

Arrowsmith Program Research Summary 2017



Arrowsmith Program
245 St. Clair Avenue West
Toronto, Ontario M4V 1R3

research@brainex.org
www.arrowsmithschool.org

ARROWSMITH PROGRAM – RESEARCH SUMMARY 2017

Over the last three decades the Arrowsmith Program has implemented an independent and ongoing series of evidence-based research initiatives. There have been multiple independent studies, by different researchers, in different schools, using different research frameworks which have all shown the same results - that the Arrowsmith Program is effective for students with learning difficulties. This research has included various levels of research design including both independent research and peer-reviewed research. Three types of educational research have been applied to analyzing the Arrowsmith Program including descriptive research (e.g., case study and survey), associational (e.g., correlational and causal - comparative), and intervention research (which investigates the impact of an intervention on individuals or groups).

This evidence-based research has used a variety of research designs, different measures, both educational and cognitive, and studied students in different schools implementing the Arrowsmith Program. Data collection methods include interview, neuroimaging, standardized academic and cognitive assessments, behavioural assessment and self-reporting. Outcomes have been measured in terms of academic results, rate of learning, cognitive results, and changes in the brain.

These studies have been undertaken by a variety of institutions around the world by respected researchers. This document outlines both the completed research, including highlights of findings and outcomes, and details of current research projects.

CHRONOLOGY OF PAST RESEARCH:

1. August 15, 1997 Correlates of a Test of Motor Symbol Sequencing Performance

Barbara A. Young, M.A. & Donald F. Burrill, Ph.D. *Professor Emeritus, Ontario Institute for Studies in Education, University of Toronto* Poster Session – 105th APA Annual Convention, Chicago, August 15, 1997

This research paper investigated the relationship between a test developed to measure the rate of learning a repeated sequence of symbols as an automatic motor pattern and standardized tests of writing and copying.

Findings: Performance on the motor symbol sequencing test, for the control group alone, and the control group combined with the learning disabled group, correlated significantly with standardized tests of copying and handwriting.

This preliminary evidence suggests that a test of learning a motor symbol sequence, developed by Arrowsmith Program, discriminates between a group identified as learning disabled and a control group. Further research is needed to see if this test could be used to identify individuals at risk of having difficulty with the motor act of the writing process.

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2. June 1998 Results from first year of St. Patrick Catholic Secondary School and Arrowsmith Program Pilot Project

Study undertaken by staff from the Toronto Catholic District School Board (TCDSB) and Arrowsmith Program on data collected by TCDSB teachers

A pilot project undertaken in co-operation with St. Patrick Catholic Secondary School in the Toronto Catholic District School Board. The purpose of the study was to provide evidence-base for the efficacy of the Arrowsmith Program in improving academic performance for a group of grade 9 and 10 learning disabled students in a public secondary school.

The report summarizes the averaged quantitative improvements seen in 19 students working on 4 cognitive areas over a 7-month period.

Findings: After 7 months of cognitive intervention, the average change in course work performance for Arrowsmith students from term 1 to term 2 was a gain of 11% and performance on standardized tests of reading comprehension, reading speed, word recognition, vocabulary, verbal reasoning, visual memory and written language improved. Parents and students reported noticeable improvements in the students' concentration, focus, listening and organizational skills, time management, self-esteem and self-expression. Based on the positive findings, the TCDSB continued to offer the Arrowsmith Program to high school students and expanded the program to implementation at the elementary school level.

3. 1999-2007 Changes Observed on Cognitive Scores of Arrowsmith Program Students

Prepared by Howard Eaton, Ed.M.

Changes on Standardized Cognitive Measures of students in the Arrowsmith Program observed at Eaton Arrowsmith School or by Eaton Learning Centre

Findings: Students demonstrated significant gains after time spent in the Arrowsmith Program on standardized measures that are directly related to learning skills, cognitive functioning and academic outcomes such as: cognitive efficiency, working memory, visual motor integration, visual perceptual functioning, auditory processing for speech sounds, semantic knowledge, and achievement skills.

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4. July 2000 Evaluation of the Implementation of the Arrowsmith Program in the Toronto Catholic District School Board (TCDSB)

Study undertaken by researchers from the Toronto Catholic District School Board and Toronto Hospital for Sick Children.

A three month study comparing 15 students in the Arrowsmith Program within the TCDSB to a group of TCDSB students using Autoskill's Academy of Reading Program. The study measures for the Autoskill's group were administered pre and post intervention whereas the Arrowsmith Program students had been in the program for several months so a true pre-intervention baseline could not be established.

Findings: The results of this brief evaluation project indicate that both Arrowsmith and AutoSkill programs produced statistically significant gains in specific academic skills over the three and one-half month period of the project.

Parent and student questionnaire responses demonstrated, that for the students in the Arrowsmith Program, this program was seen to be of benefit to the students on academic and cognitive domains in the current elementary and secondary programs as well as those students who had been in the secondary program the previous year (completed at St. Patrick in June 1999).

5. August 7, 2000 Treatment Outcome for a Motor Symbol Sequencing Dysfunction

Barbara A. Young, M.A. & Donald F. Burrill, Ph.D. *Professor Emeritus, Ontario Institute for Studies in Education, University of Toronto* Poster Session – 105th APA Annual Convention, Chicago, August 15, 1997

Study investigated the relationship between a program designed to train automatic written motor symbol sequences for a group of 12 learning disabled individuals having difficulty with the writing process and outcome measures on a test developed to measure the rate of learning a repeated sequence of symbols as an automatic motor pattern and standardized tests of writing and copying.

Findings: Significant positive changes were found from pre-to-post-treatment testing on all measures. The study concludes: "...for individuals identified as having certain specific difficulties with the writing process, the treatment program described in this paper significantly improved subjects' performance on tests of learning a symbol sequence, clerical speed and accuracy, handwriting, and copying."

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6. School year ending 2002-2003 Arrowsmith Program Evaluation Report Completed for the Vancouver School Board (VSB)

Study undertaken by Dr. Linda Siegel, Professor of Educational and Counselling Psychology and Special Education at the University of British Columbia.

Ten students were selected by the Vancouver School Board (VSB) at an Elementary School for the Arrowsmith Program experimental group and a comparison group of seven students in an Extended Learning Assistance Class (ELAC) in the VSB. The focus of the ELAC group was on improving reading and writing skills.

Findings: In 2013, an independent re-analysis of data was done by Dr. Darren Irwin of UBC and Dr. William J. Lancee of the University of Toronto. This re-analysis found only two significant results. On both the Comprehension and Spelling tests, the Arrowsmith group had significantly higher gains than the ELAC group (Comprehension; $P = 0.002$; Spelling: $P = 0.012$).

7. January 22, 2003 Report on the Toronto Catholic District School Board (TCDSB) Study of the Arrowsmith Program for Learning Disabilities

Study undertaken by Dr. William J. Lancee, Ph.D., Head of Research in the Department of Psychiatry at Mount Sinai Hospital and Associate Professor, Department of Psychiatry, University of Toronto.

A one-year research study comparing students identified as learning disabled enrolled in the Arrowsmith Program (AP) with learning disabled students in a traditional special education program that was conducted over the 2001/2002 school year in the Toronto Catholic District School Board. A study comparing outcome measures of 30 grade 2 to grade 7 students enrolled in the Arrowsmith Program from 4 schools in the Toronto Catholic District School Board (TCDSB) to 10 students in a traditional special education classroom in the TCDSB for students with learning disabilities.

Findings: The study strongly supported the Arrowsmith Program (AP) as instrumental in changing the developmental course of the majority of children with learning disabilities (LD) in this sample.

In only 12 months, almost one third of the AP students were on a course that brought them closer to their peers. Another 27% improved their performance at the same rate as expected from their non-LD peers, that is, they stayed at the same distance but did not fall further behind. All other AP students (43%) improved at least somewhat on the various achievement tests. None of the 10 students in the comparison group progressed substantially beyond their entry status.

The students in AP over the course of the year made significant gains on standardized measures of reading comprehension, word recognition, word attack, word comprehension, arithmetic, and spelling as compared to the students in the traditional special education program.

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8. November 24, 2004 TCDSB Learning Disabilities Program Review

Study undertaken by The Special Education Advisory Committee of the Toronto Catholic District School Board.

The Program review included the Arrowsmith Program, the Hospital for Sick Children Learning Disabilities Research Program, self-contained special education classroom and resource/withdrawal or integration in the regular class with modifications and/or accommodations.

With respect to the Arrowsmith Program, the report concluded:

“The Arrowsmith program has had a statistically significant impact on most processing measures and one reading measure. Effect size analyses indicate that gains were achieved on the Processing Speed measure on the WJ Pair Cancellation measure. Gains were also achieved on three of the phonological measures. On most measures, students maintained relative standing with their peers.”

Thirty-five students (11 female and 24 male) in the Arrowsmith Program in the TCDSB from grades 3 to 6 in the Arrowsmith Program were tested by TCDSB staff.

Findings: Significant gains were found on the following measures:

WISC (fourth edition)

- Processing Speed Index
- Working Memory Index

Comprehensive Test of Phonological Processing:

- Phonological Memory Composite Score
- Rapid Naming Composite Score
- Alternate Rapid Naming Composite Score

Woodcock Johnson (WJ-111)

- WJ Pair Cancellation Raw Score

9. November 20, 2005 Report on an Outcome Evaluation of the Arrowsmith Program for Treating Learning Disabled Students

Study undertaken by Dr. William J. Lancee, Ph.D. Head of Research in the Department of Psychiatry at Mount Sinai Hospital and Associate Professor, Department of Psychiatry, University of Toronto.

A three-year outcome study of 79 children with learning disabilities conducted at Arrowsmith School funded by the Canadian Donner Foundation.

A number of standardized measures were used such as achievement tests and tests of mental ability as well as measures of learning capacity and changes in rates of learning.

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Findings: The amount and rate of improvement were not dependent on ~~other~~ baseline characteristics such as age, gender or IQ and were slightly related to intake severity level. All deficit areas identified by the Arrowsmith Program improved as a result of the application of Arrowsmith cognitive exercises. A specificity of effect was found suggesting that the cognitive exercise could be directly linked to academic performance improvement, for example improvement on the cognitive functions related to quantification and reasoning were strongly correlated with improvements on a standardized test of arithmetic whereas improvement on the cognitive function related to visual symbol memory strongly correlated with improvements on standardized tests of word recognition, spelling, word attack and visual letter memory. The pattern of correlations found supported the AP theoretical frameworks of the role of specific cognitive functions underlying specific academic skill learning.

10. January 25, 2007 Report on the effectiveness of the Arrowsmith Program in the Toronto Catholic District School Board (TCDSB)

Study undertaken by Arrowsmith Program at the request of the Director of Special Education of the Toronto Catholic School Board using data collected by TCDSB teachers and supervised by Dr. William J. Lancee, Ph.D. Head of Research in the Department of Psychiatry at Mount Sinai Hospital and Associate Professor, Department of Psychiatry, University of Toronto

A follow-up study tracking progress of students in the Arrowsmith Program in the TCDSB on standardized achievement measures and on the amount of resource support needed pre and post Arrowsmith Program. Data on standardized achievement measures was available for 120 students in this study.

The purpose of the research was to study the effectiveness of the Arrowsmith Program in the TCDSB. The study included reports from parents, teachers and students of specific observable cognitive and academic gains, resource support and on the success of TCDSB Arrowsmith students in high school and post-secondary programs.

Findings: An increase in the rate of learning on academic skills by between 1.5 to 3 times the rates they were learning prior to the Arrowsmith Program (word recognition – 3 times faster, arithmetic – 1.5 to 2 times faster, reading comprehension – 2 to 3 times faster and reading speed – 2 to 3 times faster)

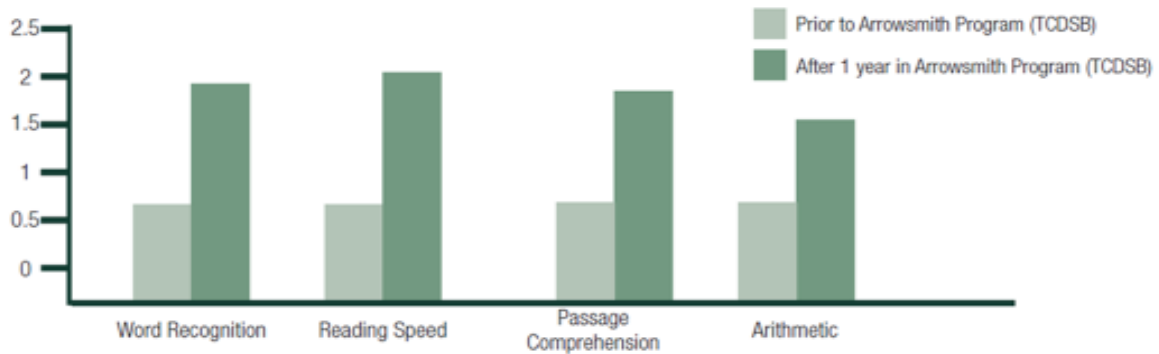
Specific changes were also noted in cognitive functioning in the areas of: visual memory; auditory memory; logical reasoning; non-verbal problem solving; concentration and focus; number sense; thinking and problem solving; conceptual understanding; and comprehension.

A significant reduction in the amount of resource support required during and after Arrowsmith Program intervention.

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Cognitive Enhancement: Impact on Rate of Learning

Average Grade Gain per Year to Arrowsmith and at End of One Year of Arrowsmith Program in the Toronto Catholic District School Board (TCDSB)



Note: Rate of learning accelerates after one year of Arrowsmith Program Cognitive exercises 60 students grades 1 to 9 (majority of students in grades 4 to 8)
Report on the Arrowsmith Program in the Toronto Catholic District School Board, 2007

11. November 2013 A Case Study of The Learning Disabilities Association Of Saskatchewan (LDAS) Arrowsmith Program

Principal Investigator: Debra Kemp-Koo PhD Candidate, University of Saskatoon, Saskatchewan

Case Study research was conducted to investigate how participation in the Learning Disabilities Association of Saskatchewan (LDAS) Arrowsmith Program affected the cognitive, academic, emotional, and interpersonal functioning of five students who attended this program for two to three years.

Findings:

Participation in the LDAS Arrowsmith program was an overall positive experience for four of the five students and their parents included in this case study research.

All of the students who participated in the research after participation in the Arrowsmith Program had significantly:

- Higher cognitive functioning/processing in at least one broad area measured by standardized tests
- Improved in some aspect of memory (working memory and/or long term retrieval).

Most of the students after participation in the Arrowsmith Program had significantly:

- Higher cognitive processing scores in many areas
- Improved in areas such as memory, focus, decision making, and comprehension
- Improved in at least one standardized achievement test result, the most common being writing and academic fluency

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All four of the students who had returned to regular schools were taking academic programming at a higher level than they were previously.

Social Emotional:

- All but one of the students increased in self-confidence and happiness after participation in the LDAS Arrowsmith program.
- Some of the students became less emotionally reactive, better decision makers, more self-reliant

The Arrowsmith Program was of benefit on cognitive, academic and social emotional measures for 4 of the 5 students studied. The one student who did not report the same benefits from the Arrowsmith Program had emotional stress levels above the optimal level for learning and development. This factor appeared to be the main reason she had less success in the program.

12. June, 2014 Effects of the Arrowsmith Program on Academic Performance: A Pilot Study

Institution: University of Calgary, Brain Gain Lab

Researchers: Hanna A. Kubas, Jessica A. Carmichael, Kim R. Fitzer, James B. Hale

A study presented at a poster session at the Canadian Psychological Convention, Vancouver June 2014

Findings: Following Arrowsmith Program intervention, all academic scores (broad reading, comprehension, mathematics, writing, spelling, and receptive language) improved significantly and were in the average range except math fluency. Strengthening cognitive neuropsychological functions presumed to underlie academic achievement deficits improves reading, mathematics, and writing by targeting the cause (i.e., cognitive deficit) rather than the symptoms (i.e., achievement deficits).

13. August, 2014 A Brain-Based Intervention Program That Changes Cognition: Implications for Academic Achievement

Institution: University of Calgary, Brain Gain Lab

Researchers: Kim R. Fitzer, Hanna A. Kubas, Jessica A. Carmichael, Howard Eaton, James B. Hale

A study presented at a poster session at the American Psychological Convention, Washington D.C. August 2014.

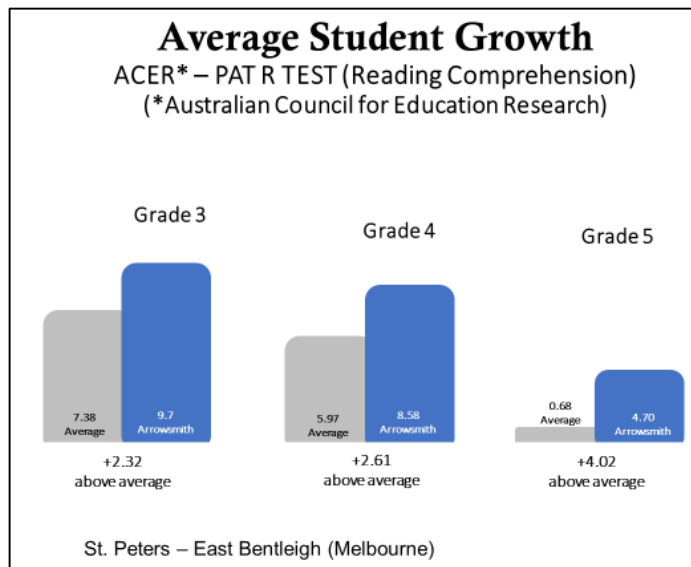
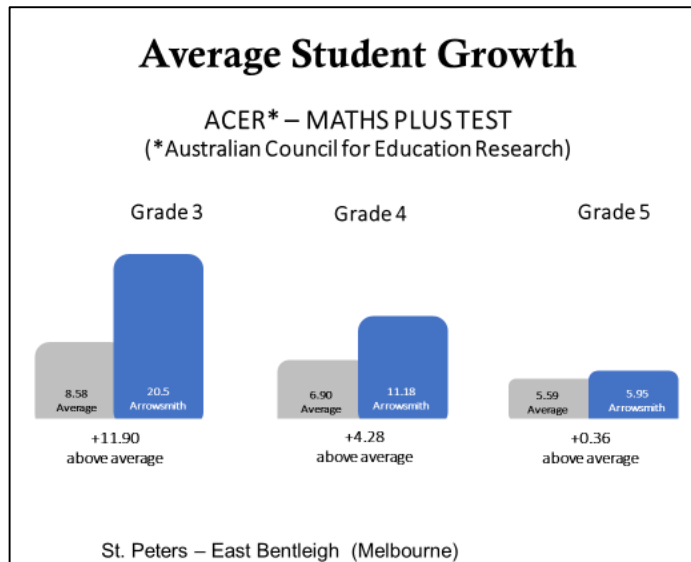
Findings: Following Arrowsmith Program intervention improvements were found on the following cognitive domains: Auditory Processing; Fluid Reasoning; Processing Speed; Short-Term Memory; Phonemic Awareness; and Working Memory.

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14. 2015 Comparison study of growth rate of students in Grades 3, 4 and 5 on standardised academic measures

Study undertaken by Holy Trinity Parish schools, East Bentleigh, Melbourne, Australia.

All students in Grades 3, 4 and 5 completed the ACER Pat Maths and Reading Comprehension assessments. The growth rate of Arrowsmith Program (AP) students in those grades was compared to their peers. Results showed that the growth rate of AP students was higher than their peers on both measures.



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15. December 2016 Motor Symbol Sequencing Whole Cohort Study

Study undertaken by a primary school in Australia.

A study comparing results across four Grade One classes.

- Students per class: 18 to 22
- 3 classes: traditional handwriting program
- 1 class: 30 minutes/day doing the Arrowsmith exercise for learning motor plans necessary for writing

Assessment Tool: Wold Sentence Copy Test - a standardized visual motor test used as a predictor of academic performance

Findings:

Student Results	Arrowsmith Class		Gifted Class		Academic Class 1		Academic Class 2	
Average Growth (letters per minute)	21		17		13		9	
	Pre Test	Post Test	Pre Test	Post Test	Pre Test	Post Test	Pre Test	Post Test
No. students at or above grade level	2	19	6	14	7	9	1	9
Change:		+17		+8		+2		+8

The students receiving 30 minutes per day of a cognitive program designed to improve motor planning involved in reading and writing showed significantly greater improvement on a measure of writing than students receiving traditional academic curriculum in grade 1.

At Risk Readers

- 5 students identified at risk for reading problems in kindergarten; Reading Recovery program recommended for Grade 1
- All 5 students placed in Arrowsmith class in Grade 1
- 10 weeks in the program, all 5 students reading at proficient level and no longer recommended as needing Reading Recovery program

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16. August 4 2017 Changes In Brain-Behavior Relationships Following A 3-Month Pilot Cognitive Intervention Program For Adults With Traumatic Brain Injury

Institution: University of British Columbia, Faculty of Medicine

Researchers: S. Porter, I.J. Torres, W. Panenka, Z. Rajwani, D. Fawcett, A. Hyder, N. Virji-Babul

Published in: Heliyon

Findings:

“Our results provide preliminary evidence that participating in an intensive cognitive intervention program was associated with neuroplastic changes in adults with chronic TBI that occurred in parallel with improvements in cognition. Overall, we observed a shift from a baseline pattern of network organization that may be characterized by neural inefficiency and decreased cognition to a reorganization that reflected improved efficiency with possible improvements in fluid cognition. Importantly this data suggests that brain network organization is capable of reorganization even in chronic patients with intense intervention. Further work with a larger sample is clearly needed to understand the nuances of how brain organization impacts on cognitive ability and performance.”

ARROWSMITH PROGRAM: Current research

Research Studies Currently Underway

1) **Structural Brain Change, Behavioural And Achievement** “Does the Arrowsmith “intervention” affect brain structure and function?”

Institution: University of British Columbia: Faculty of Medicine, Brain Behaviour Laboratory

Principal Investigator: Dr. Lara Boyd

Commenced: 2014

Research process and structure:

Brain scans of fifty-four Arrowsmith pupils as compared to two control groups—one comprising individuals without learning disabilities and the other a group with learning disabilities (LD) who are receiving traditional special education support.

The study includes children ages 12-19, and was designed with three subject groups: 1) Students with LD participating in the Arrowsmith Program; 2) Public school students without LD; 3) Public school students with LD in traditional special education programs. There are 95 participants in the study with approximately half in subject group 1 and half split between the two control groups.

Progress:

Data for four time-points has been collected:

Time-point 1 - prior to intervention;

Time-point 2 - after 3 months of intervention;

Time point 3 - after 10 months of intervention;

Time-point 4 - after 20 months of intervention.

The research team’s goal is to publish several papers on their findings.

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Some findings at end of year one:

- Significantly increased activation in the executive control network
- Changes were noted in brain regions related to numeracy, abstract thinking, and sensory integration
- Some brain areas became *less* active in the Arrowsmith group compared to the learning-disabled control group, and in this case the change suggested a more efficient brain
- Arrowsmith group made significant gains in standardized cognitive and achievement testing when compared to the learning-disabled control group at the end of one academic year.

2) Longitudinal Study Looking At Brain Change Structural And Functional Imaging, As Well As Behavioural And Achievement Changes Through Cognitive And Academic Testing

Institution: Southern Illinois University

Principal Investigator: Dr. Greg Rose - Director, Center for Integrated Research in Cognitive & Neural Sciences

Commenced: 2014

Recruitment for this study remains active as the data collection and analysis is ongoing.

Research process and structure:

The research Dr. Greg Rose is conducting on the Arrowsmith Program is a longitudinal study looking at brain change through structural and functional imaging, as well as behavioural and achievement changes through cognitive and academic testing. Multiple forms of imaging are being used in the study, including structural MRI, and functional MRI.

The study involves 40 participants enrolled at Brehm Preparatory Academy, which specializes in working with students with learning difficulties. The participants, aged 12-19, were split across two subject groups: 1) Students with learning disabilities (LD) participating in the Arrowsmith Program; 2) Students with LD not participating in the Arrowsmith Program.

Progress

Some findings at end of year one:

- Preliminary results, based on behavioral testing and fMRI measures taken one year apart are showing better executive function, which should translate into better organizing of daily tasks and following through to get them accomplished, as well as more thoughtful decision making and overall planning.
- The imaging results so far suggest that brain regions involved in internal processing of information - “thoughtfulness” - and memory should function better.
- Positive shifts in the Executive Control Network and the Attention Control Network in Arrowsmith subjects

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3) Impact Of The Arrowsmith Program On Working Memory

Institution: University of British Columbia, Faculty of Education
Principal Investigator: Dr. Rachel Weber
Commenced: October 2016
Recruitment for this study remains active.

Research process and structure:

Dr. Rachel Weber is working in collaboration with Dr. Boyd's team to study the impact of the Arrowsmith Program on working memory, which is highly correlated to academic success.

Participants from all three subject groups in Dr. Boyd's longitudinal LD study are also involved in Dr. Weber's working memory study.

4) Evaluation Of Social And Emotional Development In Students Across Three Different Educational Contexts

Institution: University of British Columbia, Faculty of Education
Principal Investigator: Dr. Kimberly Schonert-Reichl
Commenced: September 2017
Recruitment for this study remains active.

Research process and structure:

Dr. Kimberly Schonert-Reichl, in collaboration with Dr. Lara Boyd and her team, will be conducting a research investigation to evaluate social and emotional development in students across three different educational contexts, including one group in the Arrowsmith Program. In addition, it is intended to assess neural-correlates of behaviour and social emotional learning (SEL) competencies by linking the SEL data collected with data from Dr. Lara Boyd's study.

5) Study On The Effects Of Arrowsmith's Cognitive Intensive Program On Participants Ages 11-19

Institution: University of British Columbia, Faculties of Medicine and Education
Principal Investigators: Dr. Lara Boyd and Dr. Rachel Weber
Commenced: July 2017
Recruitment for this study remains active.

Research process and structure:

This six-week program focuses on the Symbol Relations cognitive function that processes and understands ideas. This is a critical function involved in processing concepts, quickly understanding what is read and heard, gaining insight, logical reasoning, and mathematical reasoning. This is the first opportunity to research the impact of one cognitive exercise on participants with no prior Arrowsmith experience. This study used pre- and post- functional imaging as well as cognitive and achievement measures.

This study will be conducted again in July/August 2018 to continue to grow the sample size.

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6) Study On The Effects Of Arrowsmith’s Cognitive Intensive Program On Participants Aged 11-19

Institution: Southern Illinois University

Principal Investigator: Dr. Greg Rose - Director, Center for Integrated Research in Cognitive & Neural Sciences

Commenced: July 2017

Research process and structure:

In July 2017, Dr. Greg Rose began a study on the effects of Arrowsmith’s Cognitive Intensive Program on participants, aged 11-19. There were 22 participants in the study that received pre- and post- functional imaging. The aim of this study is to understand the impact of the Symbol Relations exercise on brain structure and function.

Data collection for the study is complete, and data analysis began in September 2017. This study will be conducted again in July/August 2018 to continue to grow the sample size.

Participants will also receive a questionnaire, 10 months after completing the Cognitive Intensive Program, to collect information on the long-term impact of the cognitive change.

7) Effects Of The Arrowsmith Program On Students Enrolled In The Full-Time Program

Institution: Southern Illinois University

Principal Investigator: Dr. Greg Rose - Director, Center for Integrated Research in Cognitive & Neural Sciences

Commenced: September 2017

Recruitment for this study is ongoing.

Research process and structure:

In September 2017, Dr. Greg Rose began a second learning disabilities study on the effects of the Arrowsmith Program with students enrolled in the full-time program in Toronto, Canada. The study comprises of 13-study participants aged 11-19.

This study is investigating brain change through structural and functional imaging, as well as behavioural and achievement changes through cognitive and academic testing. Dr. Rose is working in collaboration with Dr. Weber from the University of British Columbia on this study.