Academic and Cognitive Remediation for Students With Learning Disabilities: A Comparison Between Orton Gillingham and NILD Educational Therapy

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Abstract

This study compared the effectiveness of Orton Gillingham (OG) tutoring and National Institute for Learning Development Educational Therapy (NILD). A randomized controlled trial using 27 participants determined whether academic and cognitive outcomes differed between the groups over a 9-month period. Participants had designated learning disabilities (LD) in reading (RD), written expression (WD), and/or math (MD), and received 64 hours of one-to-one remediation. Pre and post measures were conducted using WJ IV Cognitive and WJ IV Achievement assessments. Results indicated that the standard score median increased in both groups for Fluid Reasoning, Reading Comprehension, and Word Attack with Fluid Reasoning and Reading Comprehension increasing more dramatically for the NILD group and Word Attack increasing more dramatically for the OG group. Outcomes are congruent with the instructional focus of each approach thus supporting the efficacy of both approaches which currently lack robust empirical evidence. This preliminary research provides important contributions for researchers and practitioners considering interdisciplinary remedial options for students with LD.

Keywords: learning disabilities, cognitive remediation, reading remediation, Orton-Gillingham, NILD, neuroplasticity

As a society, we have a collective responsibility to teach our children to learn and to thrive as independent adults. Consequently, we must ensure that our education system is doing its part. It is the job of educators to prepare all children for success in whatever life path they choose (Province of British Columbia, 2018). The goal of educating students with specific learning disabilities (LD) is no exception. Specifically, educators must support students with LD in reading (RD), written expression (WD), and math (MD) to help them develop tools for independent learning in the classroom and in life (National Institute for Learning Development [NILD], n.d.).

One way to ensure learner independence is by providing appropriate remediation in literacy. To date, much of the research on word reading difficulties in students with LD has focused on phonological awareness and rapid naming, but recent research suggests that other cognitive factors such as visual attention span, short-term memory, and working memory also play a significant role in word reading level (Shaul, Katzir, Primor, & Lipka, 2016). In addition, weaknesses in other cognitive domains such as visual-spatial attention are considered to be important risk factors for reading challenges (Franceschini, Gori, Ruffino, Pedrolli, & Facoetti, 2012).

According to de Lima, Azoni, and Ciasca (2013), "children with dyslexia had more difficulties with performing visual-spatial and auditory attention tasks, as well as tasks involving executive functions (EF) such as flexibility, inhibitory control, strategy use, working memory, and verbal fluency" (p. 1). Shaul

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et al. (2016) concluded that "word reading is a complex ability which builds on a wide base of cognitive abilities" (p. 51). Consequently, support exists for the notion that reading remediation of students with LD would benefit from a multidisciplinary interventional approach that connects education to neuroscience and cognitive psychology (Gollery, 2018).

Language is the foundation for reading and literacy education (Moats, 2010). To access language systems, literacy instruction must include orthography, phonetics, phonology, morphology, syntax, semantics, discourse, and pragmatics (Moats, 2010). Siegel and Mazabel (2013) identified six processes as being significant in the development of reading skills: phonology, syntax, working memory, semantics, morphology, and orthography. For students with LD, in particular, metalinguistic awareness, which involves an understanding of phoneme-grapheme correspondence, is critical to the development of reading (Ehri, 2005).

In a meta-analysis of 22 randomized controlled studies conducted from 1985 to 2010 on treatment approaches for children and adolescents with RD, Galuschka, Ise, Krick, and Schulte-Körne (2014) looked at reading fluency, phonemic awareness, reading comprehension, phonics, auditory processing, and the use of coloured overlays. The results revealed that phonics instruction was not only the most frequently investigated treatment approach, but also the only approach whose effectiveness on the reading and spelling performance of children and adolescents with reading disabilities has been statistically confirmed. By comparison, the mean effect size of the other treatments did not reach statistical significance (Galuschka et al., 2014).

It is important to recognize, however, that effect size outcomes should not be discounted as statistically relevant in interpretation of the data. As such, a comprehensive multiple-treatment approach for reading is recommended. Moats (2010) agreed, stating that "instruction that builds phonemic awareness, phonic decoding skills, text reading fluency, vocabulary and various aspects of comprehension is the best antidote for reading difficulty" (p. 15).

Orton Gillingham (OG)

The Orton Gillingham (OG) remedial method employs the recommended structured approach to literacy instruction. Originally developed in the 1930s by Samual Orton and Anna Gillingham (Academy of Orton Gillingham Practitioners and Educators, 2018), the OG method uses direct instruction that is phonologically based and employs sequential, multisensory teaching, whereby phonemes and graphemes are connected to keywords that trigger the sound-symbol relationship.

Rose and Zirkel (2007) listed more than 15 commercial OG-based reading programs, including Wilson Reading System (Wilson, 1996), the Spalding Method (Spalding & Spalding, 1990), the Slingerland Approach (Slingerland & Aho, 1996), Alphabetic Phonics (Cox, 1992/2007) and Project Read (Enfield & Greene, 1997). However, in a meta-analysis conducted between 1979 and 2001 using experimental or quasi-experimental design, Ritchey and Goeke (2006) found only 12 published peer-reviewed studies that met the criteria of scientifically based research outlined by the No Child Left Behind Act (U.S. Department of Education, 2001). These authors found that "OG instruction has yet to be comprehensively studied and reported in peer-reviewed journals. The small number of existing studies lack methodological rigor that would be required for publication in current peer-refereed journals" (2006, p. 182).

Furthermore, according to the U.S. Department of Education's Institute of Education Sciences (IES; 2010) What Works Clearinghouse (WWC), no studies of Orton Gillingham-based strategies – unbranded or branded (including Alphabetic Phonics, Barton, Dyslexia Training Program, Herman Method, Voyager Reading Program, Wilson Reading System) – fell within the scope of the evidence standards for the Students with Learning Disabilities protocol (IES, n.d.a). This means that the WWC was unable to draw any conclusions based on the available research about the effectiveness or ineffectiveness of these interventions for students with LD. Only Project Read phonology fell within the scope of the Students with Learning Disabilities WWC evidence standards; however, no discernible effects on general reading achievement for students with LD were found (IES, 2010b).

Nevertheless, it is important to note that the "long term, extensive use of OG has been encouraged by anecdotal evidence and personal experience" (Ritchey & Goeke, 2006, p. 172). This "practice to research gap" (Ritchey & Goeke, 2006, p. 182) exists largely due to the endorsement of OG by parents who observe true progress in their child's reading. Thus, the popularity of OG is reflected in an examination of 27 reading methodology case law decisions in the United States, which revealed that OG was the preferred methodology requested by parents, at 67%, followed by Lindamood-Bell, at 16% (Rose & Zirkel, 2007). Given these findings, the lack of rigorous scientific research highlights the need for increased study on the effectiveness of OG intervention.

In spite of the lack of evidence to support OG-based reading interventions, a meta-analysis of several hundred studies conducted in 2000 by the National Reading Panel (NRP) determined that phonemic awareness training and systematic phonics instruction makes a significant improvement in reading growth in children compared to unsystematic instruction or no phonics instruction (pp. 2–130). Furthermore, an examination by the WWC of effective reading instruction for emergent readers, struggling readers, and/or readers with LD, showed positive effects on alphabetic instruction in three programs, potentially positive effects in three additional programs, and evidence of a small effect in one program. However, no specific outcomes were evaluated by the WWC for students with LD equivalent in age to the participants in the present study (IES, 2010c). Consequently, although OG-based methodology has yet to be legitimized, evidence suggests that the phonemic awareness and phonics instruction used in OG are successful instructional strategies for reading.

National Institute for Learning and Development Educational Therapy (NILD)

The NILD also adheres to a structured, sequential, multisensory keyword remedial approach to literacy instruction based on OG methodology, identified as the Blue Book method (Dwyer, 2000). However, NILD's remedial approach differs from OG in its overarching educational paradigm, which includes an emphasis on neurocognitive and social-emotional development. This paradigm is based on Feurstein's (1980, as cited in Mentis, Dunn-Bernstein, & Mentis, 2008) concept of structural cognitive modifiability, which posits that cognition is plastic and can be structurally changed through a mediated learning approach. The approach is supported by Vygotsky's (1978) theory of the Zone of Proximal Development (ZPD), whereby a mediator or more capable peer scaffolds student learning to achieve greater results than the student could do independently.

As for OG, scientific research on NILD's effectiveness remains inconclusive. Thus, a review of existing NILD studies appears to suggest a lack of rigorous scientific methodology. Stanley's (2008) study of 29 students was a quasi-experimental design, using students in grades 2 to 5 who presented as below-grade-level readers although not necessarily with an LD diagnosis.

Szabo and Balla's (2017) study of 13 students from ages 6 to 12 received pre/post math tests after receiving NILD's math intervention or no special intervention. Although greater gains were seen after seven months in the NILD treatment group than the control group, these results were not statistically confirmed. Furthermore, other studies suffer from a lack control groups (Benson & Scott, 2005; Keafer, 2008), consistency in length of intervention (Gollery, 2018), quantitative measurement (Hutchinson, 1999), randomized selection (Cawthon & Maddox, 2009; Hopkins, 1996; Szabo & Balla, 2017), and controls for IQ (Cawthon & Maddox, 2009; Gollery, 2018).

Despite these shortcomings, the available NILD studies provide some promising preliminary evidence. Specifically, significant outcomes were observed on phonological processing, decoding, and fluency (Stanley, 2008). Increases were also seen in math performance and cognitive performance compared to a control group (Szabo & Balla, 2017), within-group gains over time (Hopkins, 1996), and large effect size results on the Weschler Intelligence Scale for Children (WISC-IV; Wechsler, 2003) pre/post full-scale IQ scores (Gollery, 2018), with the perceptual reasoning subtest showing the largest mean growth. Nevertheless, the lack of rigorous research on the effectiveness of NILD highlights the need for further study.

The NRP's (2000) recommendations for comprehension instruction align with much of NILD's philosophy, stating that "reading comprehension is a cognitive process that integrates complex skills" (pp. 4-1). The NRP has advocated a "transactional strategy instruction" (pp. 4-46), whereby mental processes and cognitive strategies are explicitly discussed to aid comprehension. Other instructional techniques for reading comprehension recommended by the NRP include self-generation of questions, summarization and generalization, visualization, mnemonic strategies, and comprehension self-monitoring through the reading process. These strategies are supported by NILD's mediated instructional approach.

Other Approaches

What is clear, according to Swanson, Harris, and Graham (2014), is that the research is not conclusive as to whether various remedial delivery methods have an influence on student outcomes. According to Swanson et al., intervention efforts for children with language LD are not sufficient for complete remediation of underlying language deficits, suggesting a potential need for other types of remediation, including cognitive interventions. Shaywitz, Modyu, and Shaywitz (2006) claimed, "The utilization of advances in neuroscience to inform educational policy

and practices provides an exciting example of translational science being used for the public good" (p. 281).

Based on Swanson et al.'s (2014) assertion that current interventions do not include remediation for the underlying language deficits, there exists a need to determine whether interventions that target the underlying cognitive deficits would yield improvement in cognitive results. Furthermore, if cognitive improvements were noted, further studies could suggest that, over time, greater gains would be seen in academic outcomes.

The current study sought to compare a commonly known intervention for LD (OG) with an alternative intervention that also targets cognition (NILD) to determine if differences in academic and cognitive outcomes between the two types would inform future remedial interventions. The importance of integrating a cognitive approach to academic remediation may be understood by Hale and Fiorello's (2004) cognitive testing hypothesis (CHT). Among the four premises of this theory, the authors stated that a number of complex cognitive and neuropsychological processes have been empirically linked to academic achievement and that academic deficits must be remediated and/or compensated for based on underlying cognitive strengths and weaknesses. NILD (n.d.) has subscribed to this neuroscientific approach to remediation of students with LD.

Evidence suggests alternative methods of developing cognition. Mindfulness meditation, for example, "might cause neuroplastic changes in the structure and function of brain regions involved in regulation of attention, emotion and self-awareness" (Tang, Hözel, & Posner, 2015, as cited in McKay, 2018, Evidence that Mindfulness Meditation Affects the Brain section, para. 2). Just one year of music instruction has been correlated with improved scores in "general intelligence skills such as literacy, verbal memory, visuospatial processing, mathematics and IQ" ("First evidence," 2006, para. 1).

In summary, despite the proliferation of LD resources, there remains a lack of solid evidence to support an interdisciplinary approach to remediation. This study aimed to fill this gap by exploring outcomes of two intervention approaches.

The Current Study

The purpose of this preliminary study was to determine if there was a difference in academic and cognitive outcomes between an OG group receiving a pure literacy-based interventional approach and an NILD group receiving targeted cognitive remediation in the context of literacy instruction. Evidence suggests "a strong convergence between the brain's structural and functional alterations in the left hemisphere of the dyslexic brain" (Linkersdörfer, Lonnemann, Lindberg, Hasselhorn, & Fiebach, 2012, para. 31). This notion creates the possibility that by strengthening the brain's neuropathways through cognitive remediation, academic functions can be improved. This, in turn, suggests a need for a multidisciplinary approach to literacy remediation.

Our primary aim was to determine if there were differences in cognitive outcomes between the OG group and the NILD group, measured by fluid reasoning standard scores. A secondary aim was to determine if different instructional approaches resulted in differences in outcomes on word attack and reading comprehension standard scores post intervention. (Measurement of neural pathways was beyond the scope of the study.)

It is important to examine the two types of interventions because both claim to remediate literacy, but only NILD claims to remediate the specific cognitive processes necessary for growth in literacy. We examined pre and post academic achievement and cognitive results using the Woodcock Johnson IV Tests of Achievement (WJ-Ach) and Woodcock Johnson IV Tests of Cognitive Abilities (WJ-Cog), respectively, for both the OG and NILD groups (Schrank, McGrew, Mather, Wendling, & LaForte, 2014). For the WJ-Cog test, we selected the variable of fluid reasoning to measure general cognitive growth as this measure represents the broad ability to reason by forming novel concepts and solving problems without requiring background knowledge. This composite score consists of Concept Formation and Number Series subtests. For the WJ-Ach test, we selected two reading variables, word attack and reading comprehension. To facilitate the inquiry, we posed the following research questions:

Research Question 1: Does the type of remedial intervention produce different cognitive results between the OG and the NILD groups?

H1: Larger gains will be seen on cognitive measures of fluid reasoning in the NILD group than in the OG group post intervention.

Research Question 2: Does the type of remedial intervention produce different academic results between the OG and NILD groups?

H2: Larger gains will be seen on academic measures of reading (word attack) in the OG group than in the NILD group post intervention.

H3: Larger gains will be seen on academic measures of reading (comprehension) in the NILD group than in the OG group post intervention.

Method

Research Participants

The study adhered to the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans* and followed the core principles of respect for persons, concern for welfare, and justice (Government of Canada, Panel on Research Ethics, 2014). Free, informed, and ongoing consent was obtained in writing from parents and student participants, who voluntarily agreed to participate.

Participants were 27 students in grades 7, 8, and 9 from an urban independent school in British Columbia serving grade 2-12 students with LD. Participant ages ranged from 143 to 177 months with an average of 159.69 months or 13.3 years (see Table 1). Remediation is provided as part of the regular school schedule, and no pull-outs were required. All participants had one or more diagnosed LDs in either reading (RD), written expression (WD), or math (MD), neurocognitive disorder not otherwise specified (NOS), or LD unspecified (UNSP; see Table 2).

Participants were randomly assigned to the OG group or the NILD group using a stratified process. Names were printed on strips of paper, separated by grade, and then gender. Beginning with grade 9 boys, names were alternately assigned to the NILD and OG groups. This was followed by grade 9 girls, grade 8 boys, grade 8 girls, grade 7 boys, and finally grade 7 girls.

Participants were not stratified by LD type for two reasons. First, the majority of them had multiple diagnoses, and all educators designed individualized lessons based on students' academic and cognitive profiles, reflecting the school's practice of having each educator prescribe the intervention plan for both NILD and OG students based on formal and informal diagnostics. Second, in both OG and NILD interventions, approximately 30% of each lesson is developed from predetermined scope and sequence of options chosen at the discretion of the educator to target the students' particular areas of need. Despite the randomized assignment to an intervention type, both groups had relatively evenly distributed diagnoses between groups. As a result, it was not expected that distribution of LD types between groups would materially impact the study outcomes (see Table 2).

Each participant received 64.2 hours of one-to-one instruction in either OG (N = 15) or NILD (N = 12) for 70 minutes on alternating days with two sessions and three sessions per week, respectively, across 27 weeks. The OG group consisted of 11 males and 4 females whereas the NILD group was comprised of 8 males and 4 females. Three male students from the NILD group withdrew from the study mid-year due to departures from the school.

Selection Criteria

Research participants met the selection criteria based on their percentile scores on the WISC General Ability Index (GAI) and the Cognitive Proficiency Index (CPI). The GAI consists of the Verbal Comprehension Index (VCI) scores and the Perceptual Reasoning Index (PRI) scores; the CPI consists of the Working Memory Index (WMI) scores and Processing Speed Index (PSI) scores (Wechsler, 2003).

To meet the selection criteria, participants needed a VCI score and/or a PRI score of greater than the 25th percentile and a CPI score of less than 25th percentile on the WISC IV assessment (Wechsler, 2003). Thus, all participants had average or above-average general cognitive ability and below-average cognitive efficiency in addition to a designated LD based on psychoeducational assessment reports conducted by registered educational psychologists. These reports were provided by families upon their child's admission to the school. Students were excluded from the study if they were new to the school or had received previous NILD intervention.

Remedial Educators

All educators were full-time learning specialists (LS) and either professionally certified NILD educational therapists (PCET) and/or certified OG associate practitioners by either the Canadian Academy of Therapeutic Tutors or the Academy of Orton Gillingham Practitioners and Educators. The average years of educator experience in one-to-one remedial work for students with LD was seven for NILD and six for OG. NILD educational therapists had recently completed Level III training to achieve certification.

Study Design and Intervention

Pre and post intervention testing was conducted by qualified B level testers for the WJ-Ach and C level testers for the WJ-Cog. Testers used the WJ-Ach B version for the posttest and the WJ-Ach C version for the pretest to ensure test-retest reliability.

Table 1
Participant Demographics

Variable	OG group	NILD group
Number of participants		
Male	11	8
Female	4	4
Age in months		
Mean	160	160
Race/ethnicity		
Caucasian	14	10
African American/African Canadian	0	1
Asian/Asian Indian	1	1
Socioeconomic status		
High	15	12
Grade level		
Mean years in special education placement	2.27	1.33
Level of Placement	7,8,9	7,8,9
Intelligence (WJ-IV Cog.)		
Mean W score[a]	504	504
Range	490–524	488–519
Overall academic achievement[b]		
Mean W score	502	502
SD	12.9	13.9
Range	476–520	478–520
Specific academic achievement[c]		
Mean W score	509	503
SD	9.1	13.8
Range	490–522	472–523

Note. WJ-IV Tests of Cognitive Abilities (Jaffe, 2009). [a]The W score is a foundational metric for all derived scores standard, percentile, and relative proficiency index on an equal interval scale that allows comparison of differences between two sets of scores. [b]Measured using WJ-IV Tests of Achievement, Academic Skills Composite. [c]Measured using WJ-IV Tests of Achievement, Reading Composite.

OG group. Participants in the OG group received the school's regular one-to-one OG remedial intervention whereby the LS determined the instructional focus and lesson design based on students' individual profiles. Student information was gathered from psychoeducational assessments, individualized education programmes (IEP), informal diagnostic lessons, and LS observations.

Lessons in OG comprised eight core elements, visual drill, auditory drill, phonological awareness activities, spelling dictation, blending drills, rapid reading drills, discretionary new concept instruction, and novel reading (Leopold, 2017), using direct instruction in a multisensory, cumulative, and sequential manner. Phonemes/graphemes were introduced individually using a keyword approach with progression occurring once

Table 2
Learning Disability Diagnosis by Student

Identifier	DSM reading	DSM writing	DSM math	LD-NOS	LD Unspecified
DSM diagnosis per student for OG group					
OG1	1	0	0	0	0
OG2	1	1	1	0	0
OG3	1	1	1	0	0
OG4	1	1	0	0	0
OG5	1	1	0	0	0
OG6	1	1	0	1	0
OG7	1	1	1	0	0
OG8	1	1	1	0	0
OG9	1	0	0	1	0
OG10	1	1	0	0	0
OG11	0	0	0	0	1
OG12	1	1	1	0	0
OG13	0	1	1	0	0
OG14	0	1	1	1	0
OG15	0	0	0	0	1
Total	11	11	7	3	2
DSM diagnosis per student for NILD group					
NILD1	1	1	0	0	0
NILD2	1	1	1	0	0
NILD3	0	1	1	1	0
NILD4	1	1	1	0	0
NILD5	1	1	1	0	0
NILD6	1	1	1	0	0
NILD7	1	1	1	0	0
NILD8	1	0	1	0	0
NILD9	0	0	0	0	1
NILD10	1	1	1	0	0
NILD11	1	1	1	1	0
NILD12	0	1	0	0	0
Total	9	10	9	2	1

Note. LD-NOS = Learning disorder not otherwise specified; LD Unspecified = British Columbia Ministry designation for learning disability "Q."

Table 3
Pedagogical Similarities and Differences Between OG and NILD Approaches

Aspect	OG	NILD	Both OG and NILD
Diagnostic and Statistical Manual Reading Disorder	Starts phonological instruction at level of student independent success; uses direct instruction.	Starts phonological instruction at beginning of Blue Book; applies ZPD strategy and mediated instruction using Socratic questioning.	Sequential, cumulative, and multisensory; apply OG structured literacy approach.
	Does not move on until mastery of concept is achieved.	Moves on to new linguistic pattern or concept regardless of mastery, and reinforces previous concepts in subsequent lessons to achieve mastery.	Focus on phonology; develop skills in decoding accuracy, fluency, and comprehension.
	Does not assume student knows anything that has not been directly instructed; repetition to automaticity.	Teaches students to apply cognitive strategies such as compare, label, search for patterns, use precise accurate language, and connect to prior knowledge to discover concepts.	Emphasis on student success – student gains confidence in process; individualized instruction.
	Highly structured lessons using flash card system to introduce and reinforce concepts.	Structured literacy lesson that includes explicitly targeting cognitive skills at the input, elaboration, and output phases to develop concepts.	Keyword approach; lessons contain components of phonemic awareness, phonology, blending, syllabication, word reading, reading fluency, and morphology.
Diagnostic and Statistical Manual Disorder of Written Expression	Modeling; direct instruction and cueing; repetition and review; application of learning.	Modeling and mediated instruction; applying specific thinking actions; application of learning.	Sequential, cumulative, multisensory; focus on spelling, sentence type and structure, grammar, paragraph and essay organization and structure, editing strategies.
Diagnostic and Statistical Manual Math Disorder	Not applicable.	Math block: Builds number sense, memory strategies, math vocabulary, abstract reasoning, and real-world application; emphasizes process over product and justification of responses using precise and specific language.	Not applicable.
General strategies	Direct instruction.	Mediated instruction.	Sequential, cumulative; step-by-step, repetition, and review; use of mnemonics, extra time for processing, executive function strategies; cues to focus, breaks as needed, success oriented.

the concept had been mastered. Lessons addressed the following areas: reading (decoding, fluency, comprehension), written expression (spelling, sentence structure, grammar, mechanics, ideation, outlining, structure, editing), and executive functioning (EF) such as planning, prioritizing, and organization (see Table 3).

NILD group. Participants in the NILD group received NILD educational therapy instead of the standard OG. This approach differs from OG in that it incorporates a mediated instructional approach (Feuerstein, Rand, Hoffman, & Miller, 1980) using open-ended questioning based on student responses. NILD prompts students to connect to prior knowledge and apply specific thinking strategies in addition to learning the alphabetic code in order to build literacy. This alphabetic instruction employs The Blue Book, which differs from OG in that students learn multiple spelling options for each phoneme by linguistic pattern recognition, mnemonics, and chunking. Like OG, NILD uses a keyword approach and visual, auditory, and oral rehearsal. Sequential progression occurs regardless of mastery, which is achieved through subsequent questioning and review. A key focus of the NILD approach is targeted cognitive remediation, which underlies literacy and learning (see Table 3).

NILD lessons consist of five core elements: rhythmic writing, dictation and copy, buzzer, Blue Book, and math block. Math block is designed to develop number sense, memory strategies, math vocabulary, abstract reasoning, and real-world application. Emphasis is placed on process over product and justification of responses using precise and specific language.

In addition, NILD includes up to 19 discretionary supplementary elements selected by the LS to target academic and cognitive functions based on individual student need. These supplementary elements target visual and auditory discrimination, visual and auditory working memory, sequential processing, visual-spatial processing, EF, reading fluency and comprehension, written and oral language, and math. Students identify and verbalize their cognitive strategies, which are mediated by the instructor (see Table 3). Both OG and NILD lessons incorporate 5 to 10 minutes of EF strategies known as "EF Time" from the school's executive function curriculum (Huopalainen & Stebbings, 2017).

Study Fidelity

Contributing to study fidelity was the fact that educators used standardized lesson plan templates reflecting either the OG or NILD approach. To ensure study fidelity, a teacher-on-call (TOC) with an MEd degree conducted monthly observations of all OG and NILD lessons using a checklist to verify that the stated elements of the lessons were followed and the appropriate methodology was applied. Educators also kept daily anecdotal observational notes that were reviewed by the TOC to provide further evidence of appropriate strategy implementation. All records were reviewed by the TOC, and no variations from the prescribed instructional delivery model were reported.

Results

Data were analyzed by the University of British Columbia's Applied Statistics and Data Science Group. To test the primary and secondary hypotheses of estimating differences between the groups, a linear model was used with post measurements as outcomes, group as a main effect, and pre measurements as covariates. Additionally, age and gender were added as covariates. Thus, the estimated group differences in post measurement were adjusted for their baseline (pre) measurements, age, and gender. Linear modeling was chosen due to the imbalanced number of observations in each of the groups.

Standard Scores of Pre and Post Fluid Reasoning by Group

With regard to the first outcome of the primary hypothesis, it was expected that NILD would produce greater outcomes on the fluid reasoning variable after intervention. Results indicated that the median of the standard score for fluid reasoning increased over time for both NILD and OG, with NILD increasing more dramatically. The median of the post standard score for fluid reasoning was higher in NILD than in OG. However, variability in the data was large in both groups due to the small sample size, so there were no statistically significant differences between or within groups (see Figure 1).

Furthermore, the results suggested that the variability of standard scores of fluid reasoning within each student differed: from very small, to modest, to very large (see Figure 2). With a 95% confidence interval (CI), the average fluid reasoning scores were higher in the NILD group at both pre and post time points. Again, due to the wide range of CI, differences between NILD and OG were not statistically significant (see Figure 3). See Table 4 for the means and standard deviations for pre and post measurements.

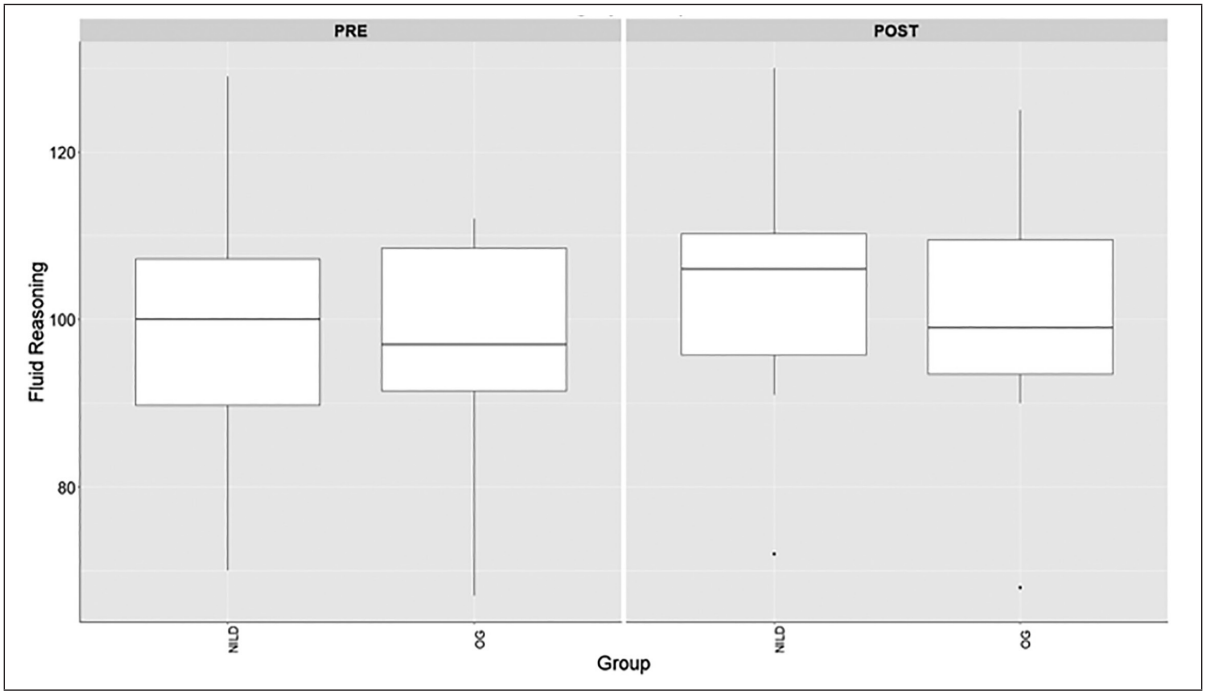

Figure 1. Boxplot of pre and post standard scores for fluid reasoning by group.

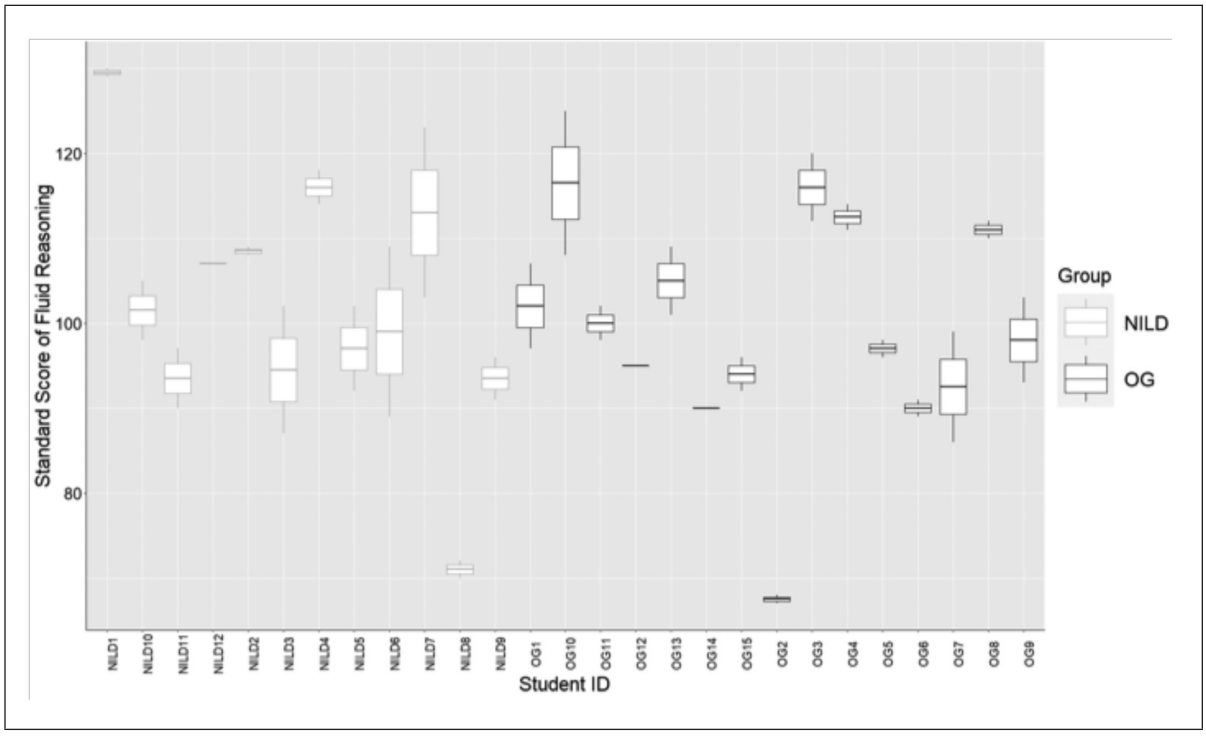

Figure 2. Boxplots of standard scores for fluid reasoning for each student by group.

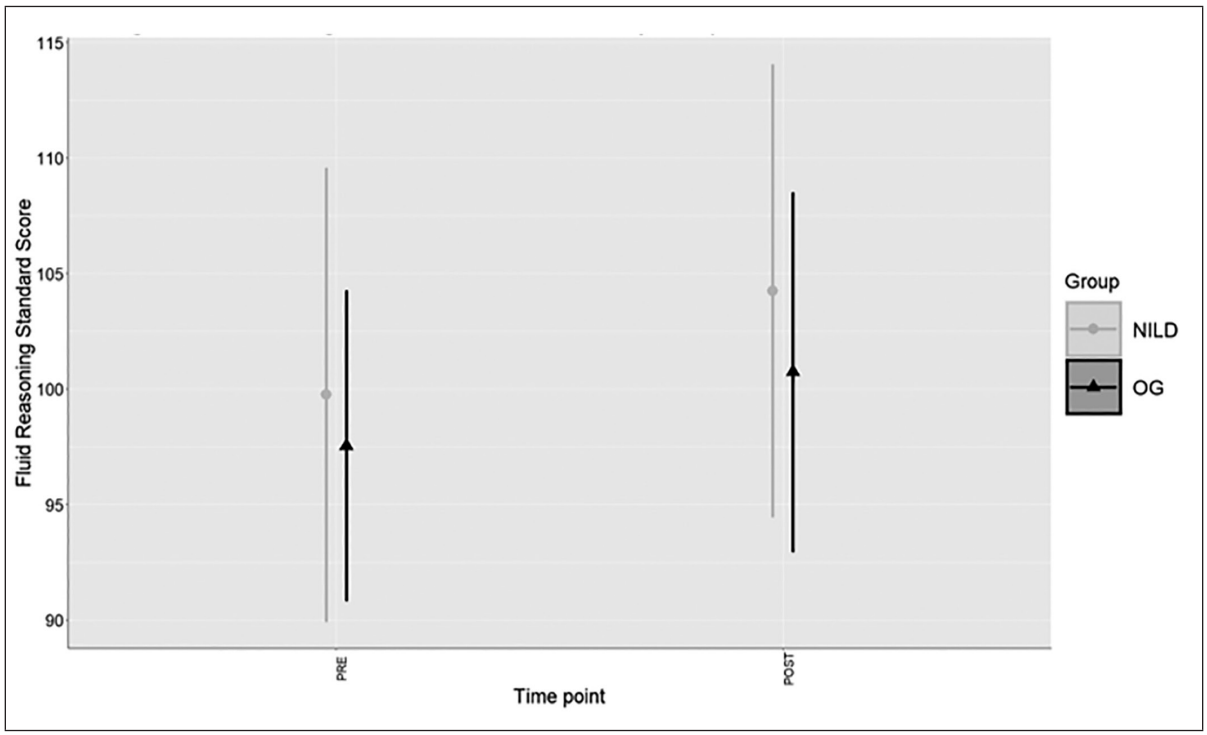

Figure 3. Average fluid reasoning standardized scores at each time point by group.
Note: The vertical lines through the points represent corresponding 95% CI.

Table 4
Three Standard Scores Outcomes

		Pre		Post	
Outcome	Group	*M*	*SD*	*M*	*SD*
FR	NILD	99.75	15.375	104.25	15.33
FR	OG	97.53	12.047	100.73	13.97
WA	NILD	94.00	15.696	102.25	11.78
WA	OG	96.67	12.028	107.60	11.59
RC	NILD	84.42	15.524	93.75	14.32
RC	OG	93.07	9.169	97.13	12.42

Note. FR = Fluid reasoning composite; WA = Word attack; RC = Reading comprehension.

Test of Primary Hypothesis on the Primary Outcome Fluid Reasoning, Linear Model

To test the first hypothesis for fluid reasoning, a linear model was used with post fluid reasoning standard scores specified as an outcome and group as a main effect. The group differences in post fluid reasoning standard scores were adjusted for pre fluid reasoning standard scores, age, and gender. Using this model, no significant difference was found between the groups in post fluid reasoning standard scores (see Table 5). However, the means estimate of post fluid reasoning standard scores for NILD was higher than OG by 1.486; 95% CI (-5.52, 8.49; see Table 6). The CI for fluid reasoning was not adjusted for multiple testing since this was our primary outcome.

Standard Scores of Pre and Post Word Attack by Group

In the secondary outcome of the secondary hypothesis, it was expected that OG would produce

Table 5
Coefficients From the Linear Model Fit for Fluid Reasoning

Coefficient	Estimate	Std. Error	*t*	*p*
(Intercept)	12.4497	25.8666	0.4813	0.6351
SS_FR_PRE	0.8922	0.1281	6.9669	0.0000
GroupNILD	1.4860	3.3794	0.4397	0.6644
Age	0.1425	1.7006	0.0838	0.9340
GenderMale	-0.7964	3.6807	-0.2164	0.8307

Note. SS_FR_POST~SS_FR_PRE+Group+Age+Gender.

greater outcomes on the post word attack standard scores. Results indicated that the median of the standard score for word attack increased over time for both NILD and OG, with OG increasing more dramatically. The median of the post standard score for word attack was higher in OG than in NILD. Again, due to higher variability in the small sample size, statistically significant outcomes were not expected between groups (see Figure 4). Not surprisingly, when looking at the variability of word attack standard scores within each student, results differed from very small, to modest, to very large (see Figure 5).

Average word attack scores in both OG and NILD groups increased over time. Notably, the word attack standard score was higher in OG at both pre and post time points. Again, as expected, based on the small sample size and variability, there were no statistically significant differences between the groups (see Figure 6). Table 4 lists the means and standard deviations for pre and post measurements.

Test of Secondary Hypothesis for the Secondary Outcome Word Attack, Linear Model

To test the secondary hypothesis for word attack standard scores, a linear model was again used, where post word attack standard score was the outcome variable and group was the main effect. The group differences were adjusted for pre word attack standard scores, age, and gender. Using this model, there was no significant difference between groups (see Table 7). However, the means estimate of post word attack standard scores for NILD was lower than for OG by 4.533; that is, the group difference estimate for NILD com-

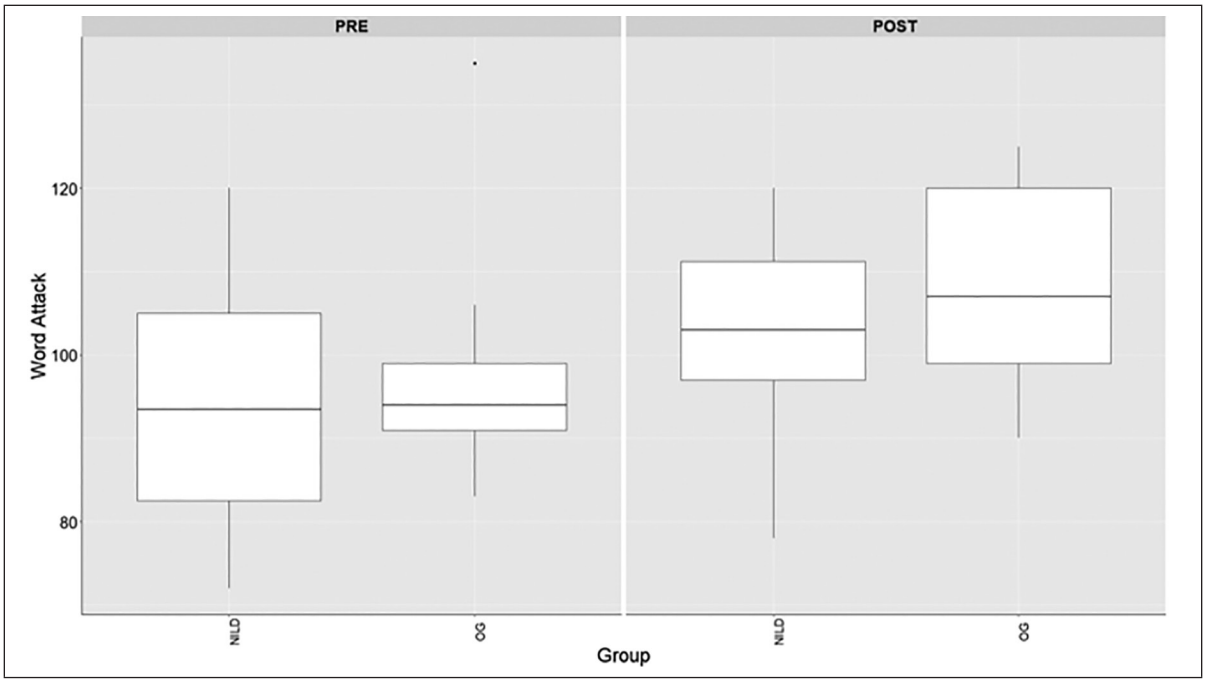

Figure 4. Boxplot of pre and post standard scores for word attack by group.

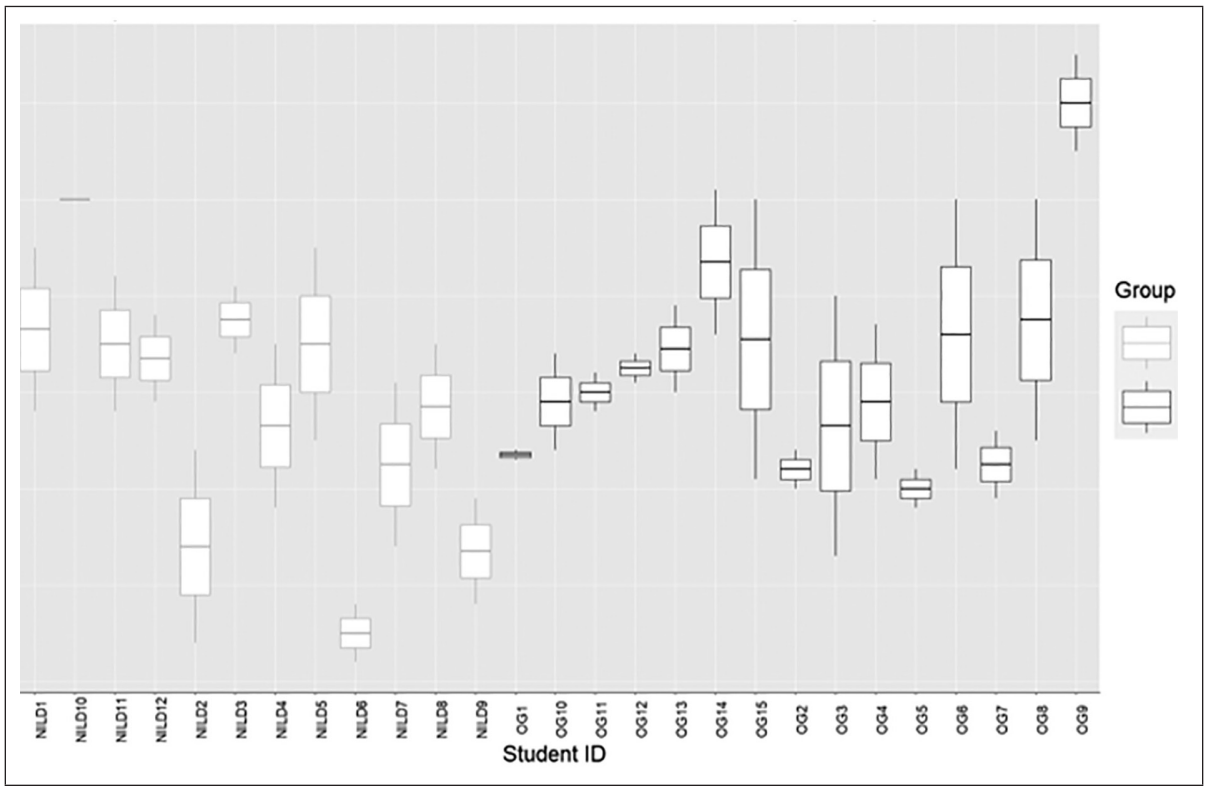

Figure 5. Boxplots of standard scores for word attack for each student by group.

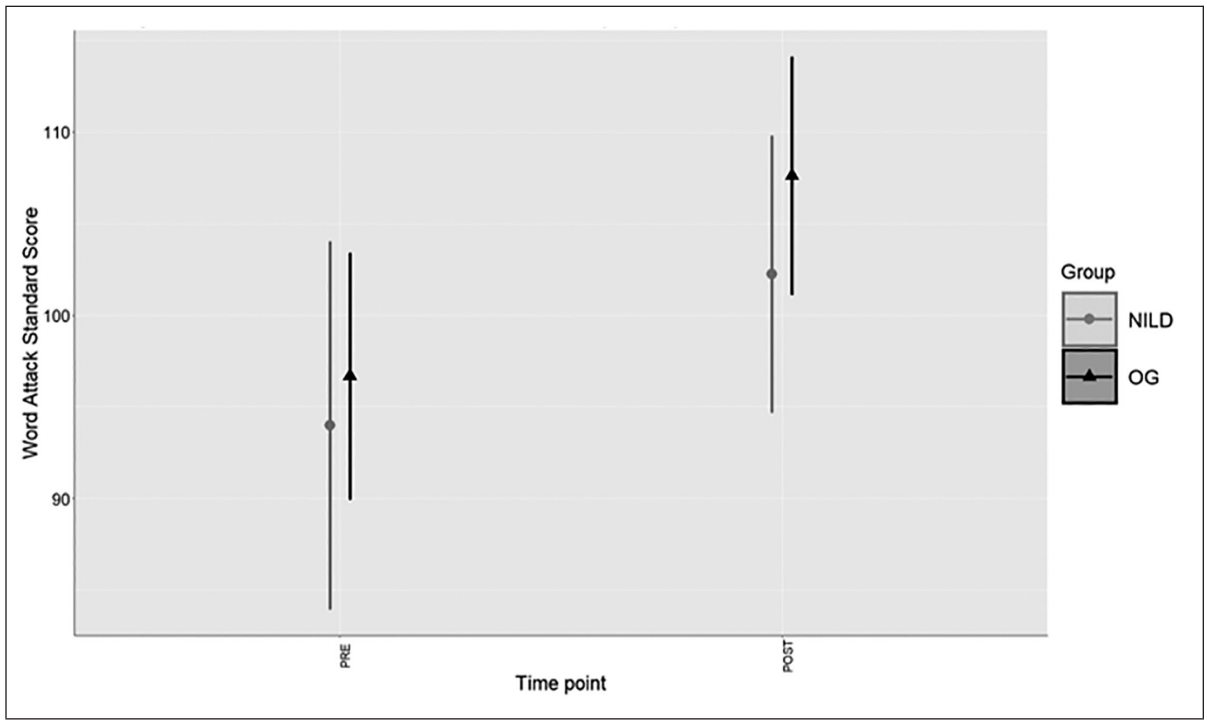

Figure 6. Average word attack standardized scores at each time point by group.
Note: The vertical lines through the points represent corresponding 95% CI.

Table 6
Estimates and Confidence Intervals for All Three Outcomes

Hypothesis	Outcome	NILD.OG.Diff	Lower_CI	Upper_CI	Cohen f^2
1	FR	1.485962	-5.52252	8.494448	0.008788
2	WA	-4.53262	-13.327	4.261793	0.069866
3	RC	4.382788	-3.5928	12.35838	0.079424

Note. FR = Fluid reasoning composite; WA = Word attack; RC = Reading comprehension.

Table 7
Coefficients From the Linear Model Fit for Word Attack

Coefficient	Estimate	Std. Error	*t*	*p*
(Intercept)	70.2563	26.8743	2.6143	0.0158
SS_WA_PRE	0.5075	0.1368	3.7094	0.0012
GroupNILD	-4.5326	3.6560	-1.2398	0.2281
Age	-0.4478	1.8409	-0.2433	0.8101
GenderMale	-8.0409	3.9729	-2.0239	0.0553

Note. SS_WA_POST~SS_WA_PRE+Group+Age+Gender.

pared to that of OG was -4.533 with 97.5% CI (-13.3, 4.26; see Table 6). The CI of the group effect estimate was adjusted for two tests (word attack and reading comprehension) using the Bonferroni correction technique for multiple testing.

Standard Scores of Pre and Post Reading Comprehension by Group

It was expected that NILD would produce greater outcomes than OG on the reading comprehension variable post intervention. Results indicated that the median of the standard score for reading comprehension increased over time for both NILD and OG, with NILD increasing more dramatically. The median of the post standard score for reading comprehension was only slightly higher in OG than in NILD. However, variability in the post reading comprehension scores was greater in the OG group than in the NILD group, so statistically significant outcomes were not expected between groups (see Figure 7). As anticipated, when looking at the variability of standard scores of reading comprehension within each student, results differed from very small, to modest, to very large (see Figure 8).

Average reading comprehension scores in both the OG and NILD groups increased over time. Notably, the reading comprehension standard score was higher in NILD at both pre and post time points. Again, as expected, based on the small sample size and great variability, there were no statistically significant differences between the groups (see Figure 9). Table 4 lists the means and standard deviations for pre and post measurements.

Test of Secondary Hypothesis on Secondary Outcome Reading Comprehension, Linear Model

To test the secondary hypothesis on reading comprehension standard scores, a linear model was used, with post reading comprehension standard scores as an outcome variable and group as a main effect. The group differences were adjusted for pre reading comprehension standard scores, age, and gender. Using this model, there was no significant difference between the groups (see Table 8). However, the means estimate of post reading comprehension standard scores for NILD was higher for OG

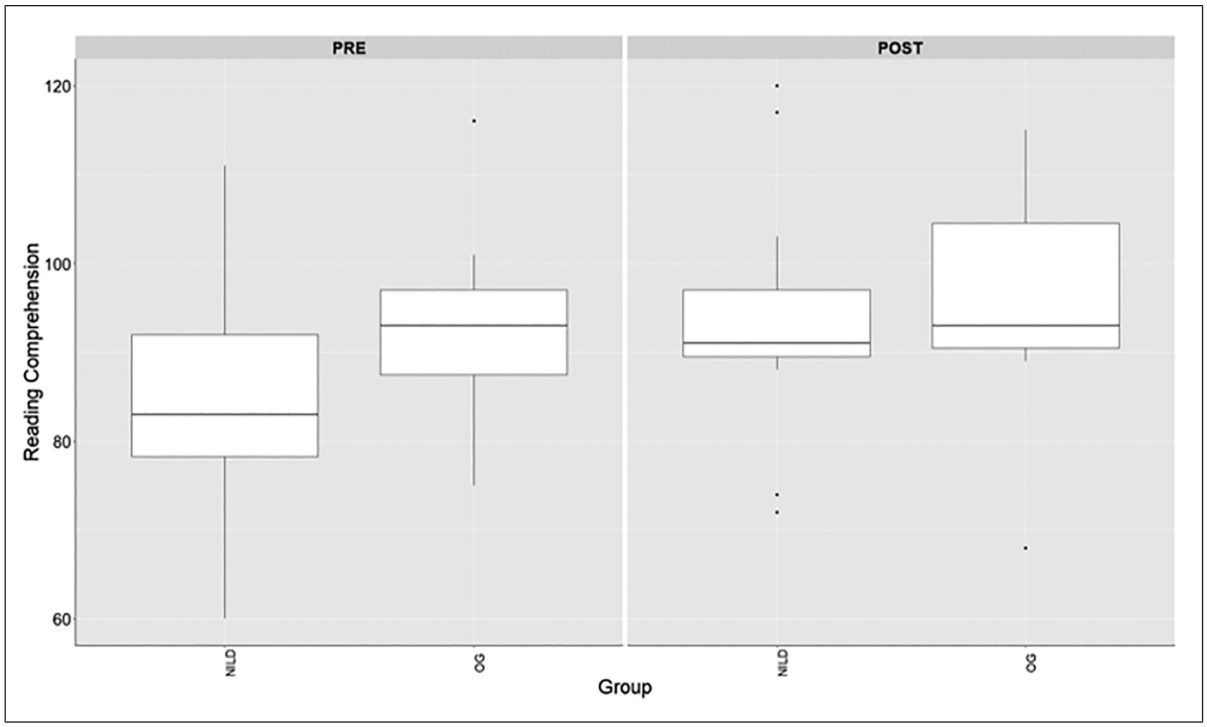

Figure 7. Boxplot of pre and post standard scores for reading comprehension by group.

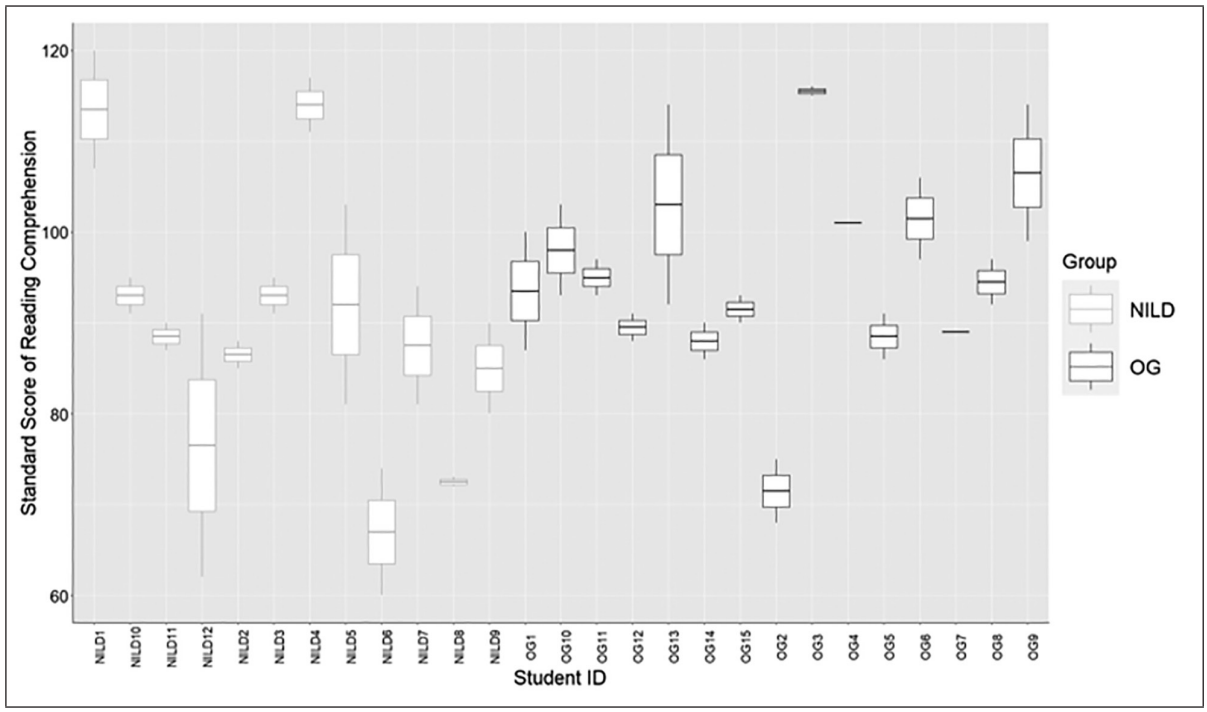

Figure 8. Boxplots of standard scores for reading comprehension for each student by group.

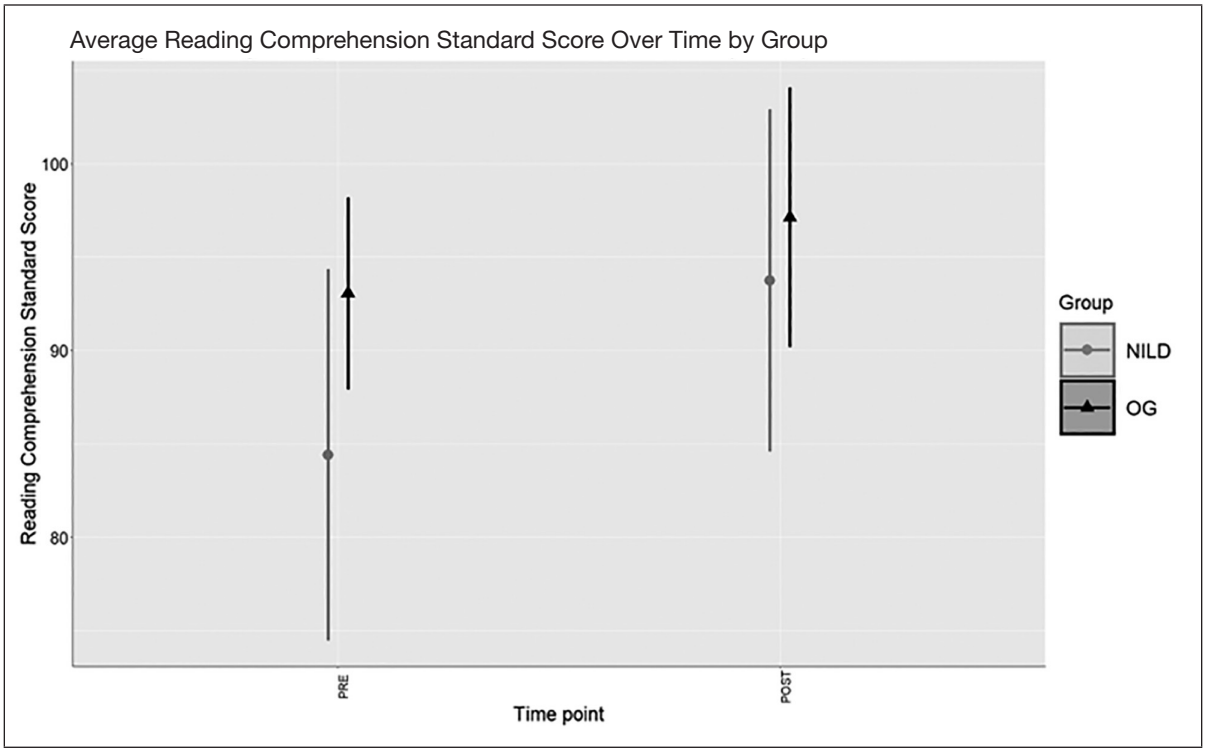

Figure 9. Average reading comprehension standardized scores at each time point by group.
Note: The vertical lines through the points represent corresponding 95% CI.

Table 8
Coefficients From the Linear Model Fit for Reading Comprehension

Coefficient	Estimate	Std. Error	*t*	*p*
(Intercept)	61.6428	24.4229	2.524	0.0193
SS_RC_PRE	0.8647	0.1337	6.469	0.0000
GroupNILD	4.3828	3.3156	1.322	0.1998
Age	-3.7027	1.5567	-2.378	0.0265
GenderMale	4.2937	3.4946	1.229	0.2322

Note. SS_RC_POST~SS_RC_PRE+Group+Age+Gender.

by 4.383; 97.5% CI (-3.60,12.36; see Table 6). The confidence interval was adjusted for two tests (for the two secondary outcomes word attack and reading comprehension) using the Bonferroni correction technique for multiple testing.

Discussion

This study offers preliminary support for the notion that targeted remedial interventions can impact academic outcomes. While it is interesting to see higher cognitive scores on fluid reasoning following cognitive remediation, the effect becomes more relevant when it impacts academic outcomes such as reading comprehension, as demonstrated by the NILD group. Equally meaningful, the intervention primarily designed to build basic reading skills was able to do just that, congruent with the instructional focus of OG. These findings further assert the notion that there is a place for both direct instruction and a mediated learning approach in remedial pedagogy.

One of the most interesting outcomes of the study was that OG showed greater results in reading decoding whereas NILD showed greater results in reading comprehension. These findings can be directly attributed to the instructional approaches used in each group.

Berninger and Richards' (2002) concept of high- and low-level reading skills provides a useful model to illustrate the two approaches. For example, OG primarily emphasizes low-level reading skills such as word recognition; in essence, learning to read. Conversely, NILD, while also remediating phonological skills and phonics, primarily focuses on the higher-level aspects of reading such as comprehension; in essence, reading to learn. These preliminary results clearly support the notion that the type of instructional approach to reading impacts academic outcomes. This idea is further supported by Fiorello, Hale, and Snyder (2006) with reference to the response to intervention (RTI) model (RTI Action Network, n.d.). Fiorello et al. stated,

> Despite the well-established research base for instruction in multiple areas of reading including phonemic awareness, phonics, fluency and comprehension (NRP, 2000), RTI interventions typically focus on one or a few areas of difficulty (e.g., phonemic awareness) to the exclusion of many others such as higher level comprehension skills. There are numerous reasons for reading disability, and focusing on a single determinant cannot effectively identify or serve all children with the disorder. (2006, p. 836)

The aim of both the OG and the NILD remediation is to foster learner independence. To do so, Fiorello et al. (2006) suggested that it is important to "develop individualized interventions based on cognitive processing strengths and weaknesses" (p. 837) and that remediation should include a neurological approach that acknowledges "the cognitive processes that underlie reading performance rather than focusing on visible input or output demands" (p. 837). The preliminary findings of this study support previous assertions that underlying cognitive processes can impact academic achievement, confirming the value of an interdisciplinary interventional approach to students with LD.

This study provides preliminary evidence that targeted cognitive remediation positively impacts reading comprehension, whereas targeted phonics remediation positively impacts reading decoding. Although both intervention types support the development of literacy, they do so using markedly different approaches, suggesting that there is value in identifying the primary area of student need in order to determine the best interventional approach.

Recommendations

Not only does this study provide preliminary evidence of where the two interventions, OG and NILD, are more effective, it also presents practical support for an approach that can address weaknesses in academic and cognitive processes, thus increasing the scope of remedial interventions. Based on the current study, we can provide preliminary recommendations for practice in the following ways.

First, for a nonreader or emergent reader with LD, intervention should include an OG remedial model. The focus for OG intervention is learning to read. Diagnosing this type of LD and prescribing treatment does not necessarily require a full cognitive assessment as the focus is on the visible input or output demands, an example of which is RTI.

Second, for a student with LD who has basic decoding skills but whose cognitive profile is impacting learning, intervention should include a cognition-targeted NILD approach in conjunction with phonological instruction. Diagnosing this type of LD and prescribing treatment would benefit from both an academic and a cognitive assessment to fully address the underlying cognitive deficits and enable appropriate remediation.

Third, both types of remediation yielded increases in posttest scores. These results suggest that both students with low-level and high-level literacy needs can benefit from instruction in OG and NILD. The task is to determine how to target instruction based on each individual student's learning profile.

Directions for Future Research

The findings of this study suggest promising results for students with LD. Future research should consider the impact of these interventions on larger sample sizes, different age groups, and in small-group settings. Further, a longitudinal study could assess the retention of academic and cognitive gains.

Limitations

Some limitations of the study need to be considered. The first pertains to the length of educator experience between groups. Educators in both groups were familiar with the student population and had a similar average number of years' experience (OG, $M = 7$; NILD, $M = 6$); however, the NILD group had only recently achieved professional certification. It was not feasible to access certified NILD educational therapists with the same experience as the OG practitioners due to lack of availability.

A second limitation is that all participants came from high socioeconomic backgrounds, therefore having the means to afford private school education. Students from differing socioeconomic backgrounds

would likely experience a range of parental support impacting their academic and cognitive growth. However, the challenge of providing one-to-one intervention to a different demographic would likely be prohibitive due to limited human and financial resources.

A third limitation is that there was no control group due to ethical considerations of withholding intervention students with diagnosed LD. Furthermore, there was no readily available LD population in the public or private system who received no intervention of any kind. In sum, the strength of this student population was that it provided a unique opportunity to study the effects of two types of LD intervention in identical settings. While having a no-intervention control group would have made it possible to assess the efficacy of each of the interventions in general, in future research one could assess the effectiveness of each intervention in general by including a control group with a standard intervention (Singal, Higgins, & Waljee, 2014).

A fourth limitation involves the length of intervention. Although positive results were achieved by both groups over 9 months, it would be beneficial to study performance over a longer period of time to determine further gains and retention. Lastly, a larger sample size in future research would be important in supporting these findings.

Conclusions and Future Implications

The results of this preliminary study suggest that effective reading instruction requires both a low-level phonological approach such as OG and a high-level cognitive approach that emphasizes comprehension, such as NILD. That is, students benefit from an interdisciplinary approach that targets academics and the underlying cognitive processes and is based on individual learning profiles.

The promising results of this study suggest that researchers can feel optimistic in conducting further studies using these remedial approaches. The challenge for psychologists and educators is to appropriately diagnose students with LD in a cost-effective way, so that they can provide the optimum intervention to promote learning independence and maximize potential. It is of the utmost importance that educational policymakers determine a feasible and economically viable way to train faculty and implement OG and NILD or similar remediation in all schools, private and public. In this way, students with LD can think, learn, and thrive as independent adults in society.

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