It is difficult to say whether these 6-month improvements are IM affects or maturation affects; however, maturation is the more likely explanation.

### *Parent Questionnaire for Interactive Metronome*

This questionnaire consists of 17 scales based upon a four point Likert Scale ranging from very easy, easy, difficult and very difficult. Parents were instructed to rate their child on each of these scales by checking the appropriate scale point. The questionnaire was developed by Pathways Center personnel and is not normed. The seventeen scales included:

- Ability to Concentrate
- Ability to Pay Attention
- Ability to Transition Between Tasks
- Ability to Follow Multi-step Directions
- Ability to Calm Self
- Handwriting
- Idea Fluency - Spoken
- Idea Fluency - Written
- Memory
- Athletic Ability - Running
- Athletic Ability - Ride Bike
- Athletic Ability - Swim
- Athletic Ability - Dribble a Ball
- Musical Ability Play Instrument with Appropriate Timing
- Ability to Play Video Games
- Social Interactions - Children/Peers
- Social Interaction - Adults

Of the 17 scales, five produced evidence of the positive impact of IM training. Ability to concentrate shows statistically significant differences between an initial mean of 2.11 compared to the posttest and the 3 and 6 month retests with p values of .067 (slightly higher above the 0.05 criterion rejection p value), .001 and .016. The ability to pay attention scale had similar significant differences for all three posttest periods showing significant p values of .015, .006 and .006 with a pretest mean of 2.13. The profiles for each of these scales show significant increases immediately after IM training followed by continued maintenance of these increases over the three and six month periods.

Three scales revealed possible IM training affects - ability to transition between tasks, idea fluency – spoken and idea fluency - written. The ability to transition between tasks shows a non-significant increase from a pretest of 2.62 to 2.91 at the immediate posttest (p value of .378, though only 11 subjects were present in this test compared to 13 subjects for the other two posttests). The 3 and 6 month posttests found significantly different means at p values of .046 and .027 possible suggesting IM training took longer to impact on task transition capacities; however, maturation affects might also explain this increase.

The idea fluency – spoken scale had both immediate posttest and 6-month test p values of .034 and .012 while the 3-month test was not significantly different (p value of .162). This suggests IM training had an immediate positive impact on written idea fluency but its long-term impact is less clearly established. A related scale, idea fluency – written showed a non significant difference (p value of .365) between the pretest mean of 1.77 and the immediate posttest mean of 2.00; however the 3-month posttest showed a significant p value of .037 while the 6-month test reached near significance at a p value of .079. This suggests IM training may possibly have improved written fluency, however, the evidence is less substantial. These two scales of idea and written fluency, though showing less clear impact, may suggest IM training can positively impact the cognitive and motor capacities underlying these two abilities. These findings of improved fluency are similar to the findings of improved reading and math fluency in the Flanagan High School Study.

### *Self Perception Profile*

This is a 36-item questionnaire that asks children to select between polar opposite descriptions of children's behaviors and feelings. The profile was developed by Susan Harter, Ph.D. of the University of Denver and is not normed.

Answers to these items are reported out in the six scales below:

Scholastic Competence

Social Acceptance  
Athletic Competence  
Physical Appearance  
Behavioral Conduct  
Global Self Worth

None of the six scales were found to show any significant patterns of improvement when comparing pretest means to the three-post test periods. This suggests that the subjects did not perceive any differences in their self-perception over the course of the study or that the Self Perception Profile was not sensitive to such changes.

### *Evaluation Tool of Children's Handwriting (ETCH)*

ETCH is an assessment of handwriting skills in six areas. It is a criterion-referenced tool designed to evaluate the handwriting skills of children in Grades 1 through 6. It was constructed by Susie Amundson, Ph.D. and published by O.T. Kids, Inc. For this study these areas were assessed:

1. Alphabet Writing - Lower Case and Upper Case Letters.
2. Near-Point Copying
3. Dictation

There is some evidence that IM training may influence on selected handwriting skills. Lower case legibility percentages showed statistically significant improvement when comparing the pretest mean of 83.00% to the immediate and 3-month posttests (p values of 0.008 and 0.013). At six months this improvement declined to a mean of 88.70 (p value of .084, just above the criterion p value of 0.05).

There is also the possibility that IM training may have resulted in delayed handwriting improvement for Upper Case Letter Legibility Percentage, Near Point Copying Speed and Dictation for Letter/Numeral Legibility percent. Upper Case Legibility Percentage showed gradual but non-significant increases in performance through the first two pretests, reaching a significant difference at the 6-month posttesting (mean of 87.83, p value of .002). Near Point Copying

Speed reached significant differences with the initial pretest mean of 37.58 letters per minute at the 3-month and 6-month post tests reaching p values of 0.031 and .000. Similarly, Dictation for Letter/Numerical Legibility Percent reached a significant difference by the 3-month posttest and just missed reaching significance at the 6-month posttest. The writing improvement shown by these three measures might also be influenced by maturation processes as well as by IM training – it is not possible to determine which might be operative. The remaining five subtest measures showed no significant patterns of writing improvement.

### *The Listening Test*

The Listening Test evaluates children's (ages 6 to 11) abilities to listen and attend to a variety of classroom language tasks. Results reveal strength and weaknesses in these listening areas: main idea, details, concepts, reasoning, and story comprehension. For this study, only the concepts and reasoning subtests were administered. The Listening Test is authored by Mark Bartrett, et. al., and is published by LinguiSystems.

Both concepts and reasoning subtests showed statistically significant improvements between the pretests and the three posttest periods. The concept pretest of 10.41 compared to three posttests means had p values of .003, .001, and .003 respectively. Even stronger significant differences were found for the reasoning pretest mean of 9.10 compared to the three posttest means with p values of .001, .001, .000 respectively.

These results strongly support the possibility that IM training may have influenced the underlying cognitive processes necessary for effective concept development and reasoning.

### *Draw A Person Test (DAP)*

The DAP asks the subject to draw three figures: a man, a woman and him/her self. Each figure is then scored using a 14-item checklist that quantifies the subject's performance producing raw scores, which are

transformed into standard scores derived from a standardized population. The test is authored by Jack Naglieri and published by the Psychological Corporation.

Analysis found no significant evidence of drawing improvement patterns for any of the three figures or for the drawing total score that combines the results of the three individual drawings. Thus, there is no evidence that IM training affected the subjects' capacity for drawing.

### **Summary**

There is little evidence that IM training had any significant impact on the Language Fundamentals subtests. However, two of the Bruininks-Oseretsky Motor Proficiency subtests did suggest IM training might have influenced significant performance improvements for Balance and Bilateral Coordination.

Caregiver evaluation of subject improvement found ten subscales of the Sensory Profile with significantly improved performances. These performance levels were maintained over a 6 month period. Two subtests also showed gradual increases in performance over the pretest and three posttest periods; however, it is not possible to know if these increases are due to IM affects and/or normal maturation.

Additionally, The Parent Questionnaire for Interactive Metronome found two scales for which parents indicated significant positive impact of IM training: ability to concentrate and ability to pay attention. IM training may also have positively impacted subject behaviors including the ability to transition between tasks and spoken and written idea fluency. IM trainees did not reflect any changes in their self-perception over the course of the research.

There is also some indication that IM training assisted in improving handwriting skills, specifically improved letter legibility, copying speed and taking simple dictation. Of particular interest is the strong significant improvement found for auditory processing related to concepts formation and reasoning tasks. The improvements in handwriting and auditory processing of concepts and reasoning tasks

suggests IM training has a significant positive impact upon underlying cognitive and executive processes related to the performance of these behaviors.

Of particular interest is the concurrence of performance improvements between the objective measures of Balance and Bilateral Coordination of the Bruininks-Oseretsky Motor Proficiency Test and the caregiver perceptions of improvements in both Sensory Profile and the Parent Questionnaire for the Interactive Metronome subtests. Caregivers report and the objective measurements affirm subject improvements in balance and physical coordination. This suggest that underlying sensory integration, attention, and ability for concentration may have improved, leading to better capacity to plan and sequence actions which in turn lead to improved environmental interactions in the physical, emotional/social and cognitive domains.

A singular contribution of this study is the 6-month follow-up of subjects. The results help to confirm that IM training has not only immediate positive affect but also can maintain these affects at least over a six-month period. This was especially true for balance, bilateral coordination, parental assessments of sensory processing, self-direction, and attentional abilities and objective measures of handwriting, concept development and reasoning abilities.

The above results supports the hypothesis that IM training has impact upon balance, physical coordination, attention, concentration, motor planning and sequencing and the more complex cognitive capacities of planning, sequencing; concept formation and reasoning. Results further confirm other IM practitioner reports and previous formal IM studies. Though the design does not allow for experimental control group comparisons, it does add additional weight to previously confirmed IM affects and tentatively supports the permanence of some of these positive changes