Research Report:
Arrowsmith Program Outcomes
SEK International Schools
Universidad Camilo José Cela

ARROWSMITH

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; thinking non-verbally and planning, goal setting and strategic problem solving.

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.

The Arrowsmith Program has helped thousands of people over the last 40+ years by using the principles of neuroplasticity to strengthen cognitive functions related to regions and networks of regions of the brain.

The Arrowsmith Cognitive Enhancement Program

Arrowsmith has several models designed to meet the needs of schools incorporating cognitive programs into their curriculum to benefit their students.

In the Whole Cohort Program all students in a grade work to enhance a specific cognitive function. A school may choose to have all grades working in this program or only selected grades. Arrowsmith has developed a sequence of developmentally appropriate cognitive exercises per grade based on the learning demands that occur in each grade. Students work a minimum of 30 minutes per day five days per week on the specific cognitive program over the academic year.

In the cognitive classroom model students from a range of grades work together in a designated classroom on specific cognitive programs for a portion of each school day.

With the opportunity to enhance a range of cognitive functions, students are able to develop the cognitive capacities necessary to understand and analyze complex abstract relationships, think critically, be flexible in thought, retain information and accept and consider other points of view. These are essential abilities required for all aspects of learning. Cognitive enhancement prepares students to be life-long learners.

Research

The research reported in this document was conducted with students enrolled in SEK International Schools engaged in the Arrowsmith Program Symbol Relations cognitive exercise. The research was conducted by researchers at Universidad Camilo José Cela in collaboration with a researcher from Southern Illinois University. For more information on the research measures used, See Appendix A: Research Measures Used.

Arrowsmith Symbol Relations Cognitive Program

The Arrowsmith Symbol Relations cognitive exercise is a computer-based task which involves sustained visual-spatial processing which progressively increases in difficulty. It requires students to use reasoning to conceptually and automatically process relationships that increase in complexity. Over the years, many research projects have been conducted with various cohorts of individuals, from those with learning difficulties/disabilities, traumatic brain injury, addiction and those without learning challenges in mainstream classrooms wishing to enhance performance. See the Symbol Relations Research Report.

The Symbol Relations cognitive function is involved in:

- cause and effect reasoning
- understanding the 'why' of things
- grasping concepts across all academic disciplines
- comprehension of what is read or heard
- making rational and considered decisions
- understanding the world, oneself, and others
- fluid reasoning and flexibility of thought

- logical grasp of mathematical concepts
- processing speed
- Insight into oneself necessary for behavioural change
- semantic grasp of language necessary for comprehension
- vocabulary development
- perspective taking which involves the ability to consider other points of view necessary for empathy

If there is a difficulty in this cognitive function these processes are impacted.

Research on the Symbol Relations program outcomes has demonstrated significant improvements in:

- neural networks in the brain
- cognitive functioning
- acquisition of academic skills
- emotional intelligence and well-being

SEK Schools, Madrid, Spain

Research Team

The research on the Arrowsmith Program outcomes at SEK International Schools has been conducted by Dr. Laura Herrero Pérez and Dr. Miguel Ángel Pérez Nieto, Universidad Camilo José Cela. Dr. Greg Rose of Southern Illinois University has collaborated on this research.

2018 – Grade 3 Mainstream Class

In January 2018, SEK St. Isabel School in Madrid Spain implemented the Symbol Relations cognitive program in their grade 3 class.

This group of students engaged in this cognitive program for 40 minutes per day five days per week over 3 months. There were 18 students in the class.

For these grade 3 students, significant improvements were measured in the following domains:

- abstract reasoning and fluid intelligence (Raven's Matrices)
- visuospatial abilities, attention, and planning (Rey-Osterrieth Complex Figure Test; WISC Symbol Search and Coding)
- selective attention, concentration, processing speed, and endurance (d2 Test of Attention)
- processing speed (Trail Making Test; WISC Symbol Search)
- deductive reasoning skills and cognitive flexibility (Claves Test)

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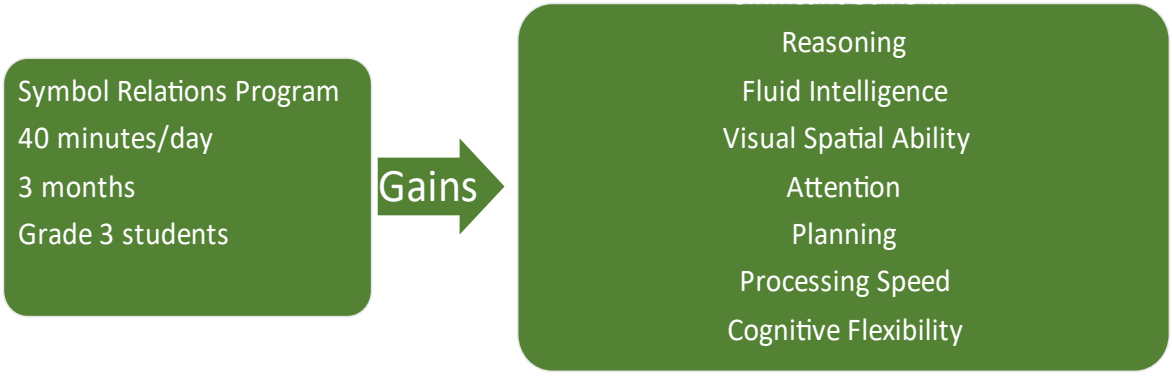
Whole Cohort - Grade 3

Symbol Relations Cognitive Program



Research conducted by Dr. Laura Herrero Perez and Dr. Miguel Angel Perez Nieto
32nd International Congress of Psychology, Prague, July 2021

Presentation

Laura Herrero Pérez, Cecilia Ines Theirs, Francisco David Pascal, and Miguel Ángel Pérez Nieto. (2021, July). *Visuo-spatial ability improvements in typical development children involved in the Arrowsmith program* [Presentation]. 32nd International Conference of Psychology, Prague, Czech Republic.

Universidad Camilo José Cela Symbol Relations Whole Cohort Study 2021

2022 – Grade 3 Mainstream Class

In January 2022 the Symbol Relations cognitive program was implemented in a grade 3 class at SEK St. Isabel.

This group of students engaged in the cognitive program for 40 minutes per day five days per week over 5 months. There were 41 students in the class engaged in the Arrowsmith cognitive program. There were 43 grade 3 students in two additional SEK Schools, matched for SES, who were engaged in regular curriculum (control group).

For the grade 3 students working on the Arrowsmith cognitive program, significant improvements were measured in the following domains:

- cognitive flexibility and working memory (Wisconsin Card Sorting Test)
- response inhibition (No Go Task)
- selective attention, concentration, processing speed, and endurance (d2 Test of Attention)

These gains were not seen in the control group.

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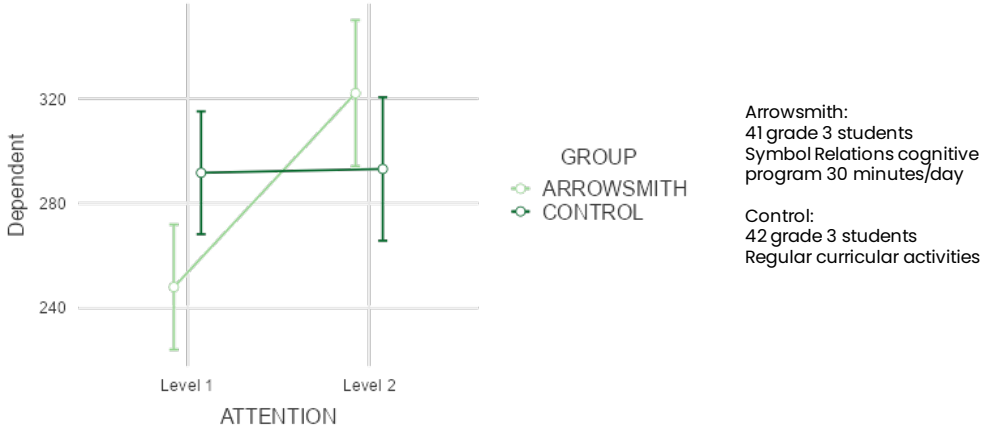
Whole Cohort – Grade 3

Symbol Relations Cognitive Program

Selective Attention and Processing Speed



Arrowsmith:
41 grade 3 students
Symbol Relations cognitive program 30 minutes/day

Control:
42 grade 3 students
Regular curricular activities

Research conducted by Dr. Laura Herrero and Dr. Miguel Angel Perez, Universidad Camilo Jose Cela, Madrid Spain
Submitted for presentation at 23rd European Society for Cognitive Psychology Conference

2024 Grade 4 to 6 Gifted Group

From February to June 2024 the Symbol Relations cognitive program was implemented with a group of 12 students in grades 4 to 6 identified as gifted at SEK-El Castillo International School in Madrid. The students ranged in age from 9.11 to 11.11 with a mean age of 10.5. The students worked 2 hours per week in class on the Symbol Relations cognitive program.

Measures

Raven's Progressive Matrices – pre-test only
Stroop Task
Tower of London
d2 Test of Attention
Claves – WISC-V Symbol Search Spanish subtest
Balanzas – WISC-V subtest
Symbol Relations Survey - post-test only
Immediate Mood Scaler

Results

Ravens Progressive Matrices

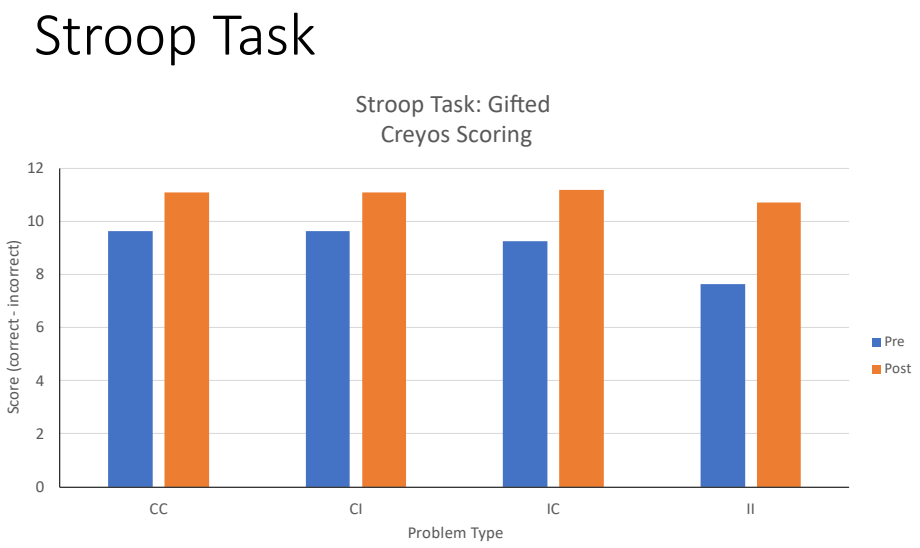
This is a nonverbal test of intelligence. The scores were normally distributed with a mean score of 41.7, a standard deviation of 6.3, and a range of 31 to 55.

Stroop Task

This measure assesses response inhibition - the ability to focus on relevant information in order to make a response when presented with distracting information. It assesses selective attention, processing speed, inhibitory cognitive control, and executive functioning.

For the group of gifted students, the Symbol Relations program resulted in significant improvement (p = .014) on this cognitive measure indicating gains in:

- selective attention
- processing speed
- inhibitory cognitive control
- executive functioning

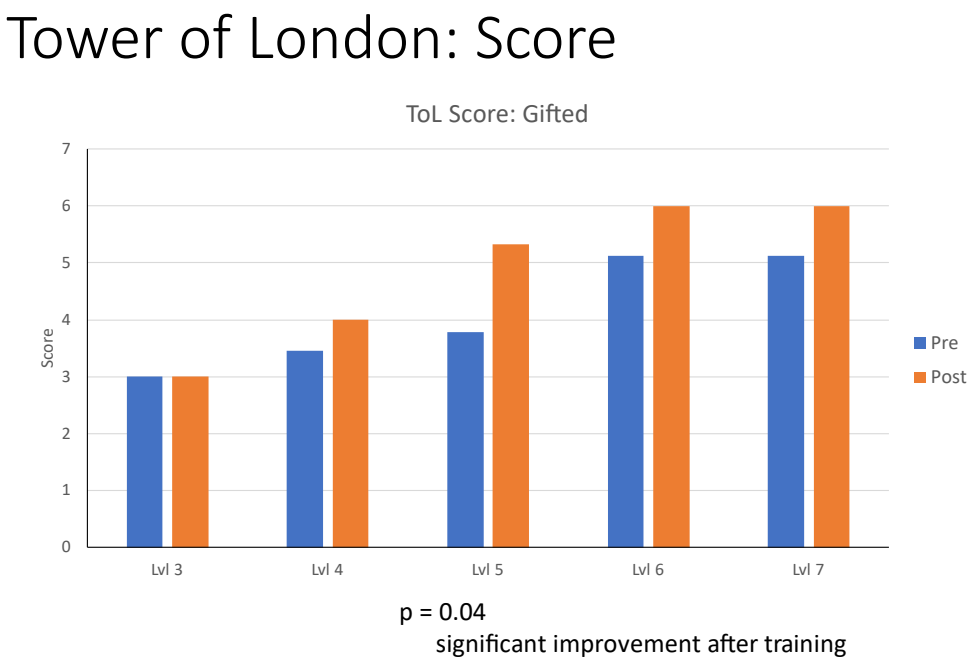


p = 0.014
significant improvement after training

Tower of London Task

This measure assesses the ability to plan and sequence behaviour to reach a goal.

The gifted group showed significant improvement in their overall score on this measure (p = .04) demonstrating that their planning ability was more accurate at the end of the cognitive program than before.



p = 0.04
significant improvement after training

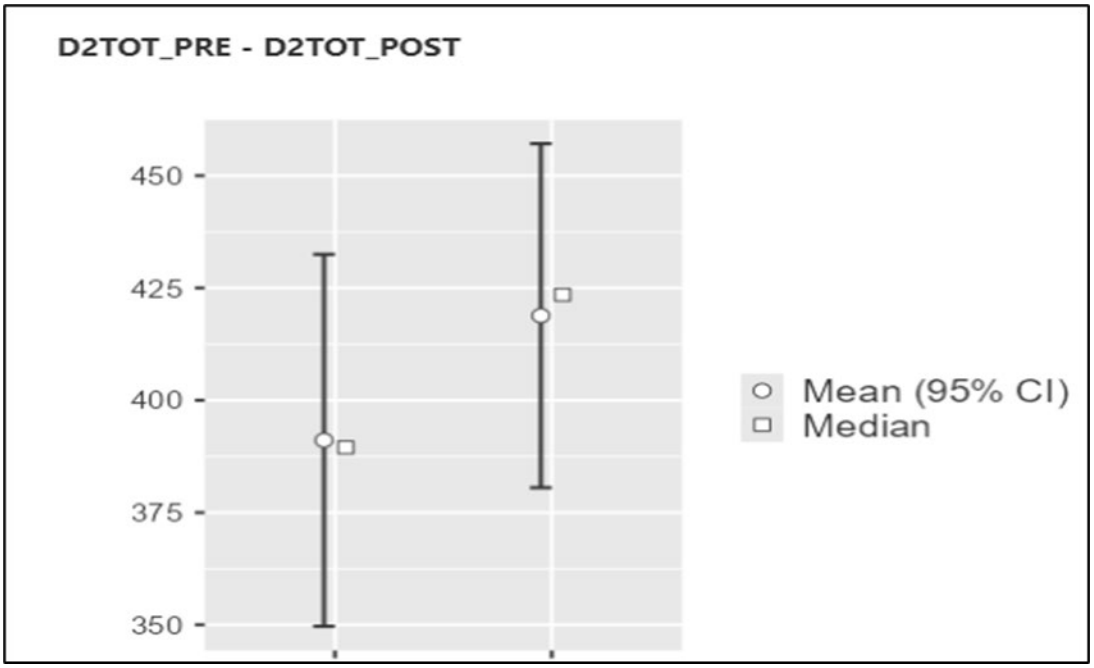
d2 Test of Attention

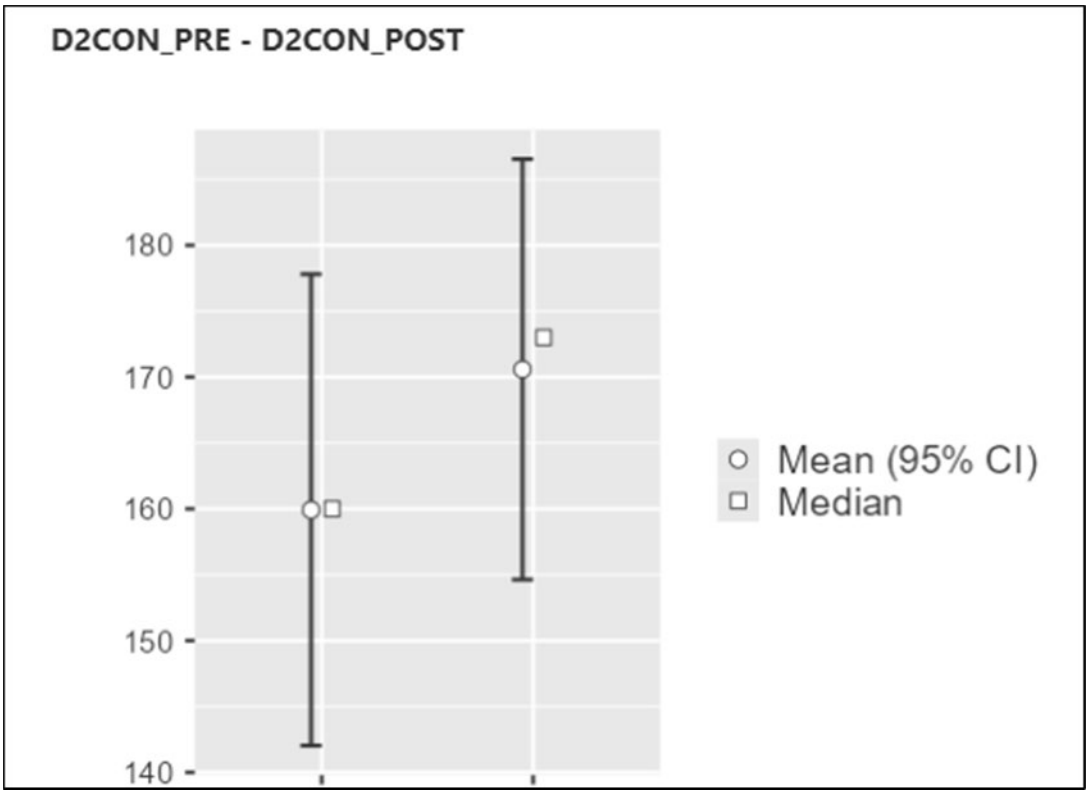
This test assesses selective attention, processing speed, adherence to instructions, and quality of execution in a task involving discrimination of similar visual stimuli. It requires focused attention to a series of relevant stimuli while ignoring irrelevant stimuli.

There are two results reported: D2 TOT which measures general processing speed and selective attention; and D2 CON which is a measure of concentration abilities.

The gifted group showed significant improvement on both aspects of this test (D2 TOT p = .04; D2 CON p = .05) demonstrating improvements in:

- selective attention
- processing speed
- concentration
- executive functioning

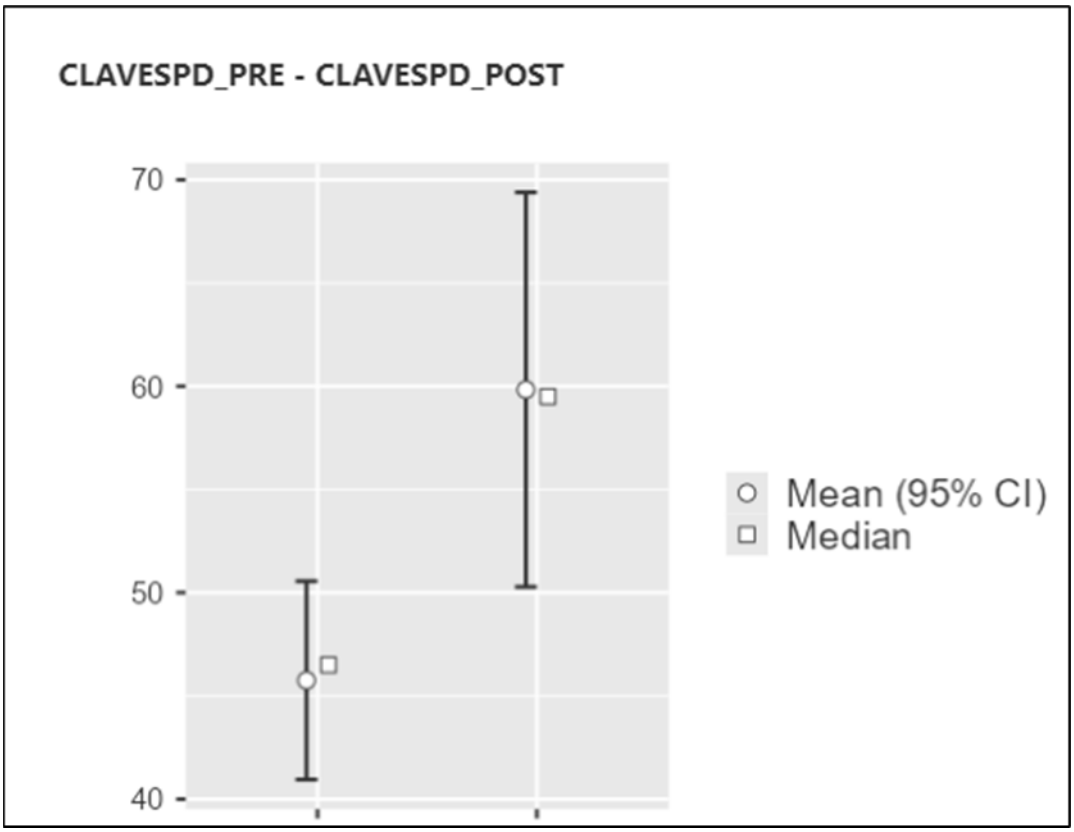



D2CON_PRE - D2CON_POST
180
170
160
150
140
Mean (95% CI)
Median

Claves (WISC-V Symbol Search)

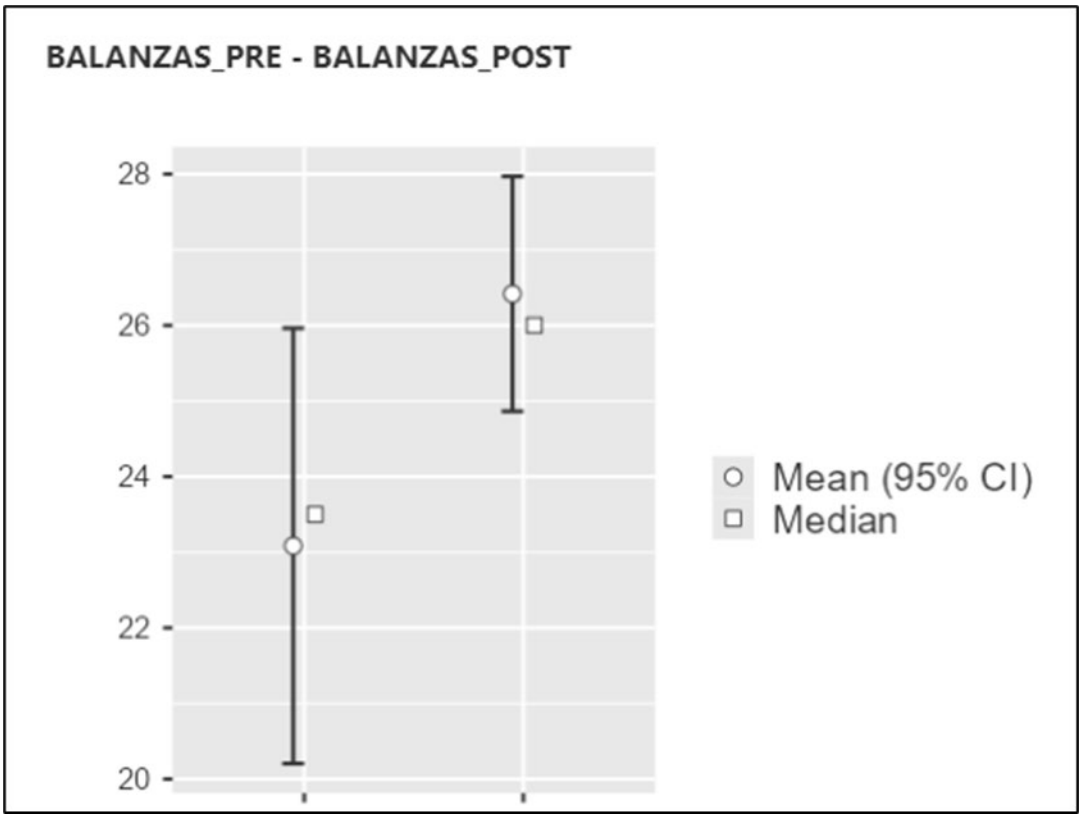
This is the Spanish version of the Symbol Search on the WISC-V. It is a measure of processing speed.

The improvement in processing speed at the end of the cognitive program for students in the gifted group was statistically significant (p = .009).



Balanzas WISC-V Subtest

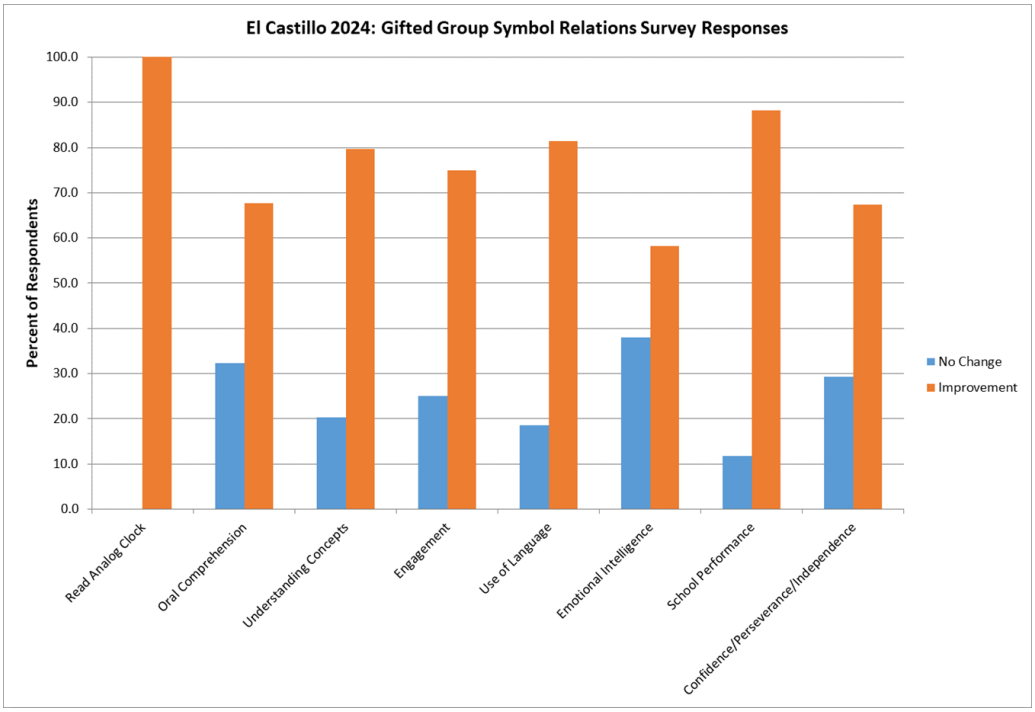
This test measures quantitative and analogical reasoning using physical principles. The change pre and post training approached significance (p = .07).



Self-Report Symbol Relations Survey Questionnaire Results

After completion of the Symbol Relations cognitive program, participants and parents completed a questionnaire.

Significant improvement was reported in several behaviours which correspond to the changes measured in these students' cognitive abilities.



On analysis, these behaviours were grouped into the following categories.

Oral Comprehension – able to grasp more quickly and accurately what is heard

Understanding Concepts – enhanced logical reasoning, understanding rules, seeing the big picture

Engagement – greater focus, attention, and mental initiative

Use of Language – improved vocabulary and communication skills

Emotional Intelligence – more able to interpret and express emotions, to reflect on behavior and problem solve in social situations, to understand interpersonal relationships, and more willing to engage in social situations

Confidence/Perseverance/Independence – more self-assured in situations, demonstrating greater perseverance, increased willingness to try new things and engage in challenging situations, more able to work independently, more self-confident.

Immediate Mood Scaler

The researcher noted that the students had difficulty understanding the emotions the test was asking them to rate, so the results were determined as not reliable.

2024 Grade 3 to 6 Dyslexia Group

From February to June 2024 the Symbol Relations cognitive program was implemented with a group of 12 students in grades 3 to 6 diagnosed as having dyslexia at SEK-El Castillo International School in Madrid. The students ranged in age from 8.3 to 11.9 with a mean age of 9.7. The students worked 2 hours per week in class on the Symbol Relations cognitive program.

Measures

Raven's Progressive Matrices – pre-test only
Stroop Task
Tower of London
d2 Test of Attention
Claves – WISC-V Symbol Search Spanish subtest
Rey-Osterrieth Complex Figures
Symbol Relations Survey – post-test only
Immediate Mood Scaler

Results

Ravens Progressive Matrices

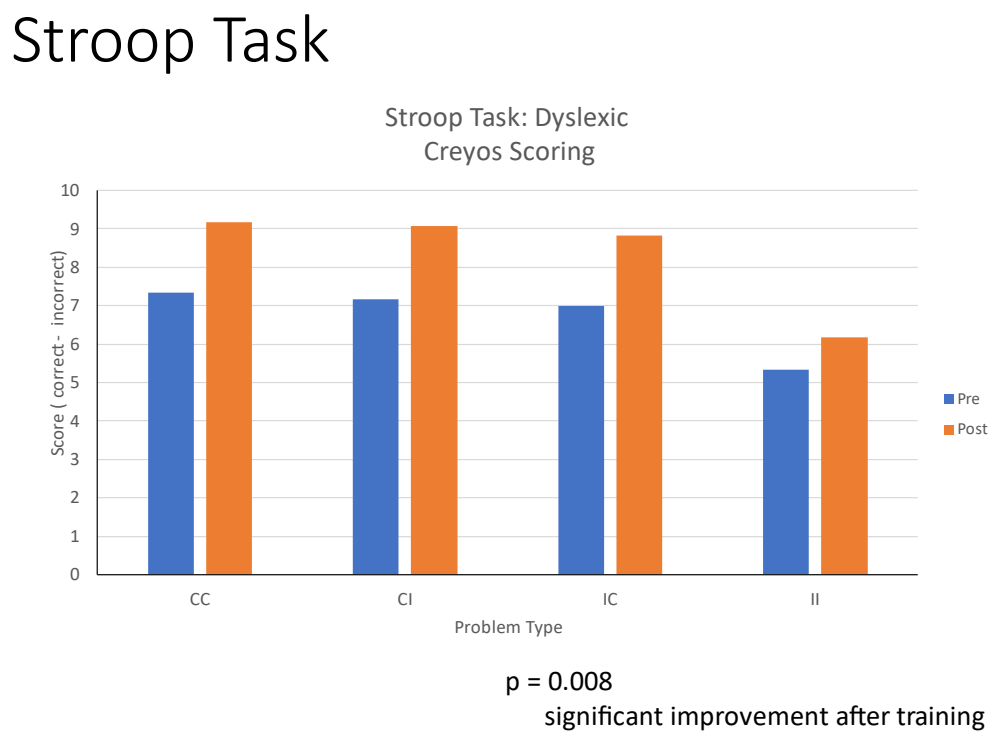
This is a nonverbal test of intelligence. The scores were normally distributed with a mean score of 31.2, a standard deviation of 7.78, and a range of 20 to 45.

Stroop Task

This measure assesses response inhibition - the ability to focus on relevant information in order to make a response when presented with distracting information. It assesses selective attention, processing speed, inhibitory cognitive control, and executive functioning.

For the students in this study diagnosed with dyslexia, the Symbol Relations program resulted in significant improvement (p = .008) on this cognitive measure indicating gains in:

- selective attention
- processing speed
- inhibitory cognitive control
- executive functioning

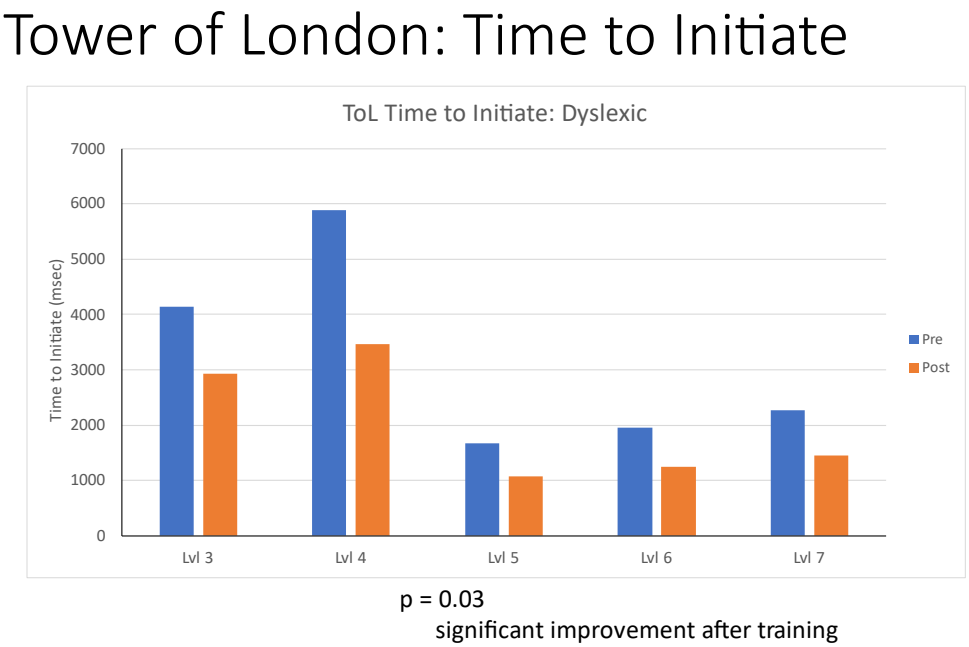


p = 0.008
significant improvement after training

Tower of London Task

This measures the ability to plan and sequence behaviour to reach a goal.

The dyslexic group showed significant improvement in their time to initiate the task (p = .03) demonstrating that their planning ability was faster at the end of the cognitive program than before.



p = 0.03
significant improvement after training

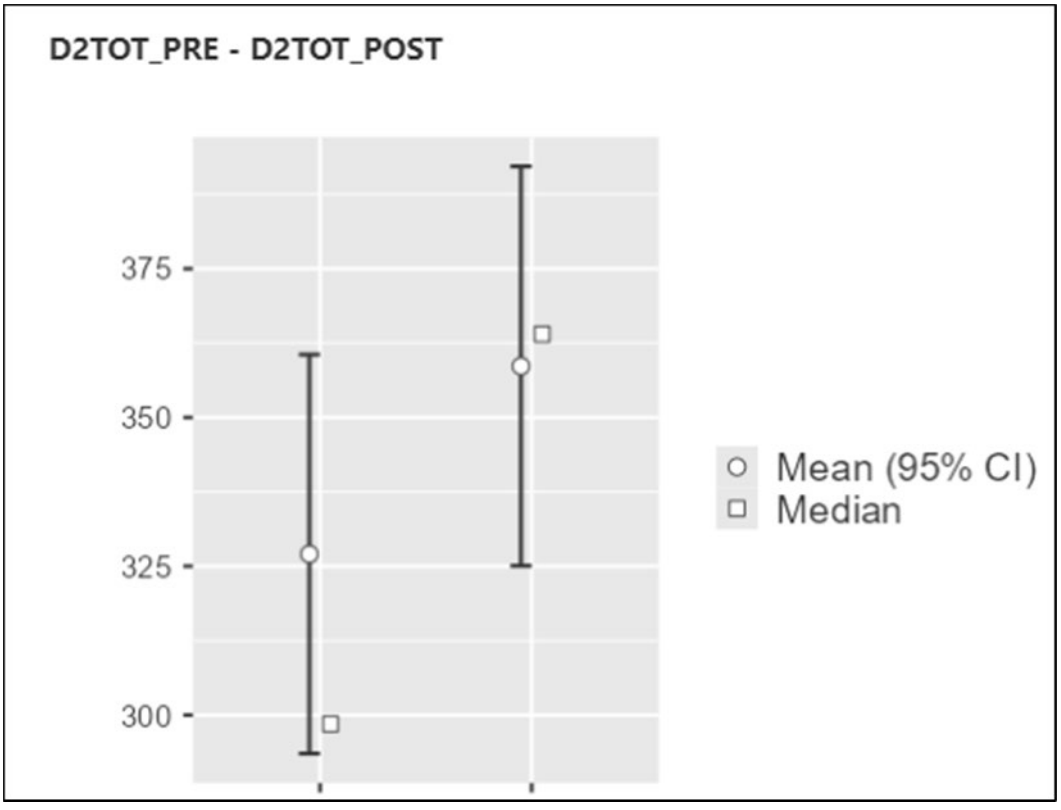
d2 Test of Attention

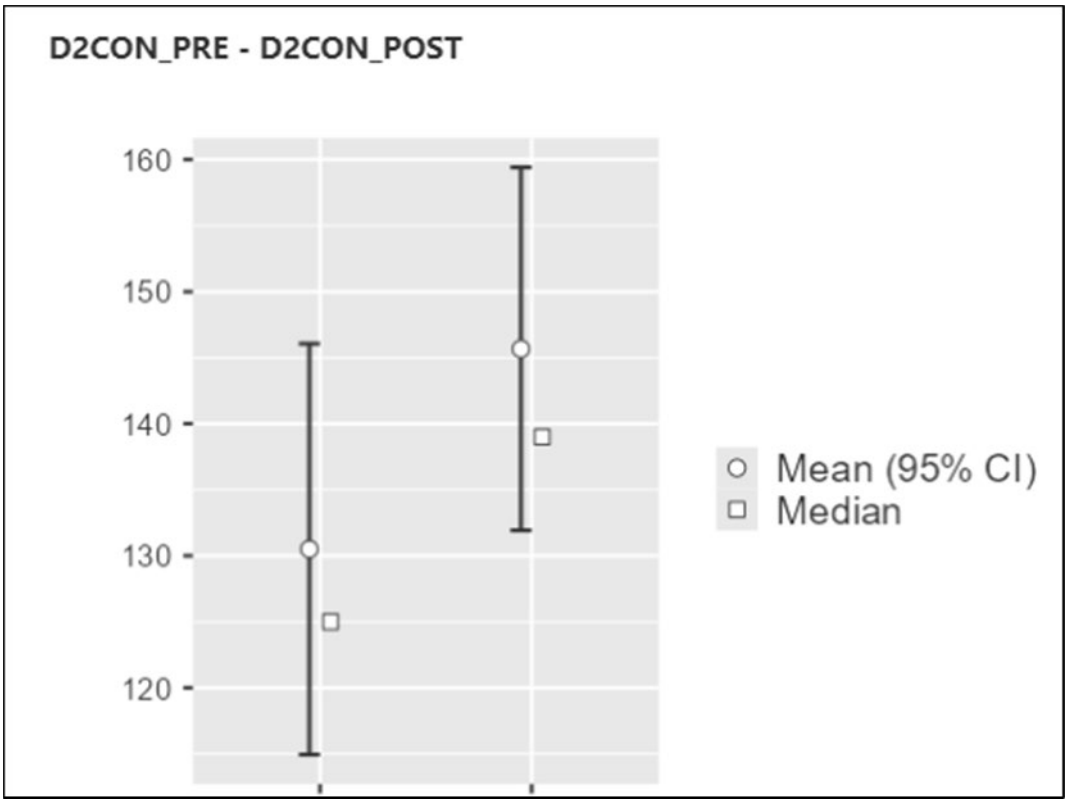
This test assesses selective attention, processing speed, adherence to instructions, and quality of execution in a task involving discrimination of similar visual stimuli. It requires focused attention to a series of relevant stimuli while ignoring irrelevant stimuli.

There are two results reported: D2 TOT which measures general processing speed and selective attention; and D2 CON which is a measure of concentration abilities.

The group of students with dyslexia showed significant improvement on both aspects of this test (D2 TOT p = .02; D2 CON p = .01) demonstrating improvements in:

- selective attention
- processing speed
- concentration
- executive functioning

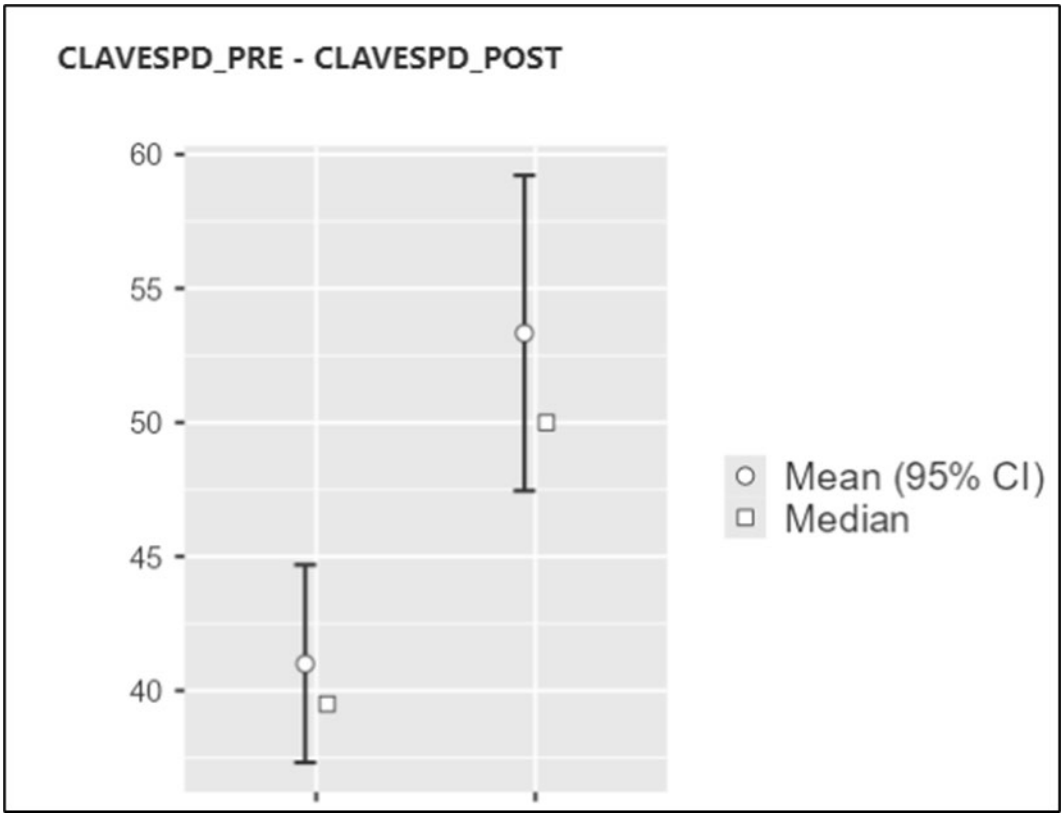



D2CON_PRE - D2CON_POST
160
150
140
130
120
Mean (95% CI)
Median

Claves (WISC-V Symbol Search)

This is the Spanish version of the Symbol Search subtest on the WISC-V. It is a measure of processing speed.

The improvement in processing speed at the end of the cognitive program for students in the dyslexic group was statistically significant (p = .005).



Rey-Osterrieth Complex Figure

This test measures visuospatial planning and memory abilities and involves copying a figure from an image and then from memory. There was improvement on this measure, however the change between pre and post testing was not significant.

Self-Report Symbol Relations Survey Questionnaire Results

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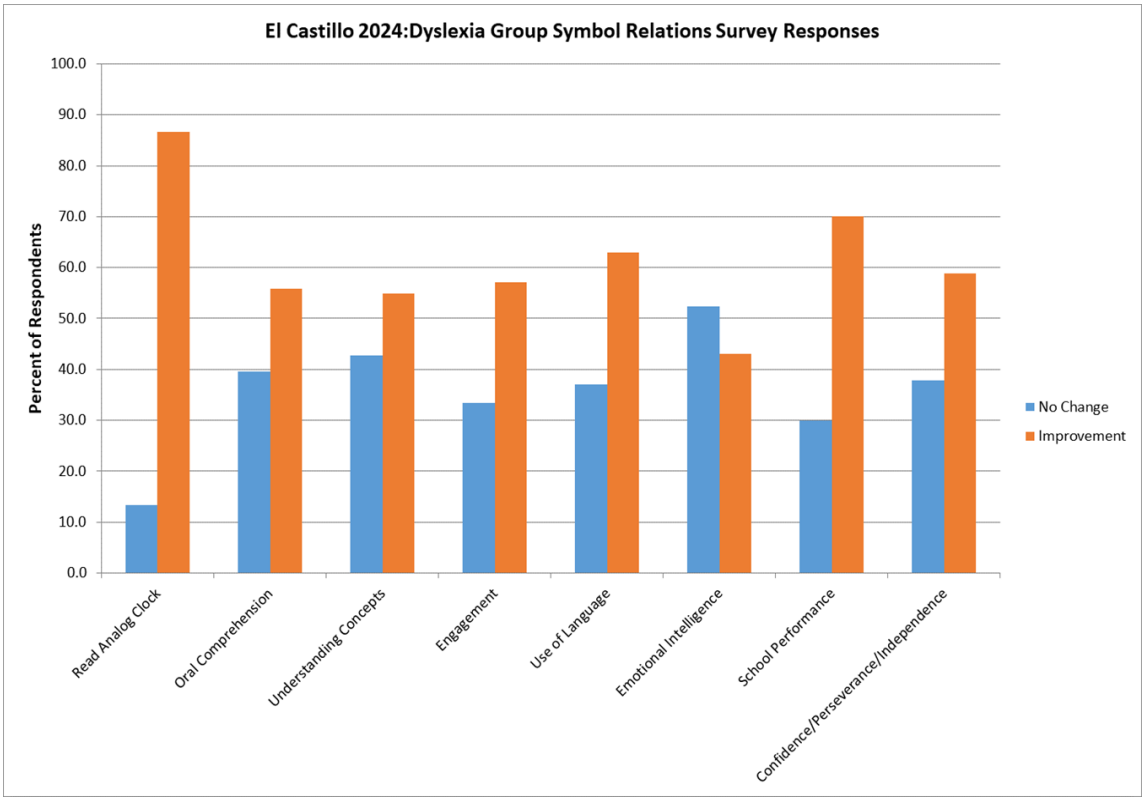

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Confidence/Perseverance/Independence – more self-assured in situations, demonstrating greater perseverance, increased willingness to try new things and engage in challenging situations, more able to work independently, more self-confident.

Immediate Mood Scaler

The researcher noted that the students had difficulty understanding the emotions the test was asking them to rate, so the results were determined as not reliable.

Summary of Research Results for Symbol Relations Cognitive Program

The research on the Symbol Relations cognitive program conducted at SEK International Schools from 2018 to 2024 has demonstrated significant positive changes in:

Cognitive Abilities

- Abstract Reasoning
- Fluid Intelligence
- Visuospatial Abilities
- Planning Ability
- Selective Attention
- Concentration
- Endurance & Persistence
- Processing Speed
- Deductive Reasoning
- Cognitive Flexibility
- Working Memory
- Response Inhibition
- Inhibitory Cognitive Control
- Executive Functioning
- Oral Comprehension
- Understanding Concepts
- Use of Language
- Engagement

Well-Being and Social-Emotional Intelligence

- Confidence
- Self-Assurance
- More able to understand and express emotions
- Better able to understand social relationships
- More able to reflect on behaviour and problem solve in social situations
- Emotional intelligence

Conclusion

The Symbol Relations cognitive program has shown significant benefit for SEK students in mainstream classes, for students with learning disabilities such as Dyslexia, and for gifted students. As the brain changes, there are positive cognitive gains which support learning as well as social-emotional well-being.

Cognitive Enhancement Program – Putting the Brain in the Education Equation

The crucial skills required for lifelong learning have been proposed by various educational think tanks, including the World Economic Forum and the Organization for Economic Co-Operation and Development (OECD).

WEF Ten 21st-century skills every student needs

OECD Future of Education and Skills 2030 (2019)

Both organizations recognize that education is more than the 3Rs and academic curriculum. They understand that students need critical cognitive skills to prepare them to function in the world of their future and for lifelong learning. Acquisition of these skills requires strong cognitive functioning.

The Arrowsmith Symbol Relations program has the ability to enhance critical cognitive functions and optimize cognitive capacity for students' current and future learning and functioning.

Additional Research

For additional research on the outcomes of the Arrowsmith cognitive programs see: Arrowsmith Research

Appendix A: Research Measures Used

Symbol Relations Whole Cohort Research

Balanzas (WISC-V)

Claves Test (WISC-V Symbol Search)

d2 Test of Attention

Go No Go Task

Immediate Mood Scaler

Raven Progressive Matrices

Rey-Osterrieth Complex Figure Test

Stroop Task

Trail Making Test

Tower of London Task

Wisconsin Card Sorting Test

Symbol Relations Survey Questionnaire

A questionnaire completed by students and parents using a five-point rating scale to report on behaviours related to the Symbol Relation cognitive function. These behaviours are grouped into the following categories: oral comprehension; understanding concepts; engagement; emotional intelligence; school performance; and confidence/perseverance/ independence.