

Research Overview

Introduction

Since 1997 there have been more than 40 research studies involving some 850 students across six universities and thirty different educational organizations all evaluating the effectiveness of the Arrowsmith Program. Seven of these studies have had control groups and eighteen have been peer reviewed. There are several research projects currently underway.

Among these studies are three published peer reviewed research papers, from the University of British Columbia and Southern Illinois University. These include the 2021 journal article on Cognitive Outcomes in [Applied Neuropsychology: Child](#); the 2019 Neuroimaging and Behavioral study in [Learning: Research and Practice](#); and the 2017 study investigating brain-behavior relationships following cognitive intervention for adults with traumatic brain injury published in the journal, [Heliyon](#).

The research has been presented at numerous conferences. The studies can be found here: [Arrowsmith Research](#)

These research studies are conducted by different investigators, in different schools and organizations, with different groups of participants, using different research frameworks. The research approach uses multiple designs and measures as recommended by the American Psychological Association in their paper, [More than one way to measure](#).

Included in these research studies are participants:

- in mainstream classes
- with learning difficulties
- experiencing learning challenges due to trauma,
- in a treatment recovery program for addiction
- who have had a traumatic brain injury.

These research studies all show similar results– that the Arrowsmith Program is effective, resulting in significant improvements in:

- brain activation and neural connectivity;
- cognitive abilities critical for learning including long-term memory, verbal-auditory learning, fluid reasoning, processing speed, verbal fluency, working memory, cognitive efficiency, cognitive flexibility, planning, and sustained attention;
- academic results including word reading, reading fluency, reading comprehension, spelling, written expression, math fluency, computation, and quantitative concepts; and
- Social, emotional well-being.

Arrowsmith Overview

In the human brain, networks of neurons are set up to perform particular cognitive functions such as: processing information; seeing relationships and making the connections necessary for insight and conceptualization; forming and retaining memories; navigating in space; recognizing familiar faces; parsing speech; learning motor plans for reading and writing; discriminating speech sounds; visually retaining symbol patterns necessary for reading, spelling and visual template learning; interpreting emotions; and thinking non-verbally.

Enhancement of these cognitive functions that underlie learning in school and throughout life is possible through the targeted application of cognitive programs utilizing the principles of neuroplasticity. This is the basis of the Arrowsmith Program.

Arrowsmith Program is highly specialized. This neuroplastic approach uses the principles of targeted differential stimulation, active sustained engagement, novelty and complexity and effortful processing. Its targeted exercises work the brain like a muscle in the gym. The goal is to strengthen critical functions in the brain that underlie learning. The cognitive programs focus on those core cognitive abilities that underpin literacy and numeracy, that are critical for reasoning, planning, problem solving and critical thinking, as well as a host of emotional intelligence and practical everyday competencies.

The research results are measured in academic outcomes and cognitive outcomes as well as through brain imaging to show how the student's brain has changed, showing improved connectivity.

Importantly changes in students' wellbeing - their happiness, confidence, and enjoyment of learning - are measured.

Arrowsmith's premise: change the brain, change cognitive capacity, change the student's capacity to learn in all aspects of life.

Research Results

The research results demonstrate the following significant positive changes –

For individuals with learning disabilities or learning difficulties:

- brain activation and connectivity
- cognitive functioning
- academic achievement
- rate of learning in the acquisition of academic skills
- social emotional well-being
- activities of daily living
- growth mindset (seeing one as an agent of change in one's life)
- stress levels (as measured by reduction in cortisol)

For students in mainstream classes in elementary and high school:

- cognitive functioning
- academic achievement

For individuals with Traumatic Brain Injury:

- brain activation and connectivity
- cognitive functioning
- social emotional well-being
- successful return to work

For individuals engaged in an addiction recovery treatment program:

- cognitive functioning
- academic achievement
- social emotional well-being

For school aged students who experience learning challenges due to significant trauma:

- cognitive functioning
- academic achievement
- social emotional well-being

Global Research Initiative

In February 2019, a research collaborative was formed comprised of researchers from the University of British Columbia, Southern Illinois University, and Universidad Camilo José Cela,

The researchers are meeting on a regular basis to collaborate on further research into the outcomes of students in the Arrowsmith Program.

Arrowsmith's vision is to create a research institute to further these investigations in the fields of learning disabilities, cognitive enhancement, education and acquired brain injury.

List of Research on the Arrowsmith Program

Research into Academic Outcomes

1998	Results of Arrowsmith Program at St. Patrick's Secondary School – Toronto Catholic District School Board (Canada)
2000	Treatment Outcome for a Motor Symbol Sequencing Dysfunction – University of Toronto (Canada)
2000	Evaluation of the Implementation of Arrowsmith in the TCDSB – Toronto Catholic District School Board (Canada)
2003	Arrowsmith Program Evaluation Report – UBC & Vancouver School Board
2003	Report on the TCDSB Study of the Arrowsmith Program – Toronto Catholic District School Board (Canada)
2004	TCDSB Learning Disabilities Review – Toronto Catholic District School Board (Canada)
2005	Outcome Evaluation of the Arrowsmith Program – Donner Foundation (Canada)
2007	Rate of Learning – Toronto Catholic District School Board (Canada)
2007	Academic and Learning Behaviours – Toronto Catholic District School Board (Canada)
2013	A Case Study of Learning Disabilities – University of Saskatchewan (Canada)
2014	Academic Achievement – University of Calgary (Canada)
2014/16	Academic Achievement – Camperdown Academy (United States)
2015	Average Academic Growth – Holy Trinity Parish Schools (Australia)
2016	Written Proficiency – Motor Symbol Sequencing Whole Cohort Study (Australia)
2016	Academic Achievement – University of British Columbia (Canada)

2017/18	Academic Achievement - University of Southern Illinois (United States)
2019	Academic Achievement - University of Southern Illinois (United States)
2017/18	Written Proficiency - Motor Symbol Sequencing Whole Cohort Study (Canada, Australia, New Zealand)
2018/19	Academic Achievement - Gateway Crosspoint Christian School (United States)
2020/21	Academic Achievement - Teen Challenge Centre QLD (Australia)
2022	Academic Achievement - Teen Challenge Centre Tasmania (Australia)

Research into Cognitive Outcomes

2004	TCDSB Learning Disabilities Review - Toronto Catholic District School Board (Canada)
2005	Outcome Evaluation of the Arrowsmith Program - Donner Foundation (Canada)
2013	A Case Study of Learning Disabilities - University of Saskatchewan (Canada)
2014	Cognitive Outcomes - University of Calgary (Canada)
2016	Cognitive Outcomes - University of British Columbia (Canada)
2016	Cognitive Outcomes - Universidad Camilo José Cela (Spain)
2017/18	Cognitive Outcomes - University of Southern Illinois (United States)
2018/19	Cognitive Outcomes - Camperdown Academy (United States)
2018	Cognitive Outcomes - University of Southern Illinois (United States)
2018	Cognitive Outcomes - Universidad Camilo José Cela (Spain)
2019	Cognitive Outcomes - University of Southern Illinois (United States)

2021	Cognitive Outcomes - University of Southern Illinois (United States)
2022	Cognitive Outcomes - University of Southern Illinois (United States)
2022	Cognitive Outcomes - Universidad Camilo José Cela (Spain)
2022	Cognitive Outcomes - Teen Challenge Centre QLD (Australia)
2022	Cognitive Outcomes - Teen Challenge Centre Tasmania (Australia)

Research into Social, Emotional and Behavioural Outcomes

2007	Social, Emotional and Behavioural Outcomes - Toronto Catholic District School Board (Canada)
2016	Social, Emotional and Behavioural Outcomes - University of British Columbia (Canada)
2017	Social, Emotional and Behavioural Outcomes - University British Columbia (Canada)
2018	Social, Emotional and Behavioural Outcomes - Plenty Valley CC (Australia)
2019	Social, Emotional and Behavioural Outcomes - University of Southern Illinois (United States)
2020/21	Social, Emotional and Behavioural Outcomes - Teen Challenge Centre QLD (Australia)
2021	Social, Emotional and Behavioural Outcomes - University of Southern Illinois (United States)
2022	Social, Emotional and Behavioural Outcomes - Teen Challenge Centre QLD (Australia)
2022	Social, Emotional and Behavioural Outcomes - University of Southern Illinois (United States)

Brain Imaging Outcomes

- 2016 Efficiency of Processing - University of British Columbia (Canada)
- 2016 Activation of the Prefrontal Cortex - University of British Columbia (Canada)
- 2016 Connectivity Within and Between Brain Networks - Southern Illinois University (United States)
- 2017 Connectivity Changes - Southern Illinois University (United States)
- 2019 Connectivity Changes - Southern Illinois University (United States)

Acquired Brain Injury (ABI) Outcome Research

- 2017 Individuals with Acquired Brain Injury - University of British Columbia, Canada
- 2019 Individuals with Acquired Brain Injury - University of British Columbia, Canada
- 2020 Individuals with Acquired Brain Injury - University of British Columbia, Canada

Other Research

- 1997 Correlates of a Test of Motor Symbol Sequencing - University of Toronto (Canada)

Research Frequently Asked Questions

What is research?

Research is a form of systematic investigation with the intention of adding knowledge to a field. It takes a variety of forms, including studies using different research designs such as single subject designs, observational studies, longitudinal designs, surveys, randomized control designs.

Is the Arrowsmith Program grounded in research?

The work of the Arrowsmith Program is grounded in research – that of Alexander Luria who identified the function or job of different regions and networks of the brain and that of Mark Rosenzweig at University of California, Berkeley looking at ‘activity-dependent neuroplasticity’ in rats. Activity-dependent neuroplasticity means that external stimulation that places a demand on the brain over a sustained period results in physiological and functional changes in the brain.

Based on Luria and Rosenzweig’s research, the following question was posed by Barbara Arrowsmith-Young in 1978 – “Can specific cognitive exercises stimulate and improve specific cognitive functions?”

The research conducted on the Arrowsmith Program demonstrates that yes, specific cognitive exercises are leading to changes in the brain along with cognitive, academic, and social emotional well-being changes.

Which research designs have been used?

The American Psychological Association Journal article, [*More than one way to measure*](#), argues for multiple research approaches to evaluate outcomes of interventions and outlines the pitfalls of randomized clinical trials. Arrowsmith, in 2010, consulted Dr. Alan Kazdin, who is quoted in this article, on the appropriate research design to evaluate Arrowsmith Program outcomes and he advised that single subject design or n-1 design would be the best approach. This research design uses a form of experimental reasoning called baseline logic to demonstrate the effects of the independent variable (in the case of Arrowsmith – the cognitive exercises) on the

behavior of individual subjects. Given it is often difficult to match control groups in education research this is a frequently used research design. In this design, students' progress over time is measured against their starting point and if progress exceeds what is expected, it is considered significant. Designs with control groups have also been used in the research on the Arrowsmith Program in which differences on outcome measures between two groups are analysed for significance.

It is argued, that in [single subject or n-1 design](#), if the research demonstrates common outcomes that are statistically significant across multiple studies using different subjects and with a range of measures, then it is probable that the intervention is the factor leading to the outcomes. All the independent research on Arrowsmith show similar outcomes.

What are the statistics on research evaluating the Arrowsmith Program?

- 40 research studies
- 850+ students
- 6 universities
- 30 different educational institutions
- 5 countries
- 18 of these studies have been peer reviewed
- 3 have been published
- 14 have been presented at conferences
- 7 of these studies have had control groups
- These studies have been conducted by different researchers using a variety of research designs and measures, with a variety of research subjects.

Has brain imaging been used to evaluate the Arrowsmith Program?

5 studies at 2 universities have used various forms of brain imaging to investigate the impact of the Arrowsmith Program. The brain imaging results have shown:

- changes in brain activation and connectivity
- more efficient processing
- increased activation in the prefrontal cortex and executive control network
- strengthened network connectivity, both within and between these 4 networks: Default Mode; Dorsal Attention; Salience; and Frontoparietal/Executive Control.

What are the academic outcomes?

Studies at three universities found significant changes on the following academic measures:

- Word Reading
- Reading Fluency
- Reading Comprehension
- Vocabulary
- Spelling
- Math Computation
- Math Fluency
- Quantitative Concepts
- Math Fluency
- Written Expression
- Writing Fluency
- Written Language
- Receptive Language
- Academic Fluency
- Academic Applications
- Broad Achievement

Studies in several elementary schools found significant changes over an academic year on:

- rate of acquisition of the skills of reading, reading comprehension, spelling, arithmetic
- amount of academic growth over an academic year on reading comprehension and mathematics
- writing speed and accuracy
- vocabulary, math computation, math concepts and problem solving

What are the cognitive outcomes?

Studies at four universities found significant changes on the following cognitive measures:

- Cognitive Efficiency
- Cognitive Flexibility
- Processing Speed
- Perceptual Speed
- Fluid Intelligence
- Auditory Processing
- Attention
- Fluid Reasoning
- Concept Formation
- Visual Auditory Learning
- Working Memory
- Verbal Fluency
- Oral Vocabulary
- Number Facility
- Working Memory
- Long Term Memory
- Phonemic Awareness
- Pair Cancellation
- Planning (Executive Functioning)
- Visual Spatial Reasoning
- Response Inhibition

What are the social-emotional well-being outcomes?

Studies at two universities found significant changes on the following social-emotional well-being measures:

- greater sense of happiness & well being
- increased sense of locus of control (view self as agent of change in one's life)
- increase in incremental theory of mind
- increase in emotional intelligence
- improvement in overall mood
- increase in optimism and self-esteem
- increase in social skills, adaptability, and leadership
- increase in attention, listening well, staying focused
- reduction in feelings of depression, anxiety, aggression
- reduction in hyperactivity
- reduction in cortisol (stress hormone)

Are there control groups?

Seven studies have compared the results of students in the Arrowsmith Program with students not receiving the Arrowsmith Program (controls). What is important to note is that in the studies with control groups, the students receiving the Arrowsmith cognitive exercises all showed significant academic and/or cognitive gains over the control groups who did not receive the Arrowsmith intervention.

Is the research independent?

The researchers from the various universities conducting research on the outcomes of the Arrowsmith Program do this work independently of Arrowsmith. As they require, from time to time, the researchers consult with Arrowsmith on various questions related to the Arrowsmith methodology and theory. All researchers that conduct research on the Arrowsmith Program have full access to the methodology from written documentation to observations of the program in action and to training in the methodology.

Are there peer reviewed studies?

Eighteen of the research studies have been peer reviewed. Three have been published in peer reviewed journals, one as a doctoral thesis, and 14 presented at conferences. All the studies presented at conferences go through a peer review process before being accepted.

Arrowsmith Research Updates

For updates on the research being conducted on the Arrowsmith Program, visit the Research page on the Arrowsmith website: [Arrowsmith Research](#)

Quick Facts about the Arrowsmith Program

- Since 1997 there have been over 40 research studies involving some 850 students looking into the effectiveness of the Arrowsmith Program. There are several ongoing research projects currently underway.
- Among these studies are three published peer-reviewed research papers. Significantly the results of all the studies show very similar results– that the program is effective for students with learning difficulties, for students in mainstream classes, for students who are experiencing learning challenges due to significant trauma, for individuals who have experienced a traumatic brain injury, and for individuals who are in a treatment recovery program for addiction.
- Somewhere between 10 to 20% of the population has learning difficulties. What is clear is that, while the traditional approaches often have benefit in increasing academic achievement in the skill areas targeted, these methods are not getting to the root cause of the learning difficulties.
- Over the past 25+ years there have been many independent studies of the Arrowsmith Program and all of them point to the same conclusion; that the program has been proven to deliver significantly positive results and that children, young people and adults have benefited.
- There is now a global research initiative made up of researchers at universities in several countries all studying the outcomes of this work and Arrowsmith welcomes researchers from around the world to join this initiative.
- Arrowsmith Program, founded in 1978, now operates in educational organizations worldwide.
- More than 10,000 students world-wide have achieved success with the Arrowsmith Program