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Supporting Learning Differences: Effects of Cognitive Training on Cognitive Abilities in a School-Based Sample

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Abstract: A growing body of research demonstrates the effectiveness of computerized cognitive training (CCT) in building specific abilities (e.g., working memory) among school-age children. As a result, CCT is increasingly cited as a means to enhance and support students' academic performance and school experience. However, many studies exploring CCT as an intervention have done so outside of the school setting, limiting its potential impact with regard to students who may benefit from it but cannot access such supports. This project examined the efficacy of a CCT program implemented within the academic day for all students attending a private school. The findings showed that two CCT programs resulted in improvements in working memory, cognitive flexibility, and/or processing speed among third graders through sixth graders (N = 95). Furthermore, this project demonstrates a model for the effective integration of CCT into a school day without interrupting the academic curriculum. The present results have important implications for the current ideological shift in education that focuses on how to more broadly address students' learning differences.

Keywords: working memory; executive function; processing speed; computerized cognitive training; educational interventions

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1. Introduction

The field of education has experienced an increasing awareness of the complex factors affecting children's academic success [1–3]. Attentiveness to children's social–emotional growth, mental health, cultural backgrounds, and exposure to trauma have been at the forefront of discussions within educational spheres, acknowledging the increasing diversity of the student population [2,4,5]. A byproduct of the consideration given to variability in the student body is the greater amount of attention paid to aspects of neurodiversity [6,7]. More specifically, greater recognition has been given to the idea that some children experience learning differences (e.g., cognitive, behavioral, or emotional challenges that impact academic performance) [5,8,9], and research has highlighted where those differences might originate [10–13] as well as how to mitigate differences that might not align well with typical academic expectations [14–18].

An area of focus on work related to learning differences is cognitive ability, as certain cognitive skills are known to contribute to students' academic functioning [3]. For instance, it is well documented in the literature that cognitive proficiencies related to working memory (WM) and executive function (EF) play an integral role in academic success [3,19–23]. Mentally holding, manipulating, and recalling information that is perceived (WM), as well as managing one's attention, emotions, and behaviors (EF), allow a student to attend to and process academic information in a way that increases their understanding and learning and results in more positive academic outcomes [24–26]. However, deficits in WM and EF often result in poor performance and/or behavior in the classroom [8,22–25,27], as students who struggle with these cognitive functions might have trouble staying focused, remembering key elements of a task, and/or maintaining behavior that is productive to learning [24,25,28].

While the relationship between WM, EF, and school achievement has been documented in the literature for some time, acknowledgement of (and acceptance for) the variation in WM and EF abilities across the student population has gained traction more recently in comparison [29–32]. Specifically, rather than basic research simply documenting differences in WM and EF functionality among learners, more recent work is bridging the gap between neuropsychology and education, moving in the direction of highlighting educational interventions (e.g., teaching strategies, training cognitive abilities, and student supports) that can be successful in supporting students who struggle with academic success as a function of deficits in WM and EF capabilities [18,33,34]. In other words, given the important role that WM and EF play in academic performance, some researchers and educators have prioritized the need to examine how teaching and other strategies (e.g., motivational techniques and classroom management) can reach an increasingly diverse student population.

In short, an ideological shift can be seen in education—one in which learning differences are acknowledged, even when they do not translate into diagnosable learning disabilities [5]. Inherent in this shift is the increased attention given to supporting all learners—not just those that might qualify for special education [5]. Whether intentional or not, this body of work serves to (a) acknowledge the role of educators in accepting learning differences, and therefore, the diversity of their student population; (b) broaden the historically narrow focus of teaching to the average learner, highlighting that much success comes from meeting students where they are neurologically and academically; and (c) move the direction of cognitive research to an applied emphasis, allowing for educators to implement strategies to create meaningful change. Therefore, increasing the examination of supports and interventions that can help to ameliorate deficits in cognitive functioning takes on added importance.

1.1. Variability in Cognitive Functioning and Academic Success

Variability in academic success has been attributed to numerous factors. While some reasons are related to teacher quality [35–37], parental support [35,38], and classroom strategies [35,39], cognitive functioning skills are particularly significant, as the academic tasks that students encounter require the effective and fluid engagement of a variety of cognitive abilities. Skills such as attention, retention, planning, and the regulation of both emotion and behavior all contribute to the learning process [22,40,41]. Core academic subjects, such as reading, writing, and math, all involve intricate WM and EF abilities [11,42,43], as these subjects require students to derive meaning from letters and words [44–47] and mentally manipulate numbers in math problems [13,48,49]. Thus, speed and efficiency in processing information [28,44,50], attentive behavior [41,51], and effective emotional regulation [40] are fundamental to learning. When students can effectively process and manipulate the information they take in from the environment (WM skills) while simultaneously maintaining their goals, following rules and directions, persisting through obstacles, and planning how to start and complete tasks (EF skills), academic success is more likely to result [8,19–23,52].

While academic functioning requires WM and EF skills, there are clear individual differences in these capabilities, leading to classrooms made up of both children who excel and others who struggle [27,53]. When WM and EF deficits are experienced, students have difficulty acquiring new knowledge, and over time, this can create learning gaps [24]. Increased academic responsibilities and more difficult school tasks can be associated with greater demands on WM as children progress through each grade [8,50]; therefore, students that have less-developed WM struggle more over time, as they experience increasingly independent learning expectations [8,50]. Additionally, students who struggle with WM and EF abilities are often identified by teachers as having poor behavior in the academic setting [24,25], leading to the potential formation of negative student perceptions from teachers [17,25]—another strike against academic success.

For these reasons, the early identification and intervention of cognitive difficulties can play a pivotal role in ameliorating any negative academic outcomes [54–57]. While deficits in WM and EF are often associated with various mathematical and reading disabilities [11,42,58] and the diagnosis of attention deficit hyperactivity disorder (ADHD) [59,60], not all students who experience WM and EF difficulties meet the criteria for formal diagnosable outcomes that lead to routinized or state-funded supports. Thus, as education continues to shift toward recognizing and valuing student diversity and works to be more inclusive in supportive practices, finding interventions that can be available to all students who might experience learning differences becomes important.

1.2. Cognitive Training to Support Learning Differences

When it comes to children who learn differently and experience deficits in the important WM and EF skills that contribute to positive academic outcomes, one area of work that has shown promising results is the use of computerized cognitive training as an intervention tool [32,34,61]. Computerized cognitive training (CCT) involves the use of brain game programs that target a variety of cognitive skills with the goal of enhancing these abilities and, ultimately, helping to increase academic achievement in children with a broad range of academic difficulties [18,34,61,62]. Studies on CCT have successfully demonstrated improvements in reading [63,64] and math [63,65] following training, with variability in levels of effectiveness attributed to factors such as the length of training [66], the cognitive or academic skills being targeted [63,67], the type of game elements within the training [64], the amount of supervision during the training [66], and the level of motivation for the training task [68].

While CCT is often used to enhance WM, studies have shown that WM contributes to EF skills, as children who have higher WM abilities also demonstrate higher proficiency in their attentiveness, planning ability, cognitive flexibility, problem solving, and self-regulation of behavior [9,25]. Therefore, CCT can also play a pivotal role in supporting children who struggle with a variety of cognitive abilities (e.g., EF and WM); this is especially important as EF and WM do not necessarily operate in isolation in impacting academic performance [26]. Instead, both WM and EF exist as foundational components to educational success [3], and CCT has resulted in improvements in both [18,34,61,64].

Given the positive results seen in previous research, CCT shows potential as an intervention that can assist with learning differences. However, over the course of the past couple of decades, as CCT research has been conducted and as this work has moved into the educational realm, one criticism has been the setting in which CCT has taken place. More specifically, much of the work in CCT has resulted in methodologies in which pre- and post-test analyses of cognitive abilities are run within a clinical or school setting, while the intervention itself is run outside of the controlled setting (e.g., at home) [63]. As researchers and educators work to understand CCT as a viable educational intervention for deficits in cognitive abilities, more calls have surfaced for understanding CCT as a part of the school curriculum [18,63].

1.3. Cognitive Training and the School Environment

School systems are designed to support students who struggle academically. For instance, school psychologists engage in assessment practices that allow for the identification of a student's existing abilities relative to their academic achievement, with the purpose of obtaining access to special education services for students who demonstrate a discrepancy between actual and expected learning outcomes [69]. However, not all students who struggle with academic success qualify for services, and not all have a diagnosable learning disability, leaving a segment of the student population still struggling to achieve their desired academic outcomes [55,69]. In these cases, there is a need for intervention; however, no formalized mechanism exists by which students who do not qualify can receive support.

It is in these situations, in particular, that a school-day CCT program might prove to be especially effective.

The notion of CCT being implemented during school is consistent with the ideological shift that is presently being seen in education that broadens the scope of identification and emphasizes the need to meet the diverse academic needs of all children, including those that might experience processing deficits that do not result in formalized services [5]. As this shift has begun to take form, traditionally outsourced services that might serve as educational interventions (e.g., mental health services) are increasingly moved into the school setting and offered during the school day [5]. The recognition that services and support must be provided within a school space has resulted (in part) from educators and other professionals raising awareness that access to care outside of schools can vary largely based on students' area of residence and socioeconomic status [5,55], leaving more marginalized groups with fewer services. Ultimately, the issue of where services (e.g., CCT) are accessible raises important system-level questions for the field of education.

1.4. The Current Study

In an effort to work toward finding support for students identified as having learning differences, as well as for the broader population of students that might experience learning challenges as a result of unidentified neurological weaknesses, the current study aimed to examine the effects of a computerized cognitive training (CCT) program on students enrolled in a school for children with learning differences. This study seeks to add to the existing literature by (1) examining the effectiveness of a CCT program in improving cognitive abilities and (2) evaluating the effectiveness of a CCT program that is incorporated into the school's curriculum. With regard to the first objective (i.e., examining the effectiveness of CCT), it is hypothesized that cognitive training will improve WM, cognitive flexibility, and processing speed. The second and primary objective (i.e., effectively integrating CCT into the school day) represents an important step toward addressing (and possibly substantiating) the ideological shift in education that seeks to better serve and support students.

2. Methods

2.1. Participants

A total of 95 students (n_{fem} = 35) participated in this study. Participants were school-age students in grades three through six (M_{age} = 11.66 years, *SD* = 1.69) attending a private school in the Southern California area that serves children with learning differences. Fifty-three percent of the students reported their ethnicity to be of European origin. In general, families with children attending the school tend to be of a higher socio-economic status; however, the school provides scholarships to some students to support their enrollment. All participants were treated in accordance with the APA principles code of conduct.

2.2. Measures

Wechsler Intelligence Scale for Children (WISC-V). The WISC-V is a normed reference measure of cognitive abilities. The Digit Span, Coding, and Symbol Search subtests were utilized in this project. The Digit Span task is a measure of working memory (and indirectly, it is a measure of short-term attention). Completion of the Digit Span task requires the individual to (1) recite a series of numbers in the same order as they are verbally presented, (2) recite a series of numbers in reverse order, and (3) recite a series of numbers in counting order. The Coding and Symbol Search tasks are measures of processing speed. The Coding task requires an individual to (as rapidly as possible) draw the associated symbol for a given number. On the other hand, the Symbol Search task requires an individual to encode two target symbols and then determine whether one of the two targets is present in a set of symbols presented adjacent to the targets. Performance on the WISC-V subtests are reported as scaled scores, ranging from 1 to 19, with a mean score of 10.

Delis-Kaplan Executive Function System (DKEFS). The DEFS is a norm-referenced measure of executive function. The Trail Making Task was used to measure cognitive flexibility (or cognitive switching). Trail Making contains five conditions. The first three conditions are measures of scanning abilities and short-term attention under timed conditions. Condition 4 is the measure of cognitive flexibility (and, indirectly, short-term attention). In this condition, an individual is asked to (as rapidly as possible) connect circles using numbers and letters in numerical and alphabetical order, respectively; however, the numbers and letters must be alternately connected. That is, the individual connects 1 to A, 2 to B, 3 to C, etc., until all of the circles are connected. The final condition is a measure of motor speed (and, indirectly, short-term attention). Performance on Condition 4 is described with a scaled score, ranging from 1 to 19 with a mean of 10.

Computerized Cognitive Training (CCT). Two iPad-based CCT programs were used in this study: Recollect the Study and Sightseeing. Both CCT programs were created and developed by the University of California, Riverside's Brain Game Center and are adaptive in that they adjust according to a player's performance in real-time. Specifically, each program becomes more or less challenging based upon a player's current performance. Recollect the Study is primarily designed to train working memory by using a classic n-back and an Item Span task that have been gamified (made to look like and be experienced like a game). During the program, players travel through space, collecting "gems" based on a rule (e.g., they collect a gem if it matches a gem 1-back or collect a gem if it matches a gem 2-back, etc.). The n-back level increases as an individual's performance improves; on the other hand, the CCT automatically adjusts the n-back level downward if the participant is making errors in their responses. Engaging in Recollect the Study effectively requires considerable attention and concentration; thus, both are trained as part of engaging in the program. Sightseeing is a visual processing program. During the task, players must select low-contrast targets that are displayed against a light grey background as quickly as possible. Targets change in appearance (shape and contrast) as the program proceeds; at times, the player is presented with a small number of targets to identify, while in other trials, they are presented with a large number of targets to select. Additionally, as the program progresses, decoys (or non-targets) are presented along with targets. Thus, Sightseeing requires sustained attention and inhibition capabilities (along with visual processing skills).

2.3. Procedure

Information flyers along with the informed consent form were sent home to all families with a student enrolled at the school. These flyers described the implementation of a CCT program into the students' school day that would also include establishing baseline indicators of cognitive abilities and the measurement of the same abilities following the CCT. Participants were pulled out of class to complete pre-testing on all cognitive measures (i.e., the WISC-V and DKEFS subtests) in order to establish a baseline prior to the CCT; these measures were administered by research personnel. Following baseline testing, random assignment was used to assign each participant to either Recollect the Study or Sightseeing for a total of six hours of training across 18 sessions (delivered on Mondays through Thursdays); Fridays were used as a make-up day for any participant who missed training earlier in the week. All training sessions occurred in the participant's classroom during the school day; thus, this CCT program was treated as a part of the school day, just as any other academic subject or experience is a part of the school day. The participant's teacher administered the CCT daily and provided the necessary support to each participant (again, as would be the case if the teacher was teaching an academic subject). Upon the completion of the 18 sessions, each participant completed the WISC-V and DKEFS subtests again (using a pull-out approach identical to the baseline phase).

Because the teachers are integral to the effective implementation of CCT in their respective classrooms, all of them received 3 h and 40 min of training on both CCT programs prior to administering the CCT. The training was broken down into a 90 min introduction to the programs, and then the teachers engaged with each program for 10 min while being observed; feedback was provided (as needed) while they played (i.e., practiced) the program from the perspective of the student. Then, teachers were given an iPad and instructed to play for another 2 h and 20 min on their own over the course of a week. Following the week-long practice, iPads were returned, and any questions from the teachers were addressed. Research personnel provided all of the training for the teachers.

2.4. Design and Statistical Analysis

The current study implemented a pretest–posttest experimental design to test the effectiveness of CCT (implemented during the school day) on improving (1) WM, (2) cognitive flexibility, and (3) processing speed. One-way repeated measures ANOVAs were conducted for each training group, with pretest and posttest differences for WM, cognitive flexibility, and processing speed abilities serving as the dependent variables. Partial eta-squares were reported as measures of effect size [70]. Partial eta-squares ranging from 0.01 to 0.06 were considered to be small, those ranging from 0.07 to 0.13 were considered to be moderate, and any value above 0.14 was considered to be a large effect [70].

3. Results

In this study, data for 95 participants are presented. Descriptive statistics for each measure are presented below in Table 1 for the Recollect training group and in Table 2 for the Sightseeing training group. Normality was approximated for the dependent variables, and no outliers were detected. Homogeneity of variance was violated, so the Greenhouse–Geisser correction was applied. One-way repeated measures ANOVAs were conducted on working memory, cognitive flexibility, and processing speed. For each training group, the pre- to posttest differences were examined. The results are presented in the following order: working memory, cognitive flexibility, and processing speed.

Table 1. Descriptive statistics for measures of working memory, cognitive flexibility, and processing speed for the Recollect training group condition.

Construct	Task	Pretest Mean (*SD*)	Posttest Mean (*SD*)
Working Memory			
	Digit Span	7.38 (2.23)	7.64 (2.55)
Cognitive Flexibility			
	Trail Making	4.52 (3.36)	5.68 (4.20)
Processing Speed			
	Coding	7.22 (2.38)	7.76 (2.61)
	Symbol Search	7.88 (2.73)	8.22 (3.26)

Note: n = 50. Standard deviations (*SD*) are provided in parentheses.

Table 2. Descriptive statistics for measures of working memory, cognitive flexibility, and processing speed for the Sightseeing training group condition.

Construct	Task	Pretest Mean (*SD*)	Posttest Mean (*SD*)
Working Memory			
	Digit Span	6.40 (1.90)	7.13 (2.05)
Cognitive Flexibility			
	Trail Making	4.76 (3.69)	5.80 (4.22)
Processing Speed			
	Coding	7.24 (3.06)	7.62 (3.11)
	Symbol Search	7.82 (2.83)	8.11 (3.26)

Note: n = 45. Standard deviations (*SD*) are provided in parentheses.

3.1. Working Memory

A one-way repeated measures ANOVA with a Greenhouse–Geisser correction was conducted for the experimental training group who completed Recollect the Study (n = 50), with the dependent variable being Digit Span scores that represent WM capacity. The results indicated that there was no significant pre- (M = 7.38) to posttest (M = 7.64) difference in the Digit Span scores for the Recollect training group ($F(1,49) = 0.91$, $p = 0.34$, $\eta^2 = 0.02$).

In addition, a one-way repeated measures ANOVA with a Greenhouse–Geisser correction was conducted for the Sightseeing training group ($n = 45$), with the dependent variable being Digit Span scores that represent WM capacity. In line with our predictions, the results show that there was a significant pre- to posttest difference in the Digit Span scores for the Sightseeing training group, such that the posttest scores (M = 7.13) were greater than the pretest scores (M = 6.40) ($F(1,44) = 5.69$, $p < 0.05$, $\eta^2 = 0.06$). The partial eta-squared value indicates a small effect.

3.2. Cognitive Flexibility

A one-way repeated measures ANOVA with a Greenhouse–Geisser correction was conducted for the experimental training group who completed Recollect the Study ($n = 50$), with the dependent variable being Trail Making task scores that represent cognitive flexibility. As predicted, the results indicated that there was a significant pre- to posttest difference in the Trail Making task scores for the Recollect training group, such that the posttest scores (M = 5.68) were greater than the pretest (M = 4.52) scores ($F(1,49) = 4.41$, $p < 0.05$, $\eta^2 = 0.08$). The eta-squared value indicates a moderate to large effect of the training intervention on the cognitive flexibility scores. Overall, for those engaging in Recollect the Study, there were significant improvements in cognitive flexibility.

Additionally, a one-way repeated measures ANOVA with a Greenhouse–Geisser correction was conducted for the Sightseeing group ($n = 45$) with the dependent variable being the Trail Making scores that represent cognitive flexibility. The results show that there was a significant pre- to posttest difference in the Trail Making scores for the Sightseeing training group, such that the posttest scores (M = 5.80) were greater than the pretest scores (M = 4.76) ($F(1,44) = 5.69$, $p < 0.05$, $\eta^2 = 0.08$). The partial eta-squared value indicates a moderate to large effect.

3.3. Processing Speed

3.3.1. Coding

A one-way repeated measures ANOVA with a Greenhouse–Geisser correction was conducted for the training group who completed Recollect the Study ($n = 50$), with the dependent variable being the Coding scores that represent processing speed. As predicted, the results indicated that there was a significant pre- to posttest difference in the Coding scores for the Recollect training group, such that the posttest scores (M = 7.76) were greater than the pretest (M = 7.22) scores ($F(1,49) = 4.57$, $p < 0.05$, $\eta^2 = 0.09$). The eta-squared value indicates a moderate to large effect of the training intervention on the processing speed scores. Overall, for those engaging in Recollect the Study, there were significant improvements in the processing speed.

Further, a one-way repeated measures ANOVA with a Greenhouse–Geisser correction was conducted for the Sightseeing training group ($n = 45$), with the dependent variable being Coding scores that represent processing speed. The results indicated that there was no significant pre- to posttest difference in the Coding scores for the Sightseeing training group, such that the posttest scores (M = 7.62) were not greater than the pretest (M = 7.24) scores ($F(1,44) = 2.60$, $p = 0.11$, $\eta^2 = 0.05$).

3.3.2. Symbol Search

A one-way repeated measures ANOVA with a Greenhouse–Geisser correction was conducted for the experimental training group who completed Recollect the Study ($n = 50$), with the dependent variable being the Symbol Search scores, which also represent processing speed. Contrary to our predictions, the results indicated that there was no significant pre- to posttest difference in the Symbol Search scores for the Recollect training group, such that the posttest scores (M = 8.22) and pretest scores (M = 7.88) did not differ ($F(1,49) = 0.69$, $p = 0.41$, $\eta^2 = 0.01$).

Moreover, a one-way repeated measures ANOVA with a Greenhouse–Geisser correction was also conducted for the Sightseeing training group (n = 45), with the dependent variable being the Symbol Search scores that represent processing speed. The results indicated that there was no significant pre- to posttest difference in the Symbol Search scores for the Sightseeing training group, such that the posttest scores (M = 8.11) and pretest scores (M = 7.82) did not differ ($F(1,44) = 0.52$, $p = 0.47$, $\eta^2 = 0.01$).

4. Discussion

A major tenet of the ideological shift that currently characterizes the field of education focuses on how to best address the learning needs of children within the school setting. Notable shifts have occurred in the recognition of a neurodiverse student population [5], with educators and other professionals acknowledging that academic support services are needed to support both children who have diagnosable learning differences as well as those who experience academic challenges that do not result in qualification for formalized services [5]. Variability in cognitive abilities is one factor that contributes to diverse learning outcomes [22,27,40,41,53], and while cognitive interventions (e.g., CCT) have been associated with increases in cognitive skills [18,34,61,62], the implementation of these interventions within the school setting has been lacking, as has a larger body of research that examines the efficacy of CCT interventions during the school day. The primary purpose of this project was to examine the efficacy of cognitive training (CCT) as an educational intervention implemented during children's time at school. This project employed two types of training, each focused on specific cognitive abilities that are significantly correlated with academic outcomes. Our results demonstrate that both training interventions produced significant improvements in working memory, cognitive flexibility, and/or processing speed among students at a school for children with learning differences. Beyond the importance of demonstrating treatment effects, this study also highlights the viability of implementing training during the school day without interrupting the academic curriculum.

4.1. Efficacy of Cognitive Training

A growing body of research has consistently demonstrated that various cognitive skills are positively correlated with successful learning outcomes [14,19,44,51]. Children who attend to the tasks given to them, retain information (e.g., reading material and assignment instructions), process class information efficiently, and plan strategies to monitor their learning and achievement tend to perform more successfully in the classroom when compared to children who do not employ these strategies [8,19–23,52]. Research has also shown that the ability to attend, retain, process, and plan has wide variability, with some students demonstrating strong skill, and others exhibiting lesser degrees of cognitive capacity, and that this variability can account for differing academic outcomes in the classroom [8,27,53]. Therefore, interventions that can be put into place to assist children who struggle with these cognitive abilities, with the goal of increasing the skills that relate to academic success, is one way to help reduce the achievement gap often seen in educational environments.

As the results of this study showed, positive changes were seen in the students' working memory, processing speed, and cognitive flexibility as a function of participation in a CCT program. For the students in the Recollect training group, significant improvements were seen in the measures of cognitive flexibility and processing speed, while their working memory did not change. The students in the Sightseeing training group experienced positive significant changes in working memory and cognitive flexibility, but not in processing speed. Although there was variation in which cognitive skills improved across the two training programs, the positive results indicate that specific abilities can be enhanced. In general, the current results are consistent with previous work documenting the effectiveness of CCT (see [32,34,62]) in enhancing attributes such as WM and EF. Although not directly addressed in the present study, these treatment effects have important implications, as some published studies have shown that improvements in cognitive skills following CCT are associated with school achievement [63–65].

It should be noted that while both intervention tools (i.e., Recollect and Sightseeing) are designed to target specific cognitive capabilities, each tool resulted in different outcomes, even for the same cognitive skills. For instance, working memory was enhanced with Sightseeing, but not with Recollect; cognitive flexibility showed improvements for both the Recollect and Sightseeing groups; and variations in processing speed were demonstrated, with the Recollect group showing higher speeds, but not the Sightseeing group. While on the surface, these mixed results seem to call into question the validity of the training programs, it is important to point out that varied findings in intervention research are not uncommon, leading some cognitive scholars to attribute this inconsistency to the lack of process pure cognitive activities [71]. In other words, given the complexity of cognitive abilities, it is highly likely that even though a cognitive measure might be designed to measure processing speed (for example), other cognitive processes (e.g., attention, inhibition, planning, and working memory) might also be simultaneously assessed [71]. Similarly, a specific CCT program does not likely target only one cognitive ability with the expectation that only the targeted skill will be improved following training. In most cases (if not all), it is likely that a CCT program is exercising multiple cognitive abilities simultaneously. Thus, training one skill is associated with improvements in other skills. For example, a CCT program might be designed to train WM, but following training, children will demonstrate greater proficiency in their attentiveness, planning ability, problem solving, and self-regulation of behavior as well. Future research should continue to work on the conceptualization and measurement of cognitive functions (see [71] for a more thorough discussion) in order to enhance the applied nature of CCT.

4.2. Implementation of Intervention during the School Day

While the enhancement of cognitive skills used in the successful completion of academic tasks is an important implication of the current results, the significance of the applied nature of the findings arguably has a deeper implication. As the education field moves toward an increased recognition that academic supports should be put in place for all learners—even when they do not quality for services—accessible intervention programs that can be integrated into the school day curriculum are needed. The current results provide evidence for such a program. While tested in a private school for children with learning differences, the model implemented in this study is one that can be executed in many school settings that serve a broad range of students who have a variety of learning needs.

Because large amounts of work conducted in the area of CCT have found successful treatment results for increasing children's cognitive abilities (see [32,34,72,73]), there is a pressing need to address how training might be meaningfully implemented within the educational setting. While successful intervention results are important, if the interventions are not accessible or easy to implement, the feasibility of the approach is questionable. Moreover, moving toward increasing the accessibility of intervention strategies within the school environment itself is critical to the applied nature of the work. This study contributes to this movement through the demonstration of an approach that bridges the gap between neuropsychology and education. That is, much of the CCT work has focused on how WM and EF deficits can be mitigated with this type of training [32,34,62]. At the same time, education scholars have highlighted the neurodiverse nature of the student population [7,74]. Further, researchers have demonstrated that cognitive skills trained by CCT can play a role in a student's successful academic achievement [63–65]. This study makes an important contribution to the literature by bringing together each of these strands of research. Students in this study participated in one of two CCT programs while at school. Further, their participation during the school day was manageable, as the 20 min period per day in which training took place resulted in successful findings without heavily interfering with time needed for other aspects of the planned curriculum.

5. Conclusions

As educators and other professionals within educational settings move toward embracing the complexity of the diverse learners with whom they work, recognition for strategies and interventions that increase successful academic outcomes for a wider number of students becomes an important focus. Broadening conceptualizations of what it means to be neurodiverse, coupled with recognizing the value of meeting students where they are (both in cognitive capacity and academic aptitude), opens the door for creating educational environments where many can thrive. Providing intervention supports that can target segments of the student population for which formalized services are not available and are carried out within a school day (thereby increasing the accessibility of supports) is a step toward meaningful educational change. Beyond the importance of demonstrating treatment effects, this study highlights the viability of implementing a cognitive training program for children with learning differences during the school day without interrupting the academic curriculum. Overall, the current project represents a potential model for how evidence-based educational interventions may be integrated into the school day to increase equitable access to school performance-supporting experiences for all students.

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