

A Brain-Based Intervention Program That Changes Cognition: Implications for Academic Achievement

Kim R. Fitzer¹, Hanna A. Kubas¹, Jessica A. Carmichael¹, Howard Eaton², James B. Hale¹

¹University of Calgary; ²Eaton Educational Group

Abstract

As a cognitive-based intervention program, the Arrowsmith Program (AP) is designed to strengthen deficit cognitive functions underlying specific learning disabilities (SLD) rather than providing achievement intervention or compensatory strategies. Pre- and post-intervention cognitive data was collected on 15 students enrolled in the AP program. NPStat non-parametric randomization tests revealed single-subject improvements across all cognitive domains except verbal ability (Gc) and long-term retrieval (Glr). Paired samples t-tests revealed improvements in short-term memory (Gsm), auditory processing (Ga), fluid reasoning (Gf), and processing speed (Gs)

Background

- Neuroimaging literature (Aylward, 2003, Finn et al., 2013) suggests systematic intervention targeting weak academic areas changes brain function and normalizes atypical learning patterns in children with SLD
- Designed to remediate specific cognitive processing deficits underlying SLD in children, the AP is built upon a neuroscience foundation and evidence of neuroplasticity
- It is unclear if strengthening neuropsychological functions underlying academic achievement could improve reading, writing, and mathematics by targeting the primary cause (i.e., cognitive deficit) rather than the symptoms (i.e., achievement deficit)

Research Questions

- Do children with base-line cognitive deficits show improvements in underlying cognitive skills following an AP intervention program?
- Does participation in the AP result in improved cognitive performance at the single subject and group level?

Participants and Methods

- Woodcock-Johnson III Cognitive data was collected on 15 students (11 males; 4 females; *M* age = 9.3 years; *SD* = 1.36) pre and post entry into the AP Program (*M* duration = 28 months; *SD* = 8.36 months)
- NPStat non-parametric randomization tests, which approximate multivariate analyses in the absence of normal data, were used to judge changes in cognitive function for each participant
- Paired sample *t*-tests (alpha level set at .001 to guard against Type I error) were used to compare pre-post group means

Results

- Inspection of individual response curves and NPStat nonparametric randomization test results revealed significant single-subject treatment response across WJIII Cognitive variables (*F* range 8.92 to 114.05; *p* < .001)
- Paired samples *t*-tests revealed improvements in Ga, Gf, Gs, Gsm (*t* range 4.40 to 12.92; *p* < .001)
- No significant differences between pre and post results for Verbal Ability (Gc), Visual-Spatial Thinking (Gv), Long-Term Memory (Glr)

Table 1. Pre- and Post Mean Analysis for WJ III Cognitive Variables

CHC Factors	Subtests	Mean	<i>t</i>	<i>p</i>
Auditory Process	Sound Blending	Pre 102.00	2.01	<.001
		Post 115.87		
Fluid Reasoning	Concept Formation	Pre 103.73	5.61	<.001
		Post 114.27		
Processing Speed	Visual Matching	Pre 69.47	12.92	<.001
		Post 89.00		
	Decision Speed	Pre 79.87	5.85	<.001
		Post 95.47		
Short-Term Memory	Numbers Reversed	Pre 87.33	5.14	<.001
		Post 96.87		
Phonemic Awareness	Memory for Words	Pre 94.20	7.27	<.001
		Post 111.67		
		Pre 84.73		
Post 102.80				
Working Memory	Auditory WM	Pre 96.20	4.40	<.001
		Post 101.80		

Discussion

- Children with baseline cognitive difficulties showed significant improvement across cognitive domains in short-term memory, auditory processing, fluid reasoning, and processing speed
- Given that these cognitive domains are associated with processing weaknesses that underlie most SLDs, improvement should ameliorate achievement deficits in children with SLD
- Results suggests that targeted and individualized interventions designed to remediate cognitive deficits may lead to improved academic performance across a broad range of domains
- Brain plasticity allows for restructuring of cognitive processes, thereby enabling improved cognition and academic performance

Future Direction

- Brain-based intervention programs that target underlying cognitive weaknesses associated with academic achievement could lead to better learning in children with and without SLD
- Research studies on AP outcomes show preliminary positive findings, but carefully controlled studies are needed to support program treatment efficacy
- Future research with larger sample sizes and different SLD subtypes is needed
- Research is necessary to determine how strengthening cognitive deficits impacts academic achievement across reading, writing, mathematics, and language domains, and/or has the potential to ameliorate SLD.

BrainGain Laboratory



James B. Hale, PhD, ABPdN, Principal Investigator
Kim R. Fitzer, MSc, Research Assistant
Correspondence: krfitzer@ucalgary.ca

References

- Arrowsmith Program. (2007) Report on the Arrowsmith Program in the Toronto Catholic District School Board. Retrieved from <http://www.arrowsmithschool.org/arrowsmithprogram-background/images/Report%20on%20the%20AP%20in%20the%20TCDSB%20%20Feb%202%2007.pdf>
- Aylward, E. H., Richards, T. L., Berninger, V. W., Nagy, W. E., Field, K. M., Grimme, A. C., ... & Cramer, S. C. (2003). Instructional treatment associated with changes in brain activation in children with dyslexia. *Neurology*, *61*(2), 212–219.
- Finn, E. S., Shen, X., Holahan, J. M., Scheinost, D., Lacadie, C., Papademetris, X., Shaywitz, S. E., Shaywitz, B. A., & Constable, R. T. (2013). Disruption of functional networks in dyslexia: A whole-brain, data-driven analysis of connectivity. *Biological Psychiatry* (*Epub ahead of print*).
- Lancee, W. (2003). Report on the TCDSB study of the Arrowsmith Program for Learning Disabilities. Retrieved from <http://www.arrowsmithschool.org/arrowsmithprogram-background/images/Final%20Report%20on%20TCDSB%20Study%20Jan%2022%202003.pdf>
- Lancee, W. (2005). Report on an Outcome Evaluation of the Arrowsmith Program for Treating Learning Disabled Student. Retrieved from http://www.arrowsmithschool.org/arrowsmithprogram-background/images/Arrowsmith_study_11_20_05.pdf
- Mary, R. B., Masson, R. E. J., Hunter, M. A., & Well, J. (1990). N.PStat 3.01 [Computer software], Victoria, Canada. University of Victoria.